B. Sc.

Program Outcomes

1. To obtain knowledge with facts and figures related to various subjects in basic sciences such as Physics, Chemistry, Botany, Zoology, Mathematics etc.
2. To understand the fundamental concepts, principles and scientific theories related to various scientific phenomena and their relevance in daily life.
3. To acquire expertise in handling scientific instruments, planning and performing laboratory experiments with accuracy in observation and logical inferences from it.
4. To aware the faculty and students about environment and sustainability
5. To be able to think innovatively to propose novel ideas in explaining facts or providing new solution to the problems.

Department of Physics

Goals

The Department has formulated two broad educational goals for the undergraduate degree programs:

Physics Fundamentals: To build and strengthen the basic foundation of the students in Physics by having interplay between theory and experiment and to inculcate scientific enthusiasm and curiosity among them through the joy of learning.
Problem solving skills: To provide students with the tools needed to understand and then analyze problems, apply mathematical formalism and experimentation and synthesize ideas of solving them in the best possible way.

Program Specific Outcomes (PO)

Knowledge Outcome

After completing B. Sc. (Physics) Program, the student will be able to:

PO1: apply the acquired fundamental knowledge of Physics, including basic concepts and principles of 1) Newtonian Mechanics, Classical Mechanics, Optics, Electronics, Electrodynamics, Thermodynamics, Quantum Mechanics, Solid State Physics and; 2) Mathematical (analytic and numerical) Methods and Experimental Methods for Physics to have further study in different branches of Physics;

PO2: problem-solving in general and, in particular, related to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information;

PO3: demonstrate the ability to translate a physical description to a mathematical equation and conversely, explain the physical meaning of the Mathematics, represent key aspects of Physics through graphs and diagrams and use geometric arguments in problem-solving;

PO4: have numerical, computational and data-processing capabilities;

PO5: reporting and presentation skills gained from projects and seminar presentations;
PO6: to seize opportunities and to set and achieve own goals;
PO7: develop good IT skills.

Professional Skill Outcomes:

After completing B. Sc. Physics Program, the students will be able to:

PO8: apply and demonstrate knowledge of the basic concepts of Physics to analyze a wide variety of physical phenomena;
PO9: demonstrate knowledge and understanding of essential facts, concepts, principles and theories;
PO10: demonstrate one's laboratory skills, enabling them to take measurements in the Physics laboratory and analyze the measurements to draw valid conclusions;
PO11: have oral and written scientific communication and will prove that they can think critically and work independently;
PO12: communicate effectively using different techniques, reports and presentations within a scientific environment;
PO13: respond effectively to unfamiliar problems in scientific contexts;
PO14: plan, design, execute and report the results of a complex extended experiment or investigation, using appropriate methods to analyze data and to evaluate the level of its uncertainty;
PO15: integrate and apply one's skills to study different branches of Physics;
PO16: ability to interact with other people and to engage in team-working;
PO17: ability to plan and implement efficient and effective modes of working;
PO18: to work well with others in order to achieve a common objective;
PO19: to have an academic group project work, to work in a committee;
PO20: to work with others to organize an event, being part of a team in a job;
PO21: to handle change and adapt to new situations

Generic Competencies Outcomes:

After completing B. Sc. Physics Program, the students will be able to:

PO22: work comfortably with numbers and analyzing an issue quantitatively;
PO23: acquire knowledge effectively by self-study and work independently;
PO24: present information in a clear, concise and logical manner and apply appropriate analytical and approximation methods.

Attitude/Value Outcomes:

After completing B. Sc. Physics Program, the student should have developed some positive attitudes and will have:

PO25: willingness to take up responsibility in study and work;
PO26: confidence in his/her capabilities;
PO27: capacity to work effectively in a team;
PO28: motivation for learning and experimentation.

Scientific Outcomes

After completing B. Sc. Physics, students will be able to:

PSO1: demonstrate and understanding of principles and theories of physics. These include: Newtonian Mechanics, Thermodynamics, Electrodynamics, Atomic and Molecular Physics, Electronics, Optics, Nuclear Physics, Quantum Mechanics;

PSO2: apply vector algebra, differential and integral calculus as well as graphical methods to solve problems;

PSO3: demonstrate ability to apply knowledge learned in classroom to set and perform simple laboratory experiments;

PSO4: solve problems using the appropriate methods in mathematical, theoretical and computational Physics.

Course Outcomes

F. Y. B. Sc.

Course: Vector analysis (PH – 101)

After successfully completing this course, the student will be able to:

CO1: understand the difference between vectors and scalars, combinations of vectors, their products and solve Physics problems using them;

CO2: study vector and scalar fields and functions along with their properties;

CO3: understand the concept of scalar and vector operators;

CO4: study gradient, divergence and curl and their examples;

CO5: be familiar with some vector identities and verify them which will be useful to them in the study of Electrodynamics and Plasma Physics.

Course: Force and Newton's Laws (PH – 101)

After successfully completing this course, the student will be able to:

CO1: understand Newton's laws of motion in detail;

CO2: use knowledge of Newton's laws and equations of motion to solve problems;

CO3: study law of conservation of momentum and its applications;

CO4: understand uniform circular motion and relative motion.

Course: Momentum and System of Particles (PH – 101)

After successfully completing this course, the student will be able to:

CO1: obtain knowledge of collision and its types; study some real life examples of collisions;

CO2: establish relations between linear and angular variables.

Course: Elasticity (PH – 101)

After successfully completing this course, the student will be able to:

CO1: understand one of the basic properties of a material: elasticity, stress and strain, difference between stress and pressure;

CO2: study Hooke's law and various types of moduli;

CO3: establish relations among elastic constants and problems based on them.

Course: Electrostatics I (PH – 102)

After successfully completing this course, the student will be able to:

CO1: understand Coulomb's law and its applications;

CO2: study some basic quantities such as field, electric field, flux, electric flux etc.;

CO3: understand Gauss's law for electrostatics and its applications for some specific charge distributions;

CO4: solve numerical problems based on Coulomb's law, principle of superposition and Gauss's law.

Course: Electrostatics II (PH – 102)

After successfully completing this course, the student will be able to:

CO1: study electrostatic potential and potential energy;
CO2: establish relationship between electric field and electrostatic potential;
CO3: discuss equi-potential surfaces and their significance;
CO4: understand electric current and emf;
CO5: do some circuit analysis and analysis of RC circuit.

Course: Diode Circuits (PH – 102)

After successfully completing this course, the student will be able to:

CO1: study transformer and rectification;
CO2: understand half-wave rectifier, full-wave rectifier and full-wave bridge rectifier along with their parameters;
CO3: study necessity of filter circuits and understand different types of filters;
CO4: discuss clippers, clampers and limiters.

Course: Optics (PH – 102)

After successfully completing this course, the student will be able to:

CO1: understand the basic nature of light;
CO2: study Fermat's principle and use it to establish laws of reflection and those of refraction;
CO3: study lens, lens system and cardinal points of a lens system;
CO4: use mathematical analysis to obtain properties of image, formed by combination of lenses and apply theory of optics to calculate the cardinal points of an optical system
CO5: establish Newton's formula of a lens and study its uses;
CO6: study aplanatic points and aplanatic surfaces;
CO7: study combination of two thin lenses and its cardinal points.

Course: Angular Momentum and Gravitation (PH – 201)

After successfully completing this course, the student will be able to:

CO1: understand rotational motion in detail along with its properties;
CO2: study torque and moment of inertia, relation between them, significance of moment of inertia, their applications and real life problems related to it;
CO3: understand the concept of angular momentum;
CO4: discuss the case of spinning top;
CO5: understand Newton's law of gravitation, gravitation near the earth's surface,
CO6: study gravitational field and gravitational potential.

Course: Oscillations and Waves (PH – 201)

After successfully completing this course, the student will be able to:

CO1: have basic ideas of oscillations and oscillatory motion, waves and its classification;
CO2: use knowledge of superposition principle to analyze the combinations of SHOs;
CO3: study law of conservation of momentum and its applications;
CO4: understand various wave properties.

Course: Particle Properties of Waves (PH – 201)

After successfully completing this course, the student will be able to:

CO1: study blackbody radiation and photoelectric effect, obtain their experimental results;

CO2: discuss dual nature of light;
CO3: study X-rays, their production, their properties and diffraction of X-rays;
CO4: discuss Compton Effect and establish particle nature of radiation;
CO5: study pair production and mass-energy relation.

Course: Elasticity (PH – 201)
After successfully completing this course, the student will be able to:
CO1: understand twisting of a cylinder, torsional pendulum and related problems;
CO2: study bending of a beam and a cantilever, to discuss real world problems of beams/ cantilevers;
CO3: determine elastic constants by Searle's method.

Course: Magneto-statics and Electromagnetic Induction (PH – 202)
After successfully completing this course, the student will be able to:
CO1: study the basics of magnetism;
CO2: study force on a moving charge and solve problems based on it;
CO3: understand torque on a current carrying loop;
CO4: Faraday's experiments on electromagnetic induction;
CO5: understand Faraday's and Lenz's law;
CO6: study motional *emf* and its applications;
CO7: understand the working of generator and motor.

Course: Thermodynamics (PH – 202)
After successfully completing this course, the student will be able to:
CO1: study the basic ideas such as that of temperature, thermal equilibrium, thermal expansion, pressure, mean free path and entropy;
CO2: discuss ideal gas and its equation;
CO3: discuss laws of thermodynamics;
CO4: change in entropy during various processes;
CO5: understand the efficiency of heat engines.

Course: Special purpose Diodes and BJTs (PH – 202)
After successfully completing this course, the student will be able to:
CO1: study the basic ideas of construction and working of special purpose diodes;
CO2: understand characteristics of zener diode and its application as a voltage regulator;
CO3: study the basic ideas of construction of transistors and its biasing;
CO4: discuss characteristics of transistors.

Course: Optics (PH – 202)
After successfully completing this course, the student will be able to:
CO1: understand the wave nature of light based on Huygens' theory;
CO2: study recti-linear propagation of light;
CO3: apply superposition principle to the waves of light;
CO4: study coherence, interference of light and diffraction of light;
CO5: obtain intensity distribution on the screen because of two waves of light under different conditions;
CO6: understand single-slit diffraction pattern.

Course: Physics Practical
After successfully completing this course, the student will be able to:
CO1: demonstrate an ability to collect data through observation;
CO2: acquire technical skills in using laboratory equipment, tools and materials;

CO3: experimentation and interpretation of data;
CO4: demonstrate an understanding of laboratory procedures using scientific methods;
CO5: demonstrate a deeper understanding of the basic concepts and theories gained by experiencing and visualizing them as authentic phenomena;
CO6: acquire complementary skills of collaborative learning and teamwork in the laboratory work.

S. Y. B. Sc.

Course: Kinetic theory of gases (PH – 303)
After successful completion of the course the student will be able to:
CO1: understand how statistics of the microscopic world can be used to explain the thermal features of the macroscopic world;
CO2: use thermal and statistical principles in a wide range of applications.
.

Course: Damped Oscillations (PH – 303)
After successful completion of the course the student will be able to:
CO1: have basic concepts of oscillations, SHM and damping;
CO2: obtain equation of motion of damped harmonic oscillator;
CO3: discuss various parameters associated with damped harmonic oscillator.

Course: Forced Oscillations (PH – 303)
After successful completion of the course the student will be able to:
CO1: study forced harmonic oscillator and resonance;
CO2: obtain equation of motion of forced harmonic oscillator;
CO3: discuss various parameters associated with forced harmonic oscillator;
CO4: understand Q-factor and sharpness of resonance;
CO5: study resonance in LCR circuit.

Course: Charged Particles in Electromagnetic Fields (PH – 303)
After successful completion of the course the student will be able to:
CO1: understand the behavior of charged particles in a crossed electric and magnetic fields;
CO2: understand the construction and working of the mass spectrograph and electron microscope.

Course (PH304): Wave Properties of Particles (PH – 304)
After successful completion of the course the student will be able to:
CO1: have basic concepts of the wave-particle duality of matter and radiation;
CO2: study de Broglie's theory and the concept of photon, along with its properties;
CO3: establish an equation of a wave and its differential equation;
CO4: have understanding of phase velocity and group velocity – the velocity with which matter waves propagate;
CO5: study of experimental confirmation of wave nature of particle by particle diffraction;
CO6: understand behavior of a particle confined to one-dimensional box which will effectively lead to further strengthen the basic concepts Quantum Mechanics;
CO7: describe uncertainty principle and its applications.

Course: Atomic Structure (PH – 304)

After successful completion of the course the student will be able to:

- **CO1:** revise the old atomic models;
- **CO2:** outline the basic structure of an atom and the concept of nucleus;
- **CO3:** explain the origin of atomic spectra;
- **CO4:** classify the atomic spectra;
- **CO5:** have a basic understanding of atomic orbits and quantized energy levels of electrons in an atom through the study of Bohr's atomic model;
- **CO6:** understand the correspondence principle;
- **CO7:** study the basic idea of nucleus;
- **CO8:** have basic concepts of absorption, spontaneous emission and stimulated emission
- **CO9:** study production and properties of laser.

Course: Fraunhofer Diffraction (PH – 304)

After successful completion of the course the student will be able to:

- **CO1:** revisit the wave nature of light, the concept of wave-front, Huygens' Principle, diffraction of light and types of diffraction;
- **CO2:** understand diffraction of light by a circular aperture;
- **CO3:** study resolving powers of various optical instruments;
- **CO4:** explain the construction of diffraction grating;
- **CO5:** establish the theory of transmission grating for different ways of incident light and solve problems based on it;
- **CO6:** study X-ray diffraction and Bragg's law.

Course: Aberrations (PH – 304)

After successful completion of the course the student will be able to:

- **CO1:** outline the basic idea of aberrations produces in the image using monochromatic light and white light;
- **CO2:** describe optical aberrations produced in image by lenses and methods;
- **CO3:** find methods of the removal of these aberrations;
- **CO4:** design eyepieces free from aberrations which can then be used in microscopes and telescopes;
- **CO5:** solve problems based on the phenomenon of aberration of light.

Course (PH305): Complex Variable (PH – 305)

After successful completion of the course the student will be able to:

- **CO1:** redefine complex number and its complex conjugate, learn graphical representation of complex numbers;
- **CO2:** understand functions of complex variables and analytical functions;
- **CO3:** establish Cauchy-Riemann conditions;
- **CO4:** study some special integrals;
- **CO5:** understand Cauchy's theorem, Cauchy's integral formula and Cauchy's residue theorem;
- **CO6:** solve problems using complex algebra and complex calculus.

Course: Thermoelectricity (PH – 305)

After successful completion of the course the student will be able to:

- **CO1:** outline the basic idea of thermo-electricity and thermos-emf;
- **CO2:** study Seeback effect, Peltier effect, Thomson effect and their applications;
- **CO3:** discuss thermos-couple, thermopile and bolometer**.**

Course: Transistor Biasing and AC Models (PH – 305)

After successful completion of the course the student will be able to:

CO1: outline the voltage and current sources, network theorems and network analysis;
CO2: understand the load line and Q-point;
CO3: describe different types of biasing and their comparison;
CO4: explain amplifiers and amplification, small-signal operation of amplifiers;
CO5: understand two-transistor model.

.

Course: Voltage and Power Amplifiers (PH – 305)

After successful completion of the course the student will be able to:

CO1: outline the basic concept of gain in an amplifier;
CO2: understand multistage amplifiers and swamped amplifiers;
CO3: get the concept of feedback in the circuits;
CO4: describe class A, class B and class C amplifiers;
CO5: study transistor power rating.

Course: Thermodynamic relations, free energies and Thermodynamic equilibrium (PH – 403)

After successful completion of the course the student will be able to:

CO1: have basic concepts of the thermodynamic variables and their classification;
CO2: study Maxwell's thermodynamic variables and Maxwell's thermodynamic relations;
CO3: solve problems using TdS equations and laws of thermodynamics;
CO4: study Gibbs-Helmholtz equation;
CO5: study various thermodynamic processes;
CO6: discuss Gibbs phase rule.

Course: Production of low temperatures (PH – 403)

After successful completion of the course the student will be able to:

CO1: discuss Ordinary methods of cooling;
CO2: understand adiabatic cooling;
CO3: study Joule-Thomson effect and Joule-Kelvin effect: An isenthalpic process;
CO4: understand adiabatic demagnetisation;
CO5: study third law of thermodynamics its consequences.

Course: Crystal Structure (PH – 403)

After successful completion of the course the student will be able to:

CO1: understand the Periodic array of atoms;
CO2: describe fundamental type of lattices;
CO3: understand index system for crystal planes;
CO4: describe simple crystal structure and direct imagining of atomic structure and non-ideal crystal structure;
CO5: explain diffraction of waves by crystals;
CO6: describe Brillouin zones.

Course: Crystal Vibrations (PH – 403)

After successful completion of the course the student will be able to:

CO1: study vibrations of crystals with monoatomic bases;
CO2: understand two atoms per primitive bases.

Course: Quantum Mechanics (PH – 404)

After successful completion of the course the student will be able to:

CO1: get some flavor of Quantum Mechanics;
CO2: distinguish Classical Mechanics and Quantum Mechanics;
CO3: get the concept of wave function of a particle and its properties;
CO4: establish time-dependent Schrodinger's Equation and its steady state form;
CO5: obtain expectation value of an observable within the given interval;
CO6: understand the significance of operators of some physical quantities/ observables in Quantum Mechanics.

Course: Quantum Mechanics (PH – 404)

After successful completion of the course the student will be able to:

CO1: establish time-dependent Schrodinger's Equation and its steady state form;
CO2: use Schrodinger's Equation for solving problems of particle in a box finite potential and harmonic oscillator;
CO3: understand tunnel effect based on Schrodinger's Equation and its solution.

Course: Polarization and Double Refraction (PH – 404)

After successful completion of the course the student will be able to:

CO1: define unpolarized and polarized light, polarization of light, polarizers;
CO2: study various methods of polarizing an unpolarized light;
CO3: understand and study applications of fundamental laws associated with polarization of light: Brewster's Law and Malus' Law;
CO4: have an understanding of optical activity and specific rotation and real life problems.

Course: Lasers: An Introduction and Optical Fiber Basics (PH – 404)

After successful completion of the course the student will be able to:

CO1: outline the importance of coherence in optical phenomena;
CO2: describe different types of coherence and the factors affecting it;
CO3: understand the concept of stimulated emission on the basis of Einstein's theory;
CO4: define absorption, spontaneous emission and stimulated emission processes and describe lasing action through EDFA;
CO5: generate different types of Lasers;
CO6: study properties and applications of Laser
CO7: outline the phenomena such as reflection, refraction, total internal reflection and interference of light;
CO8: study the structure of optical fiber, its significance in context to communication.

Course: Fourier series (PH – 405)

After successful completion of the course the student will be able to:

CO1: outline the harmonic functions, odd and even functions and their expansion as Fourier series;
CO2: establish Dirichlet's condition for the function to be Fourier expandable;
CO3: solve problems and obtain Fourier series of some definite harmonic functions;
CO4: discuss properties and advantages of Fourier series.

Course: AC bridges (PH – 405)

After successful completion of the course the student will be able to:

CO1: study phase analysis in ac circuits containing different combinations of components;
CO2: do mathematical analysis of balancing an ac bridge having arms containing circuit components such inductor, resistor, capacitor etc;
CO3: study different ac bridges and their applications.

Course: Emitter Follower (PH – 405)

After successful completion of the course the student will be able to:

CO1: have basic idea of CC amplifier and its parameters;
CO2: study Darlington connections;
CO3: understand Class B push-pull emitter follower;
CO4: describe Class B amplifiers;
CO5: discuss voltage regulation.

Course: JFETs (PH – 405)

After successful completion of the course the student will be able to:

CO1: distinguish between BJT and FET;
CO2: study FET, JFET, MOSFET and their parameters;
CO3: discuss FET amplifiers and its applications.

Course: Physics Practical (PH – 406)

After successfully completing this course, the student will be able to:

CO1: demonstrate an ability to collect data through observation;
CO2: use various instruments and equipments used in the laboratory;
CO3: design an experiment to test a hypothesis and/or determine the value of some unknown physical quantity;
CO4: set up experimental equipment to implement an experimental approach;
CO5: describe the methodology of science and the relationship between observation and theory;
CO6: obtain and analyze data, plot appropriate graphs and reach conclusions from the data analysis;
CO7: work in a group to plan, implement and report on a project/experiment;
CO8: keep a well-maintained and instructive laboratory record book;
CO9: express their knowledge and ideas through oral and written language.

T. Y. B. Sc.

Course (PH5006): Mechanics

After successful completion of the course the student will be able to:

CO1: define periodic motion and oscillatory motion along with examples;
CO2: setup and solve differential equations for simple harmonic oscillations, damped harmonic oscillations and forced oscillations;
CO3: understand the factors affecting simple harmonic motion;
CO4: describe oscillatory motion with graphs and equations and use these descriptions to solve problems of oscillatory motion;
CO5: discuss phenomenon of resonance and discuss it for various cases;
CO6: analyze the forces on the object and apply them in calculations of the motion of simple systems using the free body diagrams;
CO7: determine whether use of law of conservation of energy or law of conservation of momentum would be more appropriate for solving a dynamics problem;
CO8: solve advanced problems involving the dynamic motion of classical mechanical systems with an intermediate knowledge of Newton's laws of motion;
CO9: apply the concept of center of mass and mechanics of system of particles and conservation of energy, linear and angular momentum to solve dynamics problems;

CO10: demonstrate an intermediate knowledge of central-force motion and the concept of converting two body problems to single body problem and apply advanced methods to complex central-force motion problems;
CO11: demonstrate an intermediate knowledge of concept of laboratory frame and center of mass frame and their use to calculate results of scattering experiments;
CO12: understand generalized coordinates and their physical significance;
CO13: limitation of Newton's laws of motion which will in turn help one while solving problems;
CO14: deduce Lagrange's equation using different methods;
CO15: correlate Hamilton's principle, de Alembert's principle and Newton's laws of motion which consequently help one when one tries to solve problems of mechanics.

Course (PH5006): Mathematical Methods

After successful completion of the course the student will be able to:

CO1: define field and its types based on its directional properties;
CO2: establish and verify vector identities which find applications in almost all branches of Physics;
CO3: outline the basic concept of curvilinear coordinates and different coordinate systems;
CO4: deduce the expressions for gradient, divergence, curl and Laplacian in Cartesian coordinate system, spherical polar coordinate system and cylindrical coordinate system;
CO5: learn and use vector calculus in solving problems;
CO6: study basic theorems such as Gauss divergence theorem, Stokes' theorem and Green's theorem which find applications in many branches of Physics, particularly in the field of electrodynamics;
CO7: develop problem-solving skills and also determine strategies to solve unfamiliar problems.

Course (PH5007): Electromagnetism

After successful completion of the course the student will be able to:

CO1: understand the behavior of conductors and dielectrics in the presence of an external electric field;
CO2: study polarization of dielectrics, resulting into surface and volume charge densities;
CO3: have understanding of displacement field in the dielectric and its importance in the construction and working of a capacitor;
CO4: modify Gauss' law in the presence of dielectric and in turn derive electric field due to the given charge distribution;
CO5: study variation in electric field at the interface of two dielectrics;
CO6: outline the inter-relationship between electric field and magnetic field – how one can be used to produce the other;
CO7: study the phenomenon of electromagnetic induction and its applications;
CO8: produce motional *emf* in a close loop by various methods;
CO9: define self-induction and mutual-induction and study large number of applications of them;
CO10: understand basic properties of plasma – the fourth state of matter;
CO11: study inter-linking between the behavior of plasma and fluid by doing mathematical analysis treating plasma as a fluid and then using laws of hydrodynamics;
CO12: define magnetic pressure and its effect on plasma;
CO13: confinement of plasma using magnetic field;
CO14: study instabilities generated in plasma when one tries to confine it using magnetic field.

Course (PH5007): Optics

After successful completion of the course the student will be able to:

CO1: outline the phenomena such as reflection, refraction, total internal reflection and interference of light;

CO2: study the structure of optical fiber, its significance in context to communication;

CO3: define various parameters of optical fiber useful while employing it for a specific purpose;

CO4: list advantages of using optical fibers;

CO5: study fringes of equal inclination and its physical significance;

CO6: understand the working and uses of interferometers, such as Michelson's interferometer and Febry-Perot interferometer.

Course (PH5008): Atomic Physics

After successful completion of the course the student will be able to:

CO1: revise the old atomic models;

CO2: outline the basic structure of an atom and the concept of nucleus;

CO3: explain the origin of atomic spectra;

CO4: classify the atomic spectra;

CO5: have a basic understanding of atomic orbits and quantized energy levels of electrons in an atom through the study of Bohr's atomic model;

CO6: explain the spectral series emitted by hydrogen atoms;

CO7: apply Schrodinger's equation to the simplest possible atom – hydrogen atom;

CO8: extend the concepts of probability (of finding a particle) and (finding) expectation value (of an observable using wave function): the two pillars of Quantum Mechanics;

CO9: compare theoretical data with experimental values of observables;

CO10: understand how naturally quantum numbers get in when one solves Schrodinger's equation;

CO11: come to about the importance of quantum numbers in quantizing certain physical quantities;

CO12: determine the characteristics of atomic spectra.

Course (PH5008): Nuclear physics and cosmic rays

After successful completion of the course the student will be able to:

CO1: outline various methods of detection of fundamental particles;

CO2: classify nuclear radiations and elementary particles;

CO3: understand the significance of detection and study of these fundamental particles;

CO4: define threshold voltage, dead time and recovery time in GM counter, threshold energy, nuclear fission, nuclear fusion, critical size, critical mass;

CO5: determine the basic properties of nucleus;

CO6: study the necessity of particle accelerators in High Energy Physics;

CO7: classify particle accelerators in various ways;

CO8: understand construction, working and limitations of particle accelerators so that one can decide its usefulness depending upon the application;

CO9: come to know about the origin of cosmic rays and their properties;

CO10: decide the effects of cosmic rays.

Course (PH5009): Statistical Mechanics

After successful completion of the course the student will be able to:

CO1: outline of digital electronics, basic logic gates, Boolean algebra, truth table and Boolean notation;

CO2: study universal gates and their applications.

Course (PH5009): Relativity

After successful completion of the course the student will be able to:

CO1: outline of digital electronics, basic logic gates, Boolean algebra, truth table and Boolean notation;

CO2: study universal gates and their applications.

Course (PH5010): Instruments

After successful completion of the course the student will be able to:

CO1: study of electron microscope and its application, properties of positive rays;

CO2: outline various methods for positive ray analysis, Thomson's parabola method and discovery of stable isotopes;

CO3: construction and working of Aston's mass spectrograph, Dempter's mass spectrograph and Bainbridge mass spectrograph;

CO4: come to know about binding energy, mass defect and packing fraction;

CO5: outline spectroscopy of visible region; understand instrumentation for ultraviolet spectroscopy.

Course (PH5010): Digital Electronics

After successful completion of the course the student will be able to:

CO1: outline of digital electronics, basic logic gates, Boolean algebra, truth table and Boolean notation;

CO2: study universal gates and their applications;

CO3: understand methods of writing Boolean expressions for the given logic table/circuit;

CO4: use de Morgan theorems to simplify the given complicated Boolean expression and thereby reduce the number of components required to execute it in a circuit;

CO5: learn methods of reducing complex Boolean expressions using K-maps;

CO6: construct digital circuits for carrying out mathematical operations, such circuits have variety of applications.

Course (PH5011): Numerical Analysis

After successful completion of the course the student will be able to:

CO1: explain errors and their computations;

CO2: able to derive a general error formula;

CO3: understand errors in a series approximation;

CO4: define algebraic equation and polynomials;

CO5: know different method to solve algebraic equation;

CO6: explain bisection method and false position method to solve algebraic equation;

CO7: explain the iteration method Newton-Raphson method to solve algebraic equation;

CO8: define interpolation and understand different types of interpolation;

CO9: come to know about errors in polynomial interpolation;

CO10: outline various operators and their uses to derive different polynomials;

CO11: understand Newton's difference formulation and solve the algebraic equation;

CO12: explain Lagrange interpolation and Lagrange inverse interpolation;

CO13: understand the difference between Lagrange interpolation and Lagrange inverse interpolation;

CO14: come to about errors in different formulation.

Course (PH5011): Material Science

After successful completion of the course the student will be able to:

CO1: explain outstanding properties of metals;
CO2: understand assumptions for classical free electron theory for electron and explain concept of the theory;
CO3: understand drawbacks of classical free electron theory, explain electric conductivity, thermal conductivity and expression for electric conductivity using classical theory;
CO4: explain Weidmann Franz law and deduce it using classical free electron theory;
CO5: define and explain terms mobility, drift velocity, mean free path, collision time and relaxation time;
CO6: define and explain terms magnetic permeability, magnetization and susceptibility;
CO7: understand difference between different type of magnetic material e.g., diamagnetic material, paramagnetic, ferromagnetic;
CO8: explain properties of diamagnetic material; understand classical theory for diamagnetism;
CO9: explain properties of paramagnetic material; understand Weiss theory for paramagnetism;
CO10: explain properties of ferromagnetic material, domain model;
CO11: know history of superconductivity, mechanism of superconductors;
CO12: explain effects of magnetic field, ac resistivity, critical current, penetration depth in context to superconductors;
CO13: explain type I and type II superconductors;
CO14: understand flux exclusion: the Meissner effect for superconductors;
CO15: understand potential applications of superconductors.

Course (Generic Elective): Electronics

After successful completion of the course the student will be able to:

CO1: design, build and verify different types of amplifiers and oscillators;
CO2: use FET as difference amplifiers;
CO3: use such circuits in communication;
CO4: study modulators and demodulators.

Course (PH6006): Mechanics

After successful completion of the course the student will be able to:

CO1: revisit the definition of motion and Newton's laws of motion to understand the physical significance of frame-of-reference and their types;
CO2: analyze the motion of an object in a rotating coordinate system which ultimately leads to Coriolis force;
CO3: learn rotation of the earth through Foucault's pendulum;
CO4: redefine rigid body, rotational motion, moment of inertia and angular momentum;
CO5: establish the law of conservation of angular momentum and study its physical significance through some examples;
CO6: mathematically derive expressions for inertia tensor and principal axes of the body;
CO7: derive Euler's equations of motion and Euler's angles;
CO8: study the motion of symmetrical top in depth.

Course (PH6006): Mathematical Methods

After successful completion of the course the student will be able to:

CO1: outline the harmonic functions, odd and even functions and their expansion as Fourier series;
CO2: establish Dirichlet's condition for the function to be Fourier expandable;
CO3: solve problems and obtain Fourier series of some definite harmonic functions;
CO4: redefine complex number and its complex conjugate;

CO5: learn graphical representation of complex numbers;
CO6: study various mathematical operations of complex numbers;
CO7: understand functions of complex variables and analytical functions;
CO8: establish Cauchy-Riemann conditions;
CO9: solve problems using complex algebra and complex calculus.

Course (PH6007): Electromagnetism

After successful completion of the course the student will be able to:

CO1: classify materials based on their magnetic properties;
CO2: study how to magnetize an unmagnetized substance, such substances have many applications;
CO3: study the origin of magnetic field in a substance;
CO4: effect of magnetic field on diamagnetic, paramagnetic and ferromagnetic substances;
CO5: study hysteresis cycle of a ferromagnetic substance;
CO6: signify the work of Maxwell by studying displacement current;
CO7: analyze Maxwell's equations in different media;
CO8: understand the nature and the properties of electromagnetic waves;
CO9: mathematically understand propagation of energy during the propagation of electro-magnetic waves;
CO10: obtain plane wave solution of Maxwell's equations.

Course (PH6007): Optics

After successful completion of the course the student will be able to:

CO1: outline the importance of coherence in optical phenomena;
CO2: describe different types of coherence and the factors affecting it;
CO3: understand the concept of stimulated emission on the basis of Einstein's theory;
CO4: define absorption, spontaneous emission and stimulated emission processes and describe lasing action through EDFA;
CO5: generate different types of Lasers;
CO6: study properties and applications of Laser.

Course (PH6008): Atomic Physics

After successful completion of the course the student will be able to:

CO1: define vector atom models and quantum numbers required to study it;
CO2: outline the basic coupling schemes of spin and orbital motions of electrons in an atom and obtain the outcome as a result;
CO3: understand the distribution of electrons in different shells and sub-shells in the atoms of the elements using Pauli's exclusion principle, prepare electron configuration in them and ultimately construct the periodic table;
CO4: calculate quantum state of electrons in an atom and establish spectral notation;
CO5: understand the origin of magnetic field of an atom by examining the orbital and spin motions of electrons it;
CO6: have experimental confirmation of spin motion of electron by studying Stern-Gerlach experiment;
CO7: understand how one gets optical spectra;
CO8: study effect of magnetic field on spectral lines (Zeeman Effect) and that of electric field on them (Stark Effect);
CO9: obtain an expression for Zeeman shift through classical and quantum mechanical theories.

Course (PH6008): Radioactivity

After successful completion of the course the student will be able to:

CO1: outline the history of radioactivity and radioactive radiations;
CO2: describe various properties of radioactive radiations;
CO3: obtain parameters of radioactive radiations;
CO4: classify elementary particles;
CO5: discuss fundamentals interactions, responsible for all the phenomena observed in nature;
CO6: understand how symmetry is related to quantum numbers of elementary particles;
CO7: explain the internal structures of elementary particles based on quark model.

Course (PH6009): Statistical Mechanics

After successful completion of the course the student will be able to:

CO1: outline of digital electronics, basic logic gates, Boolean algebra, truth table and Boolean notation;
CO2: study universal gates and their applications.

Course (PH6009): Relativity

After successful completion of the course the student will be able to:

CO1: outline of digital electronics, basic logic gates, Boolean algebra, truth table and Boolean notation;
CO2: study universal gates and their applications.

Course (PH6010): Instruments

After successful completion of the course the student will be able to:

CO1: outline exhaust pump and their characteristic, study of rotary oil pump;
CO2: explain construction and working of diffusion and molecular pump;
CO3: outline various methods for low pressure measurement; learn construction of Mcleod gauge;
CO4: use of thermocouple, pirani and ionization gauge for low pressure measurement;
CO5: explain construction and working of Knudsen Gauge.

Course (PH6010): Digital Electronics

After successful completion of the course the student will be able to:

CO1: outline of digital electronics, basic logic gates, Boolean algebra, truth table and Boolean notation;
CO2: study universal gates and their applications;
CO3: understand methods of writing Boolean expressions for the given logic table/circuit;
CO4: use de Morgan theorems to simplify the given complicated Boolean expression and thereby reduce the number of components required to execute it in a circuit;
CO5: learn methods of reducing complex Boolean expressions using K-maps;
CO6: construct digital circuits for carrying out mathematical operations, such circuits have variety of applications.

Course (PH6011): Astrophysics and Cosmology

After successful completion of the course the student will be able to:

CO1: describe the science of cosmology and its relation to other fields of science, identify and describe cosmology's current unanswered questions, explain how the scientific method and quantitative arguments are used in cosmology;
CO2: define light year, astronomical unit, describe the Cosmological Principle and its consequences, describe the observational evidence for the expanding universe;

CO3: define red-shift and Hubble constant, explain Hubble's Law and interpret a Hubble diagram, describe the relation between the expansion rate of the universe and its age;
CO4: define dark matter; explain observational evidence for dark matter;
CO5: explain how general relativity is used in understanding the structure and evolution of the universe, identify the four fundamental forces and describe their role in the past and present universe;
CO6: define and explain Cosmic Microwave Background Radiation, give the relationship between time, average energy, and temperature in the universe, explain the concept of thermal equilibrium and its importance in cosmology, describe what happened (and approximate timescales) for the various eras in the early universe;
CO7: explain what is meant by Big Bang theory and list some evidence for it, define nucleus, element, isotope, list and correctly order the most abundant elements in the universe and explain where and how these elements are formed, describe how the abundances of elements changes with time;
CO8: explain how the possible fates of the universe relate to the matter and energy densities.

Course (PH6011): Programing in C

After successful completion of the course the student will be able to:

CO1: define types of programming languages and their uses, basic idea of flow chart;
CO2: gain basic competency with numerical constants, define operators and expression in C-programming;
CO3: explain arithmetic operators and modes of expression, defining constants and declaring variable names;
CO4: present arithmetic conversion, assignment expression and increment decrement statement;
CO5: describe input and output statement, conditional statement and loops;
CO6: implement numerical algorithms into C-program and visualize the results of the computations.

Course (Generic Elective): Electronics

After successful completion of the course the student will be able to:

CO1: understand how the revolution in Electronics happened from discrete components to ICs;
CO2: study Op Amp (IC-741), timer IC (IC-555) and their applications.

Course: Physics Practical

After successful completion of the course the student will be able to:

CO1: describe the underlying theory of experiments in the course;
CO2: perform derivations of theoretical models of relevance for the experiments in the course;
CO3: follow instructions to perform laboratory experiments in Optics, Thermo-dynamics, Mechanics, Modern Physics, Electronics and Electromagnetism;
CO4: document their results, using correct procedures and protocols;
CO5: perform a quantitative analysis of experimental data including the use of computational and statistical methods where relevant;
CO6: interpret relationships in graphed data and develop an intuition for alternative plotting methods and communicate results from laboratory experiments, orally or in a written laboratory report;
CO7: calculate permissible standard error in any physics experiment;
CO8: derive conclusions from the analysis of own data;

CO9: assess the language used to describe physics experiments and how it can alter perceptions of the method and results.

Department of Chemistry

Goals

The Bachelor of Science Degree in Chemistry intended for students who are primarily interested in careers as professional chemists or wish a thorough grounding in chemistry.
This three years' undergraduate program prepares students by developing knowledge base in theory as well as expertise in experimental science.
Because South Gujarat is famous Chemical Industrial Zone, the main objective of this course is to increase the job opportunity of the students by preparing them with the experimental and theoretical aspects of this continuously evolving subject.

Program Outcomes (PO)

PO-1: Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Organic, Inorganic, Physical and Analytical Chemistries.

PO-2: To develop critical thinking, students carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO-3: Students will be skilled in independent problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO-4: Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

PO-5: Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, environment, health and medicine.

PO-6: To inculcate the scientific temperament in the students and outside the scientific community.

PO-7: To develop skills in the proper handling of apparatus and chemicals. To be exposed to the different processes used in industries and their applications.

Program Specific Outcomes (PO)

After successful completion of the course the student will be able to:

PSO-1: have sound knowledge about the fundamentals and applications of chemical and scientific theories;

PSO-2: demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the subject;

PSO-3: acquire technical skills required for synthesis, Identification and structural characterization of chemical compounds;

PSO-4: apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories. Handling of basic equipments, acquiring technical skills accurately and effectively communicate scientific ideas in graphic oral and written form;

PSO-5: be familiar with the different branches of chemistry like analytical, organic, inorganic, physical, environmental and polymer;
PSO-6: gain knowledge to correlate Chemistry with other disciplines of science;
PSO-7: help in understanding the causes of environmental pollution and can open up new methods for environmental pollution control;
PSO-8: develop analytical skills and problem solving skills requiring application of chemical principles.

F. Y. B. Sc.

Sem I Paper-I: Physical and Inorganic Chemistry

At the end of the course, student will be able to

CO-1: define noble gases, clathrate compounds, atomic size, atomic radii, ionic radii, ionization energy, electron affinity, electro-negativity and diagonal relationship of s-block elements, nuclear charge, Lewis acid and base, Lowry Bronsted acid-base, hard soft acid-base;
CO-2: discuss electronic configuration of noble gas, composition of clathrate compounds, bonding in clathrate compounds, co-ordination clathrate compounds, fluorides of xenon, uses of vanadium metal, properties of vanadium metal, properties of s-block elements, importance of metal ion of s-block elements in bio system, historical perspective of atomic structure, Rutherford's atomic model, Bohr's model, spectrum of H-atom;
CO-3: explain geometry and bond angle in xenon compounds, properties of xenon fluoride, structure and bonding in xenon fluoride as pr VBT, bonding in xenon compounds on the basis of MOT, reduction of V_2O_5, trend of atomic/ionic radii, ionization energy, electron-affinity, electro-negativity in the periodic table, difference between Arhenis, Lowry Bronsted and Lewis concept of acid-base, HSAB, quantum number, Aufbau, Hund and Pauli exclusion principles;
CO-4: describe steps involve extraction of vanadium from in some ores, salvation and hydration of s-block elements, complexation of cation of s-block elements;
CO-5: understand basic characteristics of noble gases and fluorides of xenon, basic concept of extraction of metal from ores, acid-base character of oxides and hydroxides of elements in the periodic table, ionic character and its effect on covalent bond;
CO-6: calculate % ionic character of covalent bond; classify ionic, polar and non-polar covalent bond theoretically;
CO-7: definition of space lattice, Unit cell, Difference between crystalline and amorphous state, types of crystals with illustrations, Law of crystallography; Steno's law and laws of symmetry, lattice planes, Miller indices, Bravais indices, type of cubic system, diagrammatic representation of cubic system and d_{100}, d_{110}, d_{111} planes, Bragg's equation (X-ray diffraction), Crystal structure of NaCl, KCl;
CO-8: chemical kinetics and its scope, rate of reaction, factors affecting rate of reaction: temperature, concentration, pressure, solvent, light and catalyst, molecularity of reaction, classification of chemical reaction, order of reaction with illustration (first order, second order, third order, zero order, pseudo first order) reaction, : second order (a=b), half life and mean life.

Sem I Paper-II: Organic Chemistry

At the end of the course, student will be able to

CO-1: describe and identify the isomerism to structures of organic compounds;
CO-2: define and identify the optical activity in to structures of organic compounds
CO-3: explain the chemical Preparation and separation of isomers;

CO-4: explain Stereochemistry of chiral and achiral chemistry organic compounds;
CO-5: interpret R/S Configurations of organic compounds;
CO-6: describe E/Z, Syn/Anti, D/L and R/S isomers;
CO-7: have basic information of heterocyclic compounds, nomenclature, classification, five and benzofused heterocyclic compounds, Aromaticity and resonance structure of heterocyclic compounds;
CO-8: five membered heterocyclic compound, synthesis and important chemical reactions and some examples, Benzofused heterocyclic compound, synthesis and important chemical reactions and some examples;
CO-9: have basic knowledge of poly cyclic aromatic hydrocarbon and type, classification and nomenclature, some examples of polycyclic aromatic hydrocarbon, important chemicals reactions of PAHs;
CO-10: understand oxidation and reduction and their uses.

Sem I: Chemistry Practical
At the end of course student will able to
CO-1: handle laboratory glassware's, hazardous chemicals safely in laboratory;
CO-2: set up the apparatus properly for the given experiments;
CO-3: perform all the activities in the laboratory with neatness and cleanness;
CO-4: to develop skills for quantitative estimation using the different branches of volumetric analysis;
CO-5: to develop skills required for the qualitative analysis of organic compounds.

Sem II Paper-I: Physical and Inorganic Chemistry
At the end of the course student will be able to
CO-1: define covalent , co-ordination covalent, ionic ,metallic, H-bond and wander walls force of attraction, bonding molecular orbital, non-bonding molecular orbital, anti bonding molecular orbital, acid radicals ,base radicals and CFSE, argentiferrous lead;
CO-2: understand basic concepts of bonding between atoms, crystal field theory, linkage between metal ion and Ligand, separation of cation in inorganic qualitative analysis, extraction of metal from its ores, electroplating and purification of metal, application of common ion effect;
CO-3: explain bonding, non-bonding and bonding molecular orbital, bond order and magnetic properties of hetronuclear diatomic molecules, theory behind borex bead test, flame test, effect of solubility product constant, complexometric reaction involve in inorganic qualitative analysis;
CO-4: describe polarizability (Fajan's rule), VSEPR theory, structure of flame, properties of uses of pure silver metal, extraction of silver metal from its ore, use of silver metal in photography and electroplating;
CO-5: identify practically metal ions from the given mixture, separate ion in presence of each others;
CO-6: explain of definition of conductance, resistance, specific conductance and equivalent conductance and the relation between specific conductance and equivalent conductance
CO-7: define of cell constant, numerical related cell constant, specific conductance and equivalent conductance, Discuss about Ostwald dilution law;
CO-8: explain buffer solution, buffer capacity and numerical;
CO-9: explain second law of thermodynamics, state different scientists about second law of thermodynamics, Carnot cycle, define deficiency of engine and numerical, discussion of entropy and change of entropy for reversible, isothermic, isoberic and isophoric processes as well as change for ideal gases;

CO-10: explain classification of physical properties, atomic volume, molar volume and chemical constitution, discussion about surface tension, paracor, viscosity, Ostwald viscometer method and numerical.

Sem II Paper-II: Organic Chemistry

After completion of course student will able to

CO-1: define the terms related to organic reactions such as Homolytic and Heterolytic fission free radicals carbonium ions, carbanions, carbenes, arynes and nitrenes;

CO-2: classify organic reactions like Addition, substitution, elimination, rearrange-ments, addition, and substitution with respect toelectrophilic and nucleophilic, SN_1, SN_2, Mechanism of addition reaction to alkenes and dienes, substitution in benzene, Perkin reaction, Benzoin condensation and Cannizero's reaction;

CO-3: determine empirical formula and its relation with molecular formula determination of molecular weight of organic acid by titration and silver salt method and organic base by chioroplatinate method and its limitations;

CO-4: define the term carbohydrate, its classification, structure of glucose and fructose, conversion of glucose to fructose and fructose to glucose, step up, step down and kilyani synthesis;

CO-5: identify Alkenes: Nomenclature, method of preparation, properties and uses of ethylene and propylene Morkwonikoffs rule and Satytzeff rule, polymerization of ethylene styrene and vinyl chloride;

CO-6: identify dienes: nomenclature, classification of dienes methods of formation of butadiene chemical reactions 1, 2 and 1, 4 additions, Diel's – Aider reaction;

CO-7: identify Alkynes: nomenclature, methods of formation, chemical reactions, electrophilic and nucleophilic addition reactions if acetylene.

Sem II: Chemistry Practical

At the end of course student will able to

CO-1: explain mole concept and its application in the preparation of normal and molar solutions, and use of mole concept in quantitative calculations for inorganic analysis;

CO-2: develop skills for quantitative estimation using the different branches of volumetric Analysis;

CO-3: impart the students a thorough knowledge of Systematic qualitative analysis of inorganic compounds.

S. Y. B. Sc.

Sem-III Paper-III: Inorganic Chemistry

After completion of course student will able to

CO-1: acquire working knowledge of the quantum mechanics postulate on the evolution of physical system;

CO-2: solve the time independent Schrodinger's equation, derive the equation for particle in the one dimensional box, applies boundary conditions to constraint the set of possible states;

CO-3: understand wave function, probability function, well behaved wave function.

CO-4: define and derivation of different operators, derivation of Hamiltonian equation, Hamiltonian operators for H – atom, H_2^+, He_2^+ and Li;

CO-5: principle of chromatography, classification of chromatography according to mobile phase and stationary phase, types of paper chromatography, Rf values, use of paper chromatography in inorganic analysis, separation of groups, halide and amino acid;

CO-6: define d-block elements; explain characteristic properties of d-block elements and properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states;

CO-7: understand L-S coupling, J-J coupling (introduction) and term symbol, determination of microstate of *p* and *d* orbital for several atom, calculation of term symbol of C, N, O, Ni, Ni^{+2}, Fe, Fe^{2+}, Fe^{3+}, Cr, Cr^{3+}, Co^{2+}, V, V^{+3} and Cl^{-};

CO-8: define potable water;

CO-9: explain different methods of purification of water for potable and industrial purposes, explain soft and hard water, discuss method of desalination of sea water by reverse osmosis and electro dialysis.

Sem-III Paper-IV: Organic Chemistry

After completion of course student will able to

CO-1: write and explain mechanism of Michael reaction Wolf-Kishner reduction, Wittig reaction, Fridel-Craft reaction, Mannich reaction, Benzoin reaction (condensation), Reimer-Tiemann reaction, Aldol Condensation;

CO-2: explain the Elimination reactions, stereo chemistry of elimination reaction, elimination reaction vs substitution reaction;

CO-3: recall definition, classification, IUPAC nomenclature of heterocyclic compounds with synthesis of some heterocyclic compounds;

CO-4: define, classify, do nomenclature of poly-nuclear aromatic hydrocarbons with synthesis;

CO-5: determine of configuration of D (+) glucose D (–) fructose – method of ascending and descending sugar series, Objections against open chain structure of D (+) glucose and D (–) fructose- ring structure of them, determination of size of the ring of glucose and fructose, methods of methylating sugars;

CO-6: synthesize and apply compound containing reactive methylene group like malonic ester and aceto acetic ester, Keto-enol tautomerism: factors affecting Keto-enol tautomerism and its mechanism.

Sem-III Paper –V: Physical Chemistry

At the end of the course student will be able to

CO-1: explain Arrhenius theory and collision theory of rate of reaction, energy of activation, effect of catalysis on it;

CO-2: solve numerical problems related to theories of reaction rate;

CO-3: understand fundamentals of photochemistry, basics of electromagnetic radiations, photons, thermal and photochemical laws (a) Grothus Draper's law (b) Lambert Beer's law (c) Einstein's law of photochemical equivalence;

CO-4: explain quantum efficiency, experimental determination of quantum yields; reasons of low and high quantum efficiency, primary and secondary photochemical reactions, factors affecting quantum efficiency, isomeric changes, polymerization, photosensitization, photophysical processes fluorescence, phosphorescence, chemiluminescene, factor affecting fluorescence, phosphorescence and solve numerical problems related to quantum efficiency;

CO-5: discuss formation of ions in solutions, difference between metallic conductance and electrolytic conductance, electrolysis, migration of ions, transport number of ions and its determination by moving boundary method;

CO-6: explain Kohlraush law of ionic conductance and application of Kohlraush law to (a) determine degree of dissociation of weak electrolyte, (b) determine equivalent conductivity of weak electrolyte at infinite diluation, (c) determine solubility and solubility product of sparingly soluble salts (d) determine ionic product of water;

CO-7: solve numerical problems related to determination of transport number and applications of Kohlrausch law;

CO-8: explain basics of electromagnetic radiation with wavelength and energy, radio frequency, microwave, IR, UV/visible region, pure rotational spectra, vibrational and vibrational-rotational spectra, Raman spectra, rotational spectra, calculation of bond-length, vibrational rotational spectra, Hook's law, vibrational energy level;

CO-9: solve numerical problems related to moment of inertia, force constant, reduced weight and bond length.

Industrial Chemistry

At the end of this course, student will able to

CO-1: manufacturing process of synthetic fibres with uses;

CO-2: general information and synthesis of some synthetic and natural rubber with flow sheet diagram;

CO-3: industrial important and manufacturing process of Plastics and Resins with flow sheet diagram;

CO-4: get knowledge about the synthesis of some herbicides, pesticides, insecticides and fungicides used for household and agriculture purpose;

CO-5: manufacture process of soap and detergents with the classification of detergents;

CO-6: get general information and manufacturing process of explosive;

CO-7: explain therapeutic uses and manufacture processes of drugs;

CO-8: find industrial uses and manufacturing process of some important dye pigment and dye intermediate;

CO-9: synthesize of perfume which is resemble to natural perfume such as vanillin and musk;

CO-10: explain industrial importance and various methods for the synthesis of phenol;

CO-11: explain industrial uses and various Industrial important manufacturing process of acetylene.

Sem-III: Chemistry Practical:

At the end of the course, student will be able to

CO-1: study the reaction kinetics practically [1st order];

CO-2: study the conduct metric and pH metric principles and application of conduct metric, and pH metric measurement in quantitative analysis;

CO-3: do viscosity measurement and its application;

CO-4: study the adsorption of given organic acid on charcoal;

CO-5: get trained in the quantitative analysis using gravimetric method;

CO-6: develop skills required for the qualitative analysis of organic compounds.

Sem-IV Paper – III: Inorganic Chemistry

At the end of course, students will able to

CO-1: define lanthanides and actinides, electronic configuration, sources, occurrence, extraction by solvent and ion exchange, properties, lanthanide contraction, use of lanthanide compounds, industrial use uranium and plutonium, misch metal;

CO-2: study of theory of hydrogen bonding, classification, importance of hydrogen bonding in ice, Effect of hydrogen bonding in various fields;

CO-3: define CFSE, chromatography, ion exchange, influent, effluent, sorption, desorption, elution, eluant, eluate, break through capacity;

CO-4: understand basic concept of CFT, CFSE, splitting of d-orbital in octahedral and tetrahedral geometry, interaction of visible light and complex compound, ion exchange chromatography, separation of ion through ion exchange chroma-tography, purification of water;

CO-5: explain effect of strong and weak ligand on CFSE, magnetic property and color of the metal complexes, synthesis of ion exchange resin, type of resin, steps of ion exchange chromatography, application of ion exchange chromatography, function of various metals in to biological system, importance of metallo-propyrins, hemoglobin (with reactions), myoglobin.

Sem-IV Paper – IV: Organic Chemistry

At the end of course, students will able to

CO-1: basics of diazonium salt, it's a mechanism, mole ratio, different salts, preparation of the diazonium salt;

CO-2: study nomenclature of diazonium salts;

CO-3: study reactions of diazonium salts, replacement reactions in which nitrogen is eliminated, its application in the synthesis of aromatic compounds;

CO-4: laws of coupling, coupling agents, synthesis of diazomino and aminizo compounds;

CO-5: prepare and physical properties and chemical reactions of nitriles, isonitriles, carbamates, semi-carbazides and their application in synthetic organic chemistry;

CO-6: structure and nomenclature of amines, preparation of aryl amines, physical properties and chemical reactions. Gabriel-pthalimide reaction, Hofmann Bromamide reaction;

CO-7: structure and nomenclature of acid chloride, ester, amides of monocarboxylic acid; method of formation of monocarboxylic acid derivatives and chemical reactions; their definitions, classification, analytical and synthetic evidences to prove the structure of Ascorbic acid and Adrenaline;

CO-8: how to use of reagents anhydrous aluminium chloride, nbs, grignard ragents, lithium aluminium hydride;

CO-9: aliphatic sulphur compounds: nomenclature, general methods of preparation and Reaction, Aromatic sulfonic acid: nomenclature, preparation, reactions and uses of sulfonic acids of toluene;

CO-10: UV and visible spectroscopy, ultraviolet absorption spectroscopy, absorption laws (Beer-Lambert law) terminology used in UV and visible spectra, molar absorptivity, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome and hypsochromic shifts UV spectra of conjugated enes and enones, effect of solvent substitution on electronic transition.

CO-11: solve problems based on calculation of λ_{max} for conjugated dienes and unsaturated carbonyl compounds and substituted Benzene derivatives using relevant rule.

Sem-IV Paper –V: Physical Chemistry

At the end of course, students will able to

CO-1: explain Nernst distribution law and its conditions for the validity, complications arising in distribution law due to association of solute in one of the phases, dissociation of solute in one of the phases, dissociation of solute in both the phase, derivation of distribution law from kinetic consideration explanation of solvent extraction process;

CO-2: solve problems related to determination of molecularity and quantity of solvent extracted;

CO-2: distinguish between adsorption and absorption, physical adsorption and chemical adsorption, explain heat of adsorption, characteristics of adsorption, Freundlich's adsorption isotherm, Langmuir's adsorption isotherm, catalysis, general features of catalysis, heterogeneous catalysis, adsorption theory of catalysis;

CO-3: explain free energy or work function [Gibbs free energy (G) and Helmholtz free energy (A)], Derive equation $G = G^0 + RT \ln p$, relation of ΔG and equilibrium constant KP (Vant Hoff isotherm), derive Clapeyron and Clapeyron-Clausius

equations, apply Clapeyron–Clausius equation in the derivation of molal elevation constant and molal depression constant;

CO-4: solve numerical problems related to latent heat of fusion, latent heat of vaporization, elevation of boiling point and depression of freezing point;

CO-5: use Principle of conductometric titrations to explain following titrations: (1) strong acid v/s strong base (2) strong acid v/s weak base (3) weak acid v/s strong base (4) weak acid v/s weak base (5) mixture of strong acid and weak acid v/s strong base (6) precipitation titrations of (i) $BaCl_2$ v/s K_2CrO_4 (ii) NaCl v/s $AgNO_3$, explain advantages of conductometric titrations over indicator method;

CO-6: discuss relation between degree of hydrolysis, hydrolysis constant and pH of solutions of (1) salts of weak acid and strong base (2) salts of strong acid and weak base (3) salts of weak acid and weak base, explain theories of acid-base indicators, choice of indicators, indicator exponent and useful range of pH of an indicator, solve numerical problems related to degree of hydrolysis, hydrolysis constant, determination of pH.

Industrial Chemistry

At the end of course, students will able to

CO-1: give details processes of manufacture of some industrial important inorganic chemicals with uses;

CO-2: industrial uses and manufacturing process of lime, cement and refractories;

CO-3: industrial preparation and uses of some important chemical such as potassium permanganate, potassium dichromate, titanium dioxide, bleaching powder, white lead;

CO-4: information about plant nutrient and symptoms of nutrient deficiency in plant kingdom. Classify fertilizer and industrial manufacturing process of widely used some fertilizer;

CO-5: classify fuel, information and synthesis of some synthetic and eco friendly fuel;

CO-6: property, classification and industrial manufacturing process of glass use frequently for industries and house hold purpose;

CO-7: property and industrial making process of various ferrous and non ferrous alloys;

CO-8: define fermentation, various factors affecting fermentation process, micro-organisms and various chemical nutrient uses for fermentation process.

Sem-IV: Chemistry Practical

At the end of course, students will able to

CO-1: develop laboratory skills for the purpose handling different instruments; interpret results of experiments and their correlation with theory;

CO-2: determine the molecular condition of benzoic acid in its solution in kerosene by the method of partition coefficient;

CO-3: determine the relative strength of mineral acids;

CO-4: study the conduct metric and pH metric principles and application of conduct metric, and pH metric measurement in quantitative analysis;

CO-5: maintain records of chemical and instrumental analysis; develop laboratory skills for the purpose of collecting, interpreting, analyzing, practical data;

CO-6: impart the students a thorough knowledge of systematic qualitative analysis of inorganic mixtures.

T. Y. B. Sc.

Sem-V Paper-VI: Inorganic Chemistry

At the end of course, student will be able to

CO-1: study postulates of quantum mechanics, particles in three dimensional box, Schrodinger's wave equation in polar coordinates, its separation in to R, θ and Φ;

CO-2: Jahn Teller Theorem, distortation in octahedral complexes, crystal field splitting energy level diagram for octahedral and tetrahedral, tetragonal and square planar complexes;

CO-3: concept of Ligand field theory;

CO-4: distinguish between atomic and molecular orbitals, bonding and antibonding molecular orbitals, different theories of co-ordination chemistry;

CO-5: draw MO energy level diagram for metal complexes and its magnetic properties;

CO-6: define classify metal carbonyls, metal ligand π–bonding (back bonding), define EAN and 18 electron rule, calculate EAN for metal carbonyl, bonding in metal carbonyl structure and IR spectra in metal carbonyl;

CO-7: differentiate between terminal and bridge carbonyl, constitution of metal carbonyls;

CO-8: define boron hydride and its classification, Wade's rule, bonding and structure in tetra Borane (10), penta borane (9) and dodeca borane (12) anion;

CO-9: outline thermodynamic stability of metal complexes and factors affecting a stability of metal complexes, Lability and inertness, factors affecting lability of metal complexes, trans effect, theories of trans effect: (i) electrostatic polarization theory (ii) - bond theory;

CO-10:define and give importance of corrosion, types of corrosion: uniform, pitting, intercrystalline and stress cracking corrosion, electro-chemical theory of corrosion, protection methods and importance of coating, inhibitors (organic, inorganic, anodic, cathodic), anodic and cathodic protection.

Sem-V Paper-VII: Organic Chemistry

At the end of course, students will able to

CO-1: give (a) Different types of mechanism for esterification and hydrolysis: B_{AC}^2 A_{AC}^2 A_{AC}^1 A_{AL}^1 B_{AL}^2 (b) mechanism of formation and hydrolysis of amides. (c) pyrolytic elimination: Cope and Chugaev reactions;

CO-2: give structural determinations of pyriodoxine and thyroxine and their synthesis, general introduction, structural determination of ribofllevin (Lactoflavin) and its synthesis;

CO-3: have basic concepts of alkaloids, occurrence and classification of alkalodis, general methods of determine of their structure, analytical and synthetic evidence to prove the structure of nicotine and papavarine;

CO-4: have general discussion about carbohydrates, definition of carbohydrates, classification of carbohydrates with example, introduction of disaccharide and poly saccharide, structure determination of maltose, lactose starch;

CO-5: introduce drugs, define drugs and ideal drugs, classify drugs based on pharmacological or functions, give important synthesis and uses of drugs;

CO-6: define peptide, synthesis of Merry Field method, Sangers method, Edman method, N-terminal determination, C-terminal determination by generation of amino alcohol and using digestive enzymes, end group analysis, selective hydrolysis of peptides classical levels of protein structure, protein denaturation /renaturation.

Sem-V Paper-VIII: Physical Chemistry

At the end of the course student will be able to

CO-1: understand and explain partial molal free energy, derive from Gibb's Duhem equation, chemical potential in case of a system of ideal gases, concept of fugacity, fugacity function, fugacity at low pressures, physical significance of fugacity, graphical method for determination of fugacity, Lewis fugacity rule, activity and activity coefficient, standard state of solid, liquid and gas, the Nernst heat theorem, its limitations, statement of the third law of thermodynamics, consequence of third law of thermodynamics, determination of absolute entropy of gases and liquids and solid,

applications of third law of thermodynamics, concept of residual entropy, exceptions to the third law of thermodynamics, solve numerical problems related to fugacity, graphical method to determine fugacity and determination of absolute entropy;

CO-2: explain and discuss concept of oxidation and reduction, electrochemical series, definition of half cell and cell, single electrode potential, sign of electrode potential, standard electrode potential, electrochemical process, Galvanic cell with example of Daniel cell, emf of a cell and its measurements, Standard Weston cell, different types of reversible electrodes, determination of single electrode potential, calculation of standard emf of cell and determination of cell reaction, standard hydrogen electrode, calomel electrode and Ag-AgCl electrode, chemical and concentration cell, electrode and electrolyte concentration cell, liquid junction potential (LJP), salt bridge in elimination of LJP, concentration cell with and without transference, free energy change and electrical energy, prediction of spontaneity of cell reaction, relation of standard free energy change with equilibrium constant, temperature coefficient of emf of a cell, entropy change and enthalpy change of cell reaction;

CO-4: solve numerical problems related to cell construction from electrochemical reaction, electrode potential, emf of various types of cell, rate constant, LJP;

CO-3: explain stable and unstable isotopes, separation of isotopes by different methods, gaseous diffusion, thermal diffusion, distillation, chemical exchange methods, Bainbridge velocity focusing mass spectrograph, Dempster's direction focusing mass spectrograph, different types of particle accelerators.

Sem-V Paper-IX: Industrial Chemistry

At the end of course, students will able to

CO-1: study nomenclature of chloro-fluoro derivatives of methane and ethane, uses of fluoro carbons;

CO-2: manufacture of freon-12 from fluorspar, manufacture of freon-12 from vinylidene fluoride;

CO-3: pollution hazard of Fluoro carbons;

CO-4: metallurgy of different metals (occurrence, extraction, properties and uses: (1) Tungsten (2) Molybdenum (3) Titanium (4) Chromium (5) Aluminium;

CO-5: do small scale preparation of (1) safety matches (2) naphthalene balls (3) wax candles (4) shoe polish (5) writing/ fountain pen ink (6) chalk crayons (7) plaster of paris;

CO-6: define nitration, nitrating agent, reaction mechanism of nitration, nitration of acetylene, nitration of benzene, nitration of naphthalene, artificial perfumes: musk xylene, musk ketone, musk ambrette. explosives: trinitrophenol, trinitrotoluene, trinitro glycerine, emitol;

CO-7: define amination, amination by reduction: metal - acid reduction, metal - alkali reduction, catalytic reduction, sulphide reduction. amination by ammonolysis: amination of chlorobenzene, phenol and sulphonic acid, importance of amination in industry in the manufacture of m-phenylene diammine, hmda, anthranilic acid, hexamethylene tetramine;

CO-8: define sulphonation, methods of sulphonation, sulphonating agents, mechanism of sulphonation, sulphonation of benzene, toluene, naphthalene.

Sem-V Paper-X: Analytical Chemistry

At the end of course, students will able to

CO-1: study chemical and instrumental analysis, advantages and disadvantages, overview of methods used in quantitative analysis, classification of classical and instrumental analysis;

CO-2: define and explain error, types of errors: determinates errors, indeterminate errors, constant and proportional errors, define and explain the following terms – accuracy

and precision, mean, median, deviation, average deviation, standard deviation, variance, coefficient of variation, relative mean deviation, range, absolute errors, relative errors, minimization of determinates errors, normal error curve, rejection of result from a set of results, 2.5 d rule, 4.0 d rule and Q-test;

CO-3: study factors affecting solubility of precipitates: (1) common ion (2) diverse ions (3) pH (4) hydrolysis (5) complex formation, the precipitation process, nucleation growth, Von Weimarn's theory of relative super saturation. digestion of precipitates;

CO-4: factor affecting quality of precipitate: Co-precipitation and post precipitation, Precipitation from homogeneous solution with illustration of barium and aluminum; thermogravimetry, general principle, application with following two specific examples (1) CaC_2O_4. H_2O (2) MgC_2O_4. $2H_2O$;

CO-5: calculate of pH at different stages of titrations of monobasic and dibasic acid with strong base construction of titration curve, titration of carbonate mixture, numerical;

CO-6: explain EDTA titration, absolute and conditional stability constant, distribution of various species of EDTA as function of pH, absolute and conditional stability constants, derivation of factors: α_4 for effect of ph, β_4 for the effect of auxiliary complexing agent, construction of titration curves: theory of metallochromic indicators, masking, demasking and kinetic masking, types of EDTA titrations.

Sem-V Paper-XI: General Chemistry

At the end of course, students will able to

CO-1: define spectroscopy, wavelength, frequency of radiation, wave number.

CO-2: classify spectroscopy atomic and molecular spectroscopy, different region of IR radiation.

CO-3: describe instrumentation of IR spectroscopy, preparation of sample for IR spectroscopy, stretching vibration of different molecule.

CO-4: explain effect of IR radiation on matter, factors affecting on absorption frequencies.

CO-5: calculate estimated absorption frequencies for various functional groups.

CO-6: study dry reaction: theory behind borax bead test with equation, flame test, analysis of cation: (a) application of common ion effect and solubility product constant. (b) complexometric reaction involved in qualitative analysis, for identification [Reaction between Cu (II) ion with ammonia, Fe (III) with thiocyanide, NH_4^+ with Nessler reagent 2, for masking $[Cd^{+2}, Cu^{+2}]3$, separation of two ion $[Ag\text{-}Hg, Zn]^{+2}$, Mn^{+2};

CO-7: organic qualitative analysis, elemental analysis, solubility of organic compounds;

CO-8: understand laboratory hygene and safety, handling of chemicals, general procedure for avoiding accidents, first aid techniques;

CO-9: define terms: solute, solvent, and solution composition of solution-normal solution, molar solution, molal solution, mole fraction, % solution, saturated, unsaturated and supersaturated solution and solubility, effect of temperature on various units of concentration, interconversion of one unit into another unit, preparation of solutions of some primary standard substances, standardization of the solution using primary standard solutions/standardized solution.

Sem-V: Petrochemicals

At the end of course, students will able to

CO-1: source of petrochemicals, natural gas: composition, natural gas as petro-chemical feed stock, crude oil: composition, distillation, and refining, utilization of various fractions;

CO-2: classify petrochemicals, first, second and third generation petrochemicals, conversion process: cracking reforming, isomerisation, hydrogenation, alkylation and hydrodealkylation, dehydrocyclisation of petroleum products, polymerization of gaseous hydrocarbons;

CO-3: study petrochemicals obtained from C_1 cut of petroleum manufacture and application of methanol, synthesis gas, ammonia, HCN, formaldehyde, hexamethylene tetramine, chlorinated methanes, per chloro ethelene and CS_2;

CO-4: study industrial fuels, natural fuels, synthetic fuels, hydrogen fuel of tomorrow, fuel for rocket, intermediates of pharmaceuticals and dyes;

CO-5: study petrochemicals obtained from C_2 cut of petroleum, manufacture and industrial applications of chemicals obtained from ethylene: ethanol, acetaldehyde, ethylene oxide, ethylene glycol, ethanolamines, acrylonitrile, styrene, vinyl acetate, manufacture and industrial application of chemicals obtained from acetylene, acrylic acid, acrylonitrile, vinylchloride, vinylacetate, acetaldehyde, chloroprene, trichloethylene, methyl vinyl ether;

CO-6: have general account of petrochemicals used as monomers in the manufacture of nylon –6, nylon–6-6, nylon –6-10, nylon –12 and nylon –8-6 fibers, industrial production of caprolactum, HMDA, adipic acid, sabecic acid, lauryl lactum.

Sem-V: Chemistry Practical

At the end of course, students will able to

CO-1: study and justify kinetics of 2^{nd} order reactions practically;

CO-2: study precipitation titration, mix acid titration using conductivity meter;

CO-3: determine degree of dissociation and dissociation constant of weak monobasic acid using pH metry;

CO-4: determine solubility and solubility product of sparingly soluble salt using potentiometry;

CO-5: study angle of rotation as well as specific rotation of optically polar substances using polarimeter;

CO-6: maintain records of chemical and instrumental analysis. Develop laboratory skills for the purpose of collecting, interpreting, analysing, practical data;

CO-7: develop laboratory skills for the purpose handling different instruments, interpretation of results of experiments and their correlation with theory;

CO-8: get training in the quantitative analysis using gravimetric method;

CO-9: develop skills required for the qualitative analysis of organic mixture.

Sem-VI Paper-VI: Inorganic Chemistry

At the end of course, students will able to

CO-1: define symmetry, symmetry elements, symmetry operations;

CO-2: enlist of symmetry elements, types of planes;

CO-3: define point group, Classification of molecules into point- groups, point – group of different molecules;

CO-4: study basic properties of a group theory;

CO-5: derive the multiplication table for C_{2v}, C_{3v} and C_{2h} point group;

CO-6: understand reaction mechanisms of ligand substitution in octahedral complexes (i) SN_1 (ii) SN_2 Acid hydrolysis and Base hydrolysis-Redox (Single Electron Transfer) reactions;

CO-7: define of hybridisation Bond angles in sp, sp^2 and sp^3 hybrid orbital using wave function;

CO-8: study water pollution: types of water pollutants, trace elements in water and their effects; Determination of BOD, COD, DO, Total hardness, Total dissolved solids.

Sem-VI Paper-VII: Organic Chemistry

At the end of course, students will able to

CO-1: have basic concept of green chemistry, fundamental principle of green chemistry, green chemistry examples, green synthesis of important compounds

CO-2: have general discussion about polymers, definition of polymer, classification of polymer with example, introduction of various type of polymerization, some important method of polymerization;

CO-3: study various types of resin phenol- formaldehyde resin, urea -formaldehyde resin, epoxy resin, natural and synthetic rubbers;

CO-4: understand pigments, classification of pigments;

CO-5: have general introduction of careteniods, analytical and synthetic evidence of β-carotene;

CO-6: get general introduction of anthocyanines and anthocyanidines analytical and synthetic evidence of Cyandine chloride;

CO-7: have an introduction of flavones and flavonols analytical and synthetic evidence of quercetin;

CO-8: have general discussion about dyes, definition of dyes and pigments;

CO-9: discuss about color and constitution – Witt's theory difference between dyes and pigments;

CO-10: classify of dyes with example, introduction of various types of dyes;

CO-11: study mechanism of rearrangements involving C to C migrations as illustrated by Wagner – Meerwein and Pinocol-Pinacolone rearrangements;

CO-12: study mechanism of rearrangements involving C to N migrations as illustrated by Hoffmann, Curtius, and Beckmann rearrangements.

Sem-VI Paper-VIII: Physical Chemistry

At the end of course, students will able to

CO-1: discuss application of radio isotopes as tracers in medicines, agriculture, in studying reaction mechanism in photosynthesis and age determination by Carbon- Dating method, Q-value of nuclear reactions, chemical and physical atomic weight scale, mass defect and binding energy, packing fraction and its relation with the stability of the nucleus, nuclear fission, atom bomb, nuclear reactor for power generation and critical mass, stellar energy and hydrogen bomb, hazards of nuclear radiation, numerical problems on Q-value, binding energy, packing fraction, and energy released during nuclear reactions;

CO-2: apply EMF measurements in the determination of (1) solubility product and solubility of sparingly soluble salts (2) ionic product of water by galvanic cell (3) transport number of ions (4) equilibrium constant (5) pH by hydrogen, glass and quinhydrone electrodes, solve numerical based on above applications to determine solubility, solubility product, ionic product of water, equilibrium constant, transport number and p^h of solution, have detail information on energy sources like Ni-Cd Cell and Li- ion cell;

CO-3: discuss statement and meaning of the terms phase, component, degree of freedom, phase rule, phase equilibria of one component system like water, CO_2, sulphur system, phase equilibria of two component system like Pb-Ag systems, KI- Water system, desilverisation of lead, basics freezing mixtures and Definition of solid solutions with congruent and incongruent melting point using example;

CO-4: explain liquid-liquid mixtures, ideal liquid mixtures, Raoult's law, non ideal or real solutions, positive and negative deviations from Raoult's law, temperature composition curves for ideal and non ideal binary solutions of miscible liquids, azeotropes, partially miscible liquids explained using phenol-water systems, immiscible liquids, steam distillation, solve numerical problems related to this topic.

Sem-VI Paper-IX: Industrial Chemistry

At the end of course, students will able to

CO-1: pulp and paper industry, Type of pulp, manufacture of chemical pulp and mechanical pulp;

CO-2: study manufacture of paper (conversion of pulp into paper, beating process, importance of fillings, sizing, colouring materials in manufacture of paper and calendaring);

CO-3: understand principles of detergency;

CO-4: classify of surface active agents, anionic detergents, cationic detergents, non-ionic detergents, amphoteric detergents, suds regulators, builders additives.

CO-5: get introduction, manufacture of sugar from sugarcane;

CO-6: study extraction of juice, purification of juice, concentration and crystallisation of purified juice, refining of sugar;

CO-7: define fermentation and fermentation process with example pH, temperature and substance;

CO-8: study various type compounds like ethanol, citric acid, acetone and penicillin –G manufacture and flow chart with uses;

CO-9: define insecticide type of insecticides, inorganic, organic, synthetic and natural insecticides, manufacture and uses of various type of compound like eldrin, dieldrin, BHC, TEPP;

CO-10: define of fungisides, bordex mixture, dithio carbamates, baygon, termik zineb;

CO-11:study manufacture and uses of various compounds like methanol from synthesis gas, isopropanol from propylene, acetone from isopropanol, formaldehyde from methanol by oxidation dehydration method, acetylene from natural gas.

Sem-VI Paper-X: Analytical Chemistry

At the end of course, students will able to

CO-1: explain components of spectrophotometer –sources, grating and prism as dispersing device, sample handling, detectors – photo tub e, photomultiplier tube, block diagram and working of single beam and double beam spectro-photometer, terms involved in beer's law, causes of deviation from beer's law, analysis of unknown by calibration curves method, standard addition method, and ratio method, determination of Cu^{+2}, Fe^{+3}, NO_2^{-1} using spectrophotometer, problems based on quantitative analysis;

CO-2: discuss classification of chromatography, principles of GC separation, components of GC, carrier gas and its selection - stationary phases: solid adsorbents, inert supports and liquid stationary phases, detectors: FID, TCD, qualitative and quantitative analysis using GC;

CO-3: know about limitation of conventional liquid chromatography, technique of HPLC, elementary idea about technique and layout diagrams of instrument, components of instrument of HPLC technique, elementary idea of TLC;

CO-4: study titrations involving Silver salts, detection of end points by Mohr's method, Volhard's method, adsorption indicators, construction of titration curves;

CO-5: study construction of titration curves for titration of Fe^{+2} and Ce^{+4}, explain types of indicator and theory of redox indicator, know about oxidants – $KMnO_4$, $K_2Cr_2O_7$, reductants – sodium thiosulphate, sodium arsenite and problems.

Sem-VI Paper-XI: General Chemistry

At the end of course, students will able to

CO-1: define adulteration;

CO-2: understand different types of adulteration, techniques of adulteration, methods of detection of different adulterants in some common food items like milk, milk products, oil and fats, food grains and their products, spices and miscellaneous

product , hazardous effect of adulteration of human, consumer's rights and some legal procedures;

CO-3: realize their social responsibility and inspire to think its solution on a student of chemistry;

CO-4: study nano-particles, properties of nano-particles, semiconductors, ceramic nano-particles, catalytic aspects of nano-particles, carbon nano-tubes, applications of nano particles;

CO-5: study different types of pollutions such as: (1) gaseous pollution in air, acid rain, green house effect and ozone depletion, (2) radiation pollution cause, effect and control, (3) noise pollution and their effect and control, (4) oil pollution and their control;

CO-6: study Nuclear Magnetic Resonance Spectroscopy–Proton Magnetic Resonance (^{1}H NMR) Spectroscopy - nuclear shielding and deshielding – chemical shift and molecule structure, spin-spin splitting and coupling constants – areas of signals – interpretation of NMR spectra of simple organic molecule such as ethyl bromide, acetaldehyde, 1,1,2-tribromoethane, ethylacetate, toluene, acetophenone, nitrobenzene, cyclopropane, isomers of pentane and hexane.

Sem-VI: Petrochemicals

At the end of course, students will able to

CO-1: petrochemicals obtained from C_3-cut of petroleum, manufacture and industrial applications of chemicals obtained from propylene: iso propyl alcohol, acetone, propylene oxide, acrylonitrile, glycerol and isoprene, propylene tetramer, acrylic acid, n-butyraldehyde, methyl isobutyl ketone, acrolein, acrylamide, methyl methacrylate;

CO-2: have general account of petrochemicals used as monomers in the manufacture of polyester fibers, manufacture of DMT, terphthalic acid, phthalic anhydride, maleic anhydride, 1:4 butanediol and other monomers like penta erithritol and di-isocyanates;

CO-3: study method for the large scale production with flow diagram and uses of: (i) acetoacetanilide (ii) anthraquinone (iii) β-naphthol from naphthalene (iv) Bon acid (v) aspirin (vi) chloramphenicol (vii) paracetamol (viii) p-amino phenol (ix) saccharin (x) 2,4-D acid;

CO-4: define synthetic detergents, hard and soft detergents, synthesis of DDBS, basic petrochemical raw materials for organic dyes, dyes derived from these raw materials with uses, synthesis of fluoresein, malachite green, chrysoidine and indigo, definition of explosive, list of basic raw materials for explosives and list of explosives derives from these raw materials, synthesis of tetryl, PETN and dynamite;

CO-5: define insecticides, classification of insecticides on basis of mode of action. Synthesis of Methoxychlor, Captan, Parathion, Malathion and Perthane;

CO-6: study chemicals obtained from C4 and C5 cut of petroleum, manufacture and industrial applications of butadiene, butylalcohols, methyl terbutyl ether (MTBE) cyclopentadiene, sulpholane;

CO-7: study recovery process of BTX, manufacture and industrial applications of benzene, toluene, xylene, naphthalene, phenol, styrene, aniline, maleic anhydride, cyclohexanol.

Sem-VI: Chemistry Practical:

At the end of course, students will able to

CO-1: study and justify kinetics of 2nd order reactions practically;

CO-2: determine quantity of active ingredient in commercial product [Vanila] using conductometric principles and conductometric titration;

CO-3: determine degree of dissociation and dissociation constant of weak monobasic acid by titration method using pH metry;

CO-4: verify Lambert-Beer law for colored solution using colorimeter/ spectro-photometer;
CO-5: determine normality and amount of given acid in mixture using conductivity meter;
CO-6: maintain records of chemical and instrumental analysis, develop laboratory skills for the purpose of collecting, interpreting, analyzing, practical data;
CO-7: develop laboratory skills for the purpose handling different instruments, interprete of results of experiments and their correlation with theory;
CO-8: get knowledge of Systematic qualitative analysis of Inorganic mixtures.

Department of Mathematics

Goals

The Mathematics program promotes mathematical skills and knowledge for their intrinsic beauty, effectiveness in developing proficiency in analytical reasoning, and utility in modeling and solving real world problems. To responsibly live within and participate in the transformation of a rapidly changing, complex, and interdependent society, students must develop and unceasingly exercise their analytical abilities. Students who have learned to logically question assertions, recognize patterns, and distinguish the essential and irrelevant aspects of problems can think deeply and precisely, nurture the products of their imagination to fruition in reality, and share their ideas and insights while seeking and benefiting from the knowledge and insights of others.

Program Outcomes

After completing B. Sc. (Physics) Program, the student will be able to:

PO1 : Explain the importance of mathematics and investigate the real world problems and learn to how to apply mathematical ideas and models to those problems.

PO2 : Reason mathematically and apply rigorous, analytic, highly numerate approach to analyze, execute tasks and solve problems in daily life and at work.

PO3 : Recognize the power of abstraction and generalization and to carry out investigative mathematical work with independent judgment.

PO4 : Investigate and apply mathematical problems and solutions in a variety of contexts related to science, technology, business and industry, and illustrate these solutions using symbolic, numeric, or graphical methods

PO5 : Identify the type and solve abstract mathematical problems and give geometrical interpretation of various concepts.

PO6 : Recognize connections between different subjects in mathematics.

PO7 : Develop an understanding of the underlying unifying structures of mathematics (sets, relations and functions, logical structure) and the relationships among them.

PO8 : Conduct self-evaluation, and continuously enrich them through lifelong learning.

PO9 : Communicate and interact effectively with different audiences and collaborate intellectually and creatively in diverse contexts, while emphasizing the importance of clarity and precision in communication and reasoning.

PO10 : Formulate and analyze mathematical problems, precisely define the key terms, and draw clear and reasonable conclusions.

Program Specific Outcomes (PO)

PSO1: Help the students to enhance their knowledge in soft skills and Computing skills.

PSO2: Enable the students to equip knowledge in various concepts involved in functions of single variable.

PSO3: Enable the students to equip knowledge in various concepts involved in calculus and geometry.

Course Outcomes (CO)

F. Y. B. Sc.

Course MTH-101: Mathematics-I (SEM - I)

After successfully completing this course, students will be able to

CO1: understand De' Moirve's theorem and its applications;

CO2: understand Euler's Expression, Understand Hyperbolic functions for real arguments;

CO3: understand the exponential, Circular and Hyperbolic functions for complex arguments;

CO4: understand the Logarithm of complex numbers, inverse hyperbolic functions and separation of these into real and imaginary parts.

Course MTH-102: Mathematics-II (SEM - I)

After successfully completing this course, students will be able to

CO1: understand Successive differentiation, nth derivatives, understand the use application of Leibnitz theorem;

CO2: understand Rolle's theorems and their geometrical interpretation, understand the use of Cauchy's theorem, and understand the use of Maclaurin and Taylor's expansions;

CO3: understand the curvatures, asymptotes, concavity and convexity, understand the decreasing and increasing functions;

CO4: derive the reduction formula of integration of various functions.

Course MTH-201: Mathematics-III (SEM - II)

After successfully completing this course, students will be able to

CO1: understand matrices and types of matrices, operations on matrices.

CO2: understand elementary row operations, row-echelon form, row rank, inverse of matrix by elementary row operations.

CO3: understand diagonalization, trace of matrix, solving the system of homogeneous and non-homogeneous linear equation by row-reduced echelon form.

CO4: understand characteristic equation of a matrix, eigen values and vectors, Cayley-Hamilton theorem, inverse of a matrix using Cayley-Hamilton theorem.

Course MTH-202: Mathematics-IV (SEM - II)

After successfully completing this course, students will be able to

CO1: understand the curve tracing and parametric equations;

CO2: understand application of integral calculus, length of a curve, intrinsic equations;

CO3: understand linear differential equations of first order, exact equations, Bernoulli's equations, Lagrange's equation, Clairaut's equation;

CO4: understand linear differential equations with constant coefficients.

S. Y. B. Sc.

Course (MTH-301): Advanced Calculus-I (Sem- III)

At the end of course, students will able to

CO1: find the differentiation, understand the difference between partial and total differentiation;

CO2: recognize composite function, homogeneous functions, Euler's theorem for homogeneous function;

CO3: solve examples using Taylor's theorem, Maclaurian's expansion and find Jacobian;
CO4: find the derivatives of vector point function;
CO5: find the gradients, curl, and divergence;
CO6: find the surface integral using Green's, Gauss's and Stoke's theorems.

Course MTH-302: Numerical Analysis-I (Sem- III)
At the end of course, students will able to
CO1: be familiar with the concept of 'error';
CO2: find the error in various calculations;
CO3: apply Bisection, Iteration, Regula-falsi and Newton-Raphson's methods to find the real roots of transcendental equations;
CO4: understand the concept of finite differences;
CO5: learn how to construct forward, backward and central difference table;
CO6: familiar with numerical interpolation and approximation of functions.

Course (MTH-303): Differential Equations (Sem- III)
At the end of course, students will able to
CO1: identify various types of ordinary differential equations and find their general solution;
CO2: understand applications of differential equations;
CO3: solve linear differential equations;
CO4: apply various methods to solve ordinary differential equations;
CO5: form partial differential equations;
CO6: solve partial differential equations by applying some special methods.

Course (E. G.): Mathematical Methods (Sem- III)
At the end of course, students will able to
CO1: familiar with finite difference operators;
CO2: familiar with relations between different operators;
CO3: use finite difference table to find missing term in the given table of data;
CO4: understand the factorial notation;
CO5: use of finite differences to express the polynomial in factorial notations;
CO6: understand and solve the homogeneous difference equations.

Course (MTH-401): Advanced Calculus-II (Sem- IV)
At the end of course, students will able to
CO1: understand maxima-minima for the functions of two variables;
CO2: familiar with the necessary and sufficient conditions for extreme points;
CO3: find double and triple integral;
CO4: find the area using integration;
CO5: know Beta-Gamma functions; relate Beta and Gamma functions;
CO6: understand the application of Beta-Gamma functions;
CO7: know Laplace transform, understand Laplace transform of some elementary functions;
CO8: know inverse Laplace transform and properties of inverse Laplace transform.

Course (MTH-402): Numerical Analysis-II (Sem- IV)
At the end of course, students will able to
CO1: be familiar with finite difference with unequal interval;
CO2: apply Lagrange's, divided differences and Newton's general interpolation formula;
CO3: understand the numerical differentiation;
CO4: apply Newton's forward and backward difference interpolation formulae to find first and second order derivatives;
CO5: understand the numerical integration.

CO6: apply Trapezoidal and Simpson's rule to evaluate integration;
CO7: use Taylor's series method, Picard's method and Euler's method to solve the ordinary differential equations.

Course (MTH-403): Introduction to Abstract Algebra (Sem- IV)
At the end of course, students will able to
CO1: have knowledge of important mathematical concepts in abstract algebra such as divisors, gcd, lcm, prime number;
CO2: understand the concept of group, example of group, elementary properties of group;
CO3: have knowledge of different types of subgroups such as normal subgroups, cyclic subgroups and understand the structure and characteristics of these subgroups;
CO4: understand the definition of ring, integral domain, field and Boolean ring.

Course (E. G.): Mathematical Modelling (Sem- IV)
At the end of course, students will able to
CO1: understand the mathematical modeling;
CO2: construct the model such as linear growth models, linear decay models, models for growth of science and scientist;
CO3: construct the mathematical models of geometrical problems and orthogonal trajectories.

T. Y. B. Sc.

Course (MTH-501): Group Theory (SEM-V)
At the end of course, students will able to
CO1: understand the concept of cosets, congruence relation in group;
CO2: understand Lagrange's theorem, Euler's theorem, Fermat's theorem;
CO3: understand subgroup, homomorphism, isomorphism, isometric groups;
CO4: understand automorphism and Cayley's theorem;
CO5: understand permutation groups, orbit, cycles, alternating group.

Course MTH-502: Linear Algebra-I (SEM-V)
At the end of course, students will able to
CO1: understand the concepts of base and dimension of vector space;
CO2: understand the concept subspace of a vector space;
CO3: understand span of a set, operations on subspaces;
CO4: identify linearly independent and linearly dependent vectors;
CO5: extend linearly independent set to a basis.

Course MTH-503: Real Analysis– I (SEM-V)
At the end of course, students will able to
CO1: understand the concepts of countable set, uncountable set, lub, glb of a sequence;
CO2: understand the concepts of sequences and limit of the sequence;
CO3: understand the concept of convergent sequence and divergent sequence, bounded sequence, monotone sequence, Cauchy sequence;
CO4: understand the operations on sequences;
CO5: understand the concept of limit superior and inferior.

Course MTH-504: Real Analysis– II (SEM-V)
At the end of course, students will able to
CO1: understand the concept of limit and continuity of a function on the real line;
CO2: understand the concept of metric space;

CO3: **e**xplain convergence and divergence of sequence in metric space;
CO4: understand the Cauchy's sequence in metric space and equivalent metrics;
CO5: understand the concept of an open ball in R^1 and metric space;
CO6: understand the continuity of a function in a metric space;
CO7: understand the concept of open sets.

Course MTH-505: Graph Theory (SEM-V)
At the end of course, students will able to
CO1: understand about graph,
CO2: identify the properties of different types of graph and their application;
CO3: understand the concept of subgraphs and isomorphism;
CO4: understand the operations on the graphs;
CO5: classify the graph such as walks, paths, circuits;
CO6: draw all types of graphs;
CO7: understand the concept of Euler's graph and its application;
CO8: classify Hamiltonian graphs, circuits and paths;
CO9: explain Konigsberg bridge problem, seating problem, utility problem, arrangement problem;
CO10: understand the concept of trees;
CO11: know about properties of trees, know about distance between two vertices, centre, radius and diameter of a tree;
CO12: identify rooted and binary trees.

Course MTH-506: Number Theory-I (SEM-V)
At the end of course, students will able to
CO1: understand the concept of divisibility of integers;
CO2: use terminology in number theory;
CO3: understand the division algorithm;
CO4: understand gcd of two integers;
CO5: understand the Euclidean algorithm;
CO6: find the remainder and quotient by division algorithm;
CO7: understand the relation between gcd and lcm;
CO8: find the solution of Diophantine equations in two variables;
CO9: classify prime and composite numbers;
CO10: understand the concept of sieve of Eratosthenes;
CO11: understand the theory of congruence;
CO12: understand the properties of congruence.

Course EG-5001: Operations Research-I (SEM-V)
At the end of course, students will able to
CO1: understand the basics of operations research;
CO2: recognize all the definitions and concepts by giving examples of operations research;
CO3: formulate the problem as linear programming problem;
CO4: understand the primal and dual of lpp;
CO5: plot the graph of lpp;
CO6: solve the lpp by graphical method;
CO7: understand the concept of solutions of lpp;
CO8: solve the lpp by simplex method;
CO9: solve the lpp by two-phase method;
CO10: solve the lpp by Big-M method;
CO11: choose appropriate method for solving lpp.

Course MTH-601: Ring Theory (SEM-VI)

At the end of course, students will able to

CO1: understand the concept of ring homomorphism and isomorphism;
CO2: understand ideal and quotient rings;
CO3: understand maximal ideal and principal ideal;
CO4: understand Euclidean ring;
CO5: understand divisibility in commutative ring;
CO6: understand gcd of two elements in ring;
CO7: understand units and associates in rings;
CO8: understand prime element in a Euclidean ring;
CO9: use unique factorization theorem in a Euclidean ring;
CO10: understand polynomial ring;
CO11: understand degree of a polynomial;
CO12: understand division algorithm and irreducible polynomial.

Course MTH-602: Linear Algebra-II (SEM-VI)

At the end of course, students will able to

CO1: recall the definition of vector space;
CO2: understand the concept linear transformations;
CO3: understand range and kernel of linear transformation;
CO4: understand rank-nullity theorem;
CO5: apply the rank-nullity theorem;
CO6: form a matrix associated with linear transformation;
CO7: understand the inner product and norm of a vector;
CO8: understand Gram-Schmidt orthogonalized process.

Course MTH-603: Real Analysis– III (SEM-VI)

At the end of course, students will able to

CO1: understand the concepts of convergence and divergence of series of real numbers;
CO2: understand the concepts of alternating, conditional and absolute convergence;
CO3: test for absolute convergence;
CO4: understand the definition of Riemann integral;
CO5: state the algebraic properties of Riemann integral;
CO6: know the mean value theorem of integral calculus.

Course MTH-604: Real Analysis– IV (SEM-VI)

At the end of course, students will able to

CO1: know the limit points, closure of a set, closed sets;
CO2: understand the concept homomorphism of metric space;
CO3: understand the dense set;
CO4: know the connected sets, bounded sets, totally bounded sets;
CO5: understand the concept of complete metric spaces;
CO6: understand the contraction mapping;
CO7: understand the Picard's fixed point theorem;
CO8: understand the concept of compact metric space;
CO9: understand the concept of open covering;
CO10: understand the Heine-Borel property;
CO11: understand the finite intersection property.

Course MTH-605: Discrete Mathematics– V (SEM-VI)

At the end of course, students will able to

CO1: apply the Set theory and Relation concepts;

CO2: find glb and lub of sets;
CO3: draw Hasse diagram;
CO4: understand the lattice and its properties;
CO5: classify the different types of lattice;
CO6: understand the concept of Boolean algebra;
CO7: represent Boolean function as sum of product canonical form;
CO8: represent Boolean function as product of sum canonical form;
CO9: minimize the Boolean function using Boolean algebra;
CO10: design the circuits using logical gates;
CO11: reduce the switching circuit diagram.

Course MTH-606: Number Theory-II (SEM-VI)

At the end of course, students will able to

CO1: solve the linear congruence;
CO2: apply Chinese-Remainder theorem to find the solution of simultaneous linear congruences;
CO3: apply Fermat's little theorem to compute powers of integers modulo prime numbers;
CO4: understand the concept of pseudo-primes;
CO5: apply the Wilson's theorem;
CO6: understand the concept of the Mobius inversion formula;
CO7: understand the Euler's Phi-function;
CO8: understand the Euler's theorem.

Course EG-6001: Operations Research-II (SEM-VI)

At the end of course, students will able to

CO1: identify the balanced and unbalanced transportation problem;
CO2: find the solution of transportation problem;
CO3: identify the balanced and unbalanced assignment problem;
CO4: find the solution of an assignment problem;
CO5: understand the terminology of Games;
CO7: identify the game without saddle point and with saddle point;
CO8: solve the game with mixed strategies;
CO9: use graphical method to solve $m \times 2$ or $2 \times n$ games.

DEPARTMENT OF BOTANY

B. Sc. Botany

Botany is a scientific study of plants. It includes the study of their structure, how they grow, how they can be effectively classified, the things that impact their development etc.
Botany is the branch of biology, which is study of all living organism.

Programme Outcomes:

Knowledge outcomes:

After completing B.Sc. Botany, students will be able to:

- **PO1:** identify cryptogamic plants;
- **PO2:** apply the knowledge of nursery management for propagation of economically important plants;
- **PO3:** cultivate some basic food crops;
- **PO4:** identify and utilize some basic medicinal plants;
- **PO5:** identify and control plant diseases;
- **PO6:** identify and control weed plants;
- **PO7:** identify phanerogamic plants.

Skill outcomes:

After completing B.Sc. Botany, students will be able to:

- **PO8:** collaborate effectively on team-oriented projects in the field of life sciences;
- **PO9:** communicate scientific information in a clear and concise manner, both orally and in writing;
- **PO10:** explain biodiversity, climate change and plant pathology;
- **PO11:** apply Physiology, Ecology and Plant breeding techniques in plant sciences;
- **PO12:** apply knowledge of medicinal and economic Botany in day to day life;
- **PO13:** apply the knowledge to develop the sustainable and eco-friendly technology in Industrial Botany.

Generic outcomes:

After completing B.Sc. Botany, students will be able to:

- **PO14:** have developed their critical reasoning, judgment and communication skills;
- **PO15:** apply their knowledge about cytology;
- **PO16:** enhance the scientific temper among the students so that they may participate in different competition at local and national level.

Program Specific Outcomes

- **PSO1:** Students get acquainted with techniques which are used in industrially important plant products;
- **PSO2:** Students get conceptual knowledge of entrepreneurships in mushroom cultivation, bio-fertilizers and bio-pesticide's production, fermentation, etc.
- **PSO3:** Understand the diversity of the plants and structural organization of plants like monocots and dicot;
- **PSO4:** Understand plant structures in the context of physiological and biochemical functions of plants.

Course Outcomes

F. Y. B. Sc. Sem I

Course 101: Plant Diversity
After successfully completing this course, students will be able to:

CO1: outline the Eichler classification system;
CO2: position the plants in five kingdom system;
CO3: describe prokaryotic and Eukaryotic cell structure;
CO4: classify the members of plants groups in to cryptogams and Phanerogams;
CO5: describe the general characters, structure and importance of Bacteria,
CO6: describe the general characters, structure and importance of Virus;
CO7: describe Nostoc and Spirogyra and their characters;
CO8: describe Mucor and Agaricus and their characters;
CO9: describe characters and importance of Lichen.

Course 102: Plant Diversity, Nursery management and utilization
After successfully completing this course, students will be able to:

CO1: describe Funaria and its characters;
CO2: describe Nephrolepis and it's characters;
CO3: practice cutting, layering, budding and grafting;
CO4: describe the importance of Fertilizers and pesticides;
CO5: describe the importance of methods of irrigation;
CO6: describe the morphology of root, stem, leaves and flowers;
CO7: describe the cultivation of Sugarcane, Paddy, Mango and Brinjal.

Course: Botany Practical (103)
After successfully completing this course, students will be able to:

CO1: examine the growth of bacteria in curd under microscope;
CO2: identify the thallus structure in Nostoc and Spirogyra;
CO3: identify Mucor and Agaricus;
CO4: identify the Lichen Usnea;
CO5: identify Funaria and Nephrolepis;
CO6: demonstrate the methods of vegetative propagation;
CO7: illustrate the root, stem, leaves, flowers and its types.

F. Y. B. Sc. Sem II

Course 201: Physiology, Ecology and Anatomy of Plants, Medicinal plants and plant pathology:
After successfully completing this course, students will be able to:

CO1: describe imbibitions, osmosis and plant movement;
CO2: describe Light and Dark reaction;
CO3: describe C_3 and C_4 cycle;
CO4: describe the ecological adaptation, morphology and anatomy of Hydrophytes, Mesophytes and Xerophytes;
CO5: describe the tissue system and vascular bundle in plants;
CO6: describe the types of stele;
CO7: describe the Ergastic matter;
CO8: describe the medicinal plants;
CO9: describe the plant pathology.

Course 202: Plant Diversity and Weed management:

After successfully completing this course, students will be able to:

CO1: describe weed management;
CO2: describe Cycas and its characters;
CO3: describe the types of phyllotaxy and aestivation;
CO4: descibe the types of Inflorescence and placentation;
CO5: describe some angiospermic families;
CO6: describe the methods of in-situ and ex-situ conservation;
CO7: describe botanical garden;
CO8: describe the importance of forest and their conservation.

Course: Botany Practical 203

After successfully completing this course, students will be able to:

CO1: demonstrate the plant physiological experiments;
CO2: identify and categorize hydrophytes, mesophytes and xerophytes;
CO3: identify different types of tissue;
CO4: identify different types of stele;
CO5: identify different types of vascular bundle;
CO6: identify and prepare slide of different types of Ergastic matter;
CO7: identify different medicinal plant;
CO8: diagnosis of different diseases in plants;
CO9: identify weed plants;
CO10: identify and prepare the slides of Cycas;
CO11: identify the morphological characters of plants;
CO12: identify the Morphological characters and floral dissection of some angiospermic families.

S. Y. B. Sc. Sem III

Course 301: **Plant Physiology and Plant Ecology**

After successfully completing this course, students will be able to:

CO1: explain water potential and root absorption;
CO2: explain respiration, it's types and mechanism;
CO3: explain ascent of sap and transpiration;
CO4: explain types and components of ecosystem;
CO5: explain energy flow in ecosystem;
CO6: explain plant communities- Halophytes, Epiphytes and Lithophytes;
CO7: explain Ecological factors;
CO8: explain Soil erosion and conservation.

Course 302: **Plant anatomy, Plant Embryology and Genetics**

After successfully completing this course, students will be able to:

CO1: explain the structure of primary tissue of roots, stem and leaves in monocot and dicot plants;
CO2: explain normal and anomalous secondary growth in some plants;
CO3: explain microsporangium and male gametophyte;
CO4: explain megasporangium and female gametophyte;
CO5: explain fertilization;
CO6: explain Mendel's laws of inheritance and his experiments in heredity;
CO7: explain genetic material and its structure.

Course 303: Diversity of Gymnosperms and Angiosperms

After successfully completing this course, students will be able to:

CO1: describe the gymnosperms Pinus and Gnetum;
CO2: describe weak stem plants and bracts;
CO3: describe special types of inflorescence and fruits;
CO4: explain Pollination and its types;
CO5: describe the defensive devices of plants;
CO6: explain aims and objectives of plant taxonomy;
CO7: describe and classify with reason some angiospermic families.

Course ID: **Nutrition and Dietetics**

After successfully completing this course, students will be able to:

CO1: explain classification of food groups and its importance;
CO2: describe nutritive value of food groups;
CO3: explain the concept of balance diet;
CO4: explain the use of RDI in planning balance diet;
CO5: explain the macro nutrients – carbohydrate, protein, fats and lipids;
CO6: describe the micro nutrients – vitamins, minerals and water;
CO7: explain food preservation and its methods;
CO8: explain meal planning and its principles.

Course 304 Botany practical

After successfully completing this course, students will be able to:

CO1: demonstrate the physiological experiment;
CO2: explain the working method of ecological instruments;
CO3: recognize ecological peculiarities of Orchid and Avicennia;
CO4: identify the primary tissue structure in stem of Sunflower and Maize;
CO5: identify the anomalous secondary in some plants;
CO6: identify the permanent slides of embryology;
CO7: prepare the slide of Pinus and Gnetum;
CO8: identify the weak stem plants, bracts, defensive devices of plants and special types of inflorescences;
CO9: identify the morphological characters of some angiospermic families and its floral dissection.

S. Y. B. Sc. Sem IV

Course 401: **Lower Cryptogams**

After successfully completing this course, students will be able to:

CO1: explain general characters and structure of phytoplankton;
CO2: explain general characters and economic importance of algae;
CO3: explain the classification of algae given by G. M. Smith;
CO4: explain and classify Oscillatoria, Oodogonium, Ectocapus and Batrachospermum;
CO5: explain the general characters, structure and economic importance of fungi;
CO6: explain the classification of fungi given by Alexopoulos;
CO7: explain and classify Pythium, Aspergillus, Peziza and Puccinia.

Course 402: **Higher Cryptogams**

After successfully completing this course, students will be able to:

CO1: explain the general characters, classification and economic importance of bryophytes;
CO2: explain the general account of Hepaticopsida, Anthocerotopsida and Bryopsida;

CO3: describe the amphibian adaptation of bryophytes;
CO4: explain classification and life history of Riccia and Anthoceros;
CO5: explain the general characters, classification, Habitat and Habit of Pteridophytes;
CO6: explain the general account of Lycopsida, Sphenopsida and Pteropsida;
CO7: explain the classification and life history of Equisetum, Marsilea and Selaginella.

Course 403: Plant Geography, Economic Botany, Seed Plants and Plant Pathology
After successfully completing this course, students will be able to:
CO1: describe minor forest product of Gujarat;
CO2: describe the cultivation of some economically importance plants;
CO3: explain the uses of some medicinal plants;
CO4: explain and classify with reason some seed plant;
CO5: explain pathogens and symptoms of some plant diseases.

Course ID: **Biodiversity**
After successfully completing this course, students will be able to:
CO1: describe the introduction and scope of biodiversity. CO2: Describe the importance and values of biodiversity;
CO2: explain the general pattern of vegetation of Gujarat;
CO3: explain the conservation of biodiversity;
CO4: describe the endangered, endemic, threatened and rare species of Gujarat;
CO5: explain the biodiversity of Flora, Fauna, Mangroves and Medicinal plants of Gujarat;
CO6: explain In-situ and Ex-situ Conservation;
CO7: explain biodiversity act and biological Hot-Spots.

Course 404: Botany practical
After successfully completing this course, students will be able to:
CO1: identify Oscillatoria, Oodogonium, Ectocarpus and Batrachospermum.
CO2: identify Pythium, Aspergillus, Peziza and Puccinia.
CO3: identify Anthoceros, Marsilea and Selaginella.
CO4: identify the minor products of forest.
CO5: identify the economically important plants.
CO6: identify the medicinally important plants .
CO7: identify the morphological characters of some angiospermic families and its floral dissection.
CO8: identify some plant diseases.

T. Y. B. Sc. Sem V

Course 501: **Algae and Fungi**
After successfully completing this course, students will be able to:
CO1: explain habit, habitat and thallus organization of algae;
CO2: explain classification according to Smith for some classes of algae;
CO3: describe the life history of some types of algae on basis of their classification with reason.
CO4: describe the general characters and classification of Fungi;
CO5: describe the general characters of division Eumycota;
CO6: explain the life history of some types of Fungi on the basis of their classification with reason.

Course 502: Plant pathology and Bryphyte

After successfully completing this course, students will be able to:

CO1: explain History of plant pathology and Indian plant pathologist;
CO2: explain Origin of plant diseases and it' reason;
CO3: explain the identification, characters and principles of control of plant diseases;
CO4: describe Fungicides and bio pesticides;
CO5: describe some bacterial and fungal diseases;
CO6: explain the general characters, classification and economic importance of bryophytes;
CO7: explain the general account of Hepaticopsida, Anthocerotopsida and Bryopsida;
CO8: describe the amphibian adaptation of bryophytes;
CO9: explain classification and life history of Marchantia, Porella, Notothyllus and Sphagnum.

Course 503: Plant biotechnology, Biostatistics and Molecular biology

After successfully completing this course, students will be able to:

CO1: describe r-DNA methods;
CO2: describe Restriction endonuclease, Ligase and cloning vectors;
CO3: describe DNA- finger printing and PCR;
CO4: explain history and importance of biotechnology;
CO5: describe somatic hybridization and artificial seed;
CO6: describe anther culture and embryo culture;
CO7: describe clonal propagation and genetic engineering of plants;
CO8: describe genetic manipulation in plant cell and uses of biotechnology;
CO9: describe history, function, limitation, importance and classification of Biostatistics;
CO10: describe Measurement of Central tendency and standard deviation.

Course 504: Plant physiology and biochemistry

After successfully completing this course, students will be able to:

CO1: explain Diffusion, Osmosis, plasmolysis and absorption;
CO2: explain Ascent of sap, translocation, photosynthesis and respiration;
CO3: explain growth and mineral nutrition;
CO4: describe growth promoters and growth retardants;
CO5: describe some physiological instrument;
CO6: explain pH and Buffer;
CO7: explain solution and colloidal system;
CO8: explain protoplasm as a colloidal system;
CO9: explain enzymes, amino acids and carbohydrates.

Course 505: Anatomy and Embryology

After successfully completing this course, students will be able to:

CO1: explain Laticiferous tissues;
CO2: explain root stem transition;
CO3: explain vascular cambium and nodal anatomy;
CO4: explain Periderm and lenticell;
CO5: explain leaf abscission and anomalous secondary growth in some plants;
CO6: explain Megasporogenesis and types of embryo sac;
CO7: explain Double fertilization and endosperm;
CO8: explain Embryo and Embryogenesis in dicot and monocot;
CO9: explain nutrition of embryo and poly embryony.

Course 506: Angiosperm morphology, Systemic botany and environmental issues:

After successfully completing this course, students will be able to:

CO1: explain plant morphology (Leaf, Calyx, Corolla and seed);

CO2: explain epiphytes, parasites and saprophytes;
CO3: explain history and types of classification of taxonomy;
CO4: explain fundamentals of nomenclature;
CO5: explain binomial nomenclature and ICBN;
CO6: explain and classify with reason some angiospermic families;
CO7: explain some environmental issues;
CO8: explain some acts related to environment protection.

CAN Course: Horticulture
After successfully completing this course, students will be able to:
CO1: explain aims, branches and importance of horticulture.
CO2: explain cutting, layering, budding and grafting.
CO3: explain preservation and it's methods.
CO4: explain preparation of Jam, Jelly and Sauce.
CO5: explain causes of spoilage of fruits.
CO6: explain the role of hormones in horticulture.
CO7: describe cultivation of some fruit plants.
CO8: describe cultivation of some vegetable plants.

Course Botany practical 11:
After successfully completing this course, students will be able to:
CO1: identify and prepare the slides of some algae.
CO2: identify and prepare the slides of some Fungi.
CO3: identify and prepare the slides of some Bryophyte.
CO4: identify some bacterial, fungal and viral diseases.

Course Botany practical 12:
After successfully completing this course, students will be able to:
CO1: demonstrate and perform the physiological experiment;
CO2: demonstrate the some physiological instrument;
CO3: test the presence of reducing sugar, non reducing sugar and amino acid by performing biochemical experiments;
CO4: mount embryo of any dicot plant;
CO5: identify the permanent slide of embryology.

Course Botany practical 13:
After successfully completing this course, students will be able to:
CO1: identify leaf shape, leaf margine and some local angiospermic plants.
CO2: identify anomalous secondary growth in some plants.
CO3: prepare permanent slides.
CO4: measure the dimensions of micro organisms by using stage micrometer and ocular micrometer.
CO5: measure the microscopic structure and sketching it with the help of camera lucida.
CO6: prepare the slides of Nodal anatomy.

T. Y. B. Sc. Sem VI

Course 601: **Pteridophytes and paleobotany**
After successfully completing this course, students will be able to:
CO1: explain the general characters and classification of pteridophytes;
CO2: explain the general characters of some classes belonging to Pteridophytes;

CO3: describe the life history of Selaginella, Ophioglossum and Azolla;
CO4: describe Fossillization and types of fossil;
CO5: describe the nomenclature of fossils and geological time table;
CO6: explain the life history and classification of Rhynia, Psilotum, Lepidodendron and Sphenophyllum.

Course 602: Gymnosperm, Fossil Gymnosperm and Botanical techniques:
After successfully completing this course, students will be able to:
CO1: explain the general characters of gymnosperm;
CO2: explain the affinities of gymnosperm with Pteridophytes and Angiosperm;
CO3: explain the classification and important characters of some orders belonging to gymnosperm;
CO4: describe classification and life history of Taxus, Ginkgo and Ephedra;
CO5: describe the general account of some fossil gymnosperm;
CO6: explain herbarium techniques and micro techniques;
CO7: explain camera lucida.

Course 603: Cell biology and Genetics
After successfully completing this course, students will be able to:
CO1: describe ultra structure and function of some organelles in plant cell;
CO2: describe cell cycle, mitosis and meiosis;
CO3: describe nucleic acids and structure and types of DNA and RNA;
CO4: explain DNA replication, transformation and transduction;
CO5: describe genetic code, mutation and Lac-operon;
CO6: describe chromosomal aberration and protein synthesis.

Course 604: Plant ecology and phytogeography
After successfully completing this course, students will be able to:
CO1: explain Soil as an Edaphic factor;
CO2: explain biotic factor relationship among the organisms;
CO3: explain characteristics and classification of plant community;
CO4: describe ecological niche;
CO5: describe quadrate ans transect method of studying vegetation;
CO6: explain causes, process, kinds and rate of succession;
CO7: explain limiting factor and trend in succession, hydrosere and xerosere;
CO8: explain forest and desert vegetation in Gujarat;
CO9: explain Mangrove Himalaya vegetation in Gujarat;
CO10: explain remote sensing and biological clock.

Course 605: Economic Botany and Pharmacognosy
After successfully completing this course, students will be able to:
CO1: explain classification of fibers and some fiber yielding plants;
CO2: explain Definition, properties, types and uses of wood;
CO3: explain some timber and firewood plants;
CO4: explain the general characters and cultivation of beverages;
CO5: explain evaluation of drugs by different methods;
CO6: explain classification of drugs;
CO7: explain drugs obtained from different parts of the plants;
CO8: explain detailed study on some medicinal plants;
CO9: explain nutrition of embryo and poly embryony.

Course 606: Taxonomy and Palynology

After successfully completing this course, students will be able to:

CO1: explain aims of botanical garden;
CO2: explain botanical gardens of world and India;
CO3: explain BSI;
CO4: explain major systems of classification of angiosperm;
CO5: explain and classify with reason some angiospermic families;
CO6: explain pollen morphology and application of palynology;
CO7: explain importance of pollen and pollen allergy.

CAN Course: Gardening

After successfully completing this course, students will be able to:

CO1: explain soil, land scaping and garden.
CO2: explain plough, manure and irrigation.
CO3: explain pruning, framing and fancing.
CO4: explain flower arrangement and cultivation of some flowering plants.

Course: Botany practical 14

After successfully completing this course, students will be able to:

CO1: identify and prepare the slides of some Pteridophyte;
CO2: identify some fossil slides of pteridophyte;
CO3: identify and prepare the slides of some Gymnosperm;
CO4: identify some fossil slides of gymnosperm and fossil stone.

Course: Botany practical 15

After successfully completing this course, students will be able to:

CO1: demonstrate and perform some experiment related to plant ecology;
CO2: demonstrate some ecological instrument;
CO3: prepare the slides of different stages of Mitosis and meiosis.

Course: Botany practical 16

After successfully completing this course, students will be able to:

CO1: identify the plants important as fibers, timbers and beverages;
CO2: identify some plant drugs;
CO3: identify some medicinal plants;
CO4: identify the morphological characters of some angiospermic families and its floral dissection.

Department of Zoology

Goals

Zoology is a branch of science that deals with the animal kingdom, including the structure embryology, evolution, classification, habits and distribution of all animals, both living and extinct and how they interact with their ecosystems. B. Sc. in Zoology is an undergraduate program which is premeditated to introduce students to the study of Zoology at the organismal and organ function levels. The theoretical part of the program deals with the general principles of classical as well as modern Zoology. The program provides the student with an introduction to the recent advances in Zoology in the areas of systematic, evolution, reproduction, development, animal diversity, biochemistry, cytology and animal ecology. This course is offered for candidates who are interested in the study of animals. The minimum time required to complete the course is three years.

Program Specific Outcomes (PO)

After successfully completing B. Sc. (Zoology) Program, the student will be able to:

PSO1: communicate scientific information through effective formal and informal methods generally used in sciences;
PSO2: conduct basic scientific research and provide inputs for societal benefits;
PSO3: develop competence in basic sciences and in the content of the specific courses that constitute the principal knowledge of their degree;
PSO4: compare and contrast the characteristics of animals that differentiate them from other forms of life;
PSO5: acquire the basic skills in handling scientific instruments, planning and performing in laboratory experiments;
PSO6: understand and be aware of relevant theories, paradigms, concepts and principles of Zoology;
PSO7: understand the structure and functions of cell types and cell organelles;
PSO8: correlate the various biotic and abiotic factors with ecosystems;
PSO9: explain the role and relevance of various bio-molecules in living systems;
PSO10: apply the knowledge of Zoology to understand the complex life processes and phenomena;
PSO11: to connect and apply biological knowledge to other disciplines and to integrate knowledge into their personal and professional lives;
PSO12: explain the origin of life with context to the origin of eukaryotic cell and endosymbiotic theory of origin, fossil records, Darwinism and Neo-Darwinism, experimental evidences;
PSO13: illustrate zoological science for its application in branches like medical entomology, apiculture, aquaculture and agriculture etc.;
PSO14: understand animal interactions with the environment and identify the major groups of organisms with an emphasis on animals and classify them within a phylogenetic framework.

Course Outcomes (CO)

F. Y. B. Sc.

Course: (Z – 101) Systematics and Animal Diversity

After successfully completing this course, students will be able to:

CO1: describe the salient features and structural organization in different non-chordate phylum (Protozoa to Echinodermata) with examples;
CO2: describe the systematic position, morphology, habit and habitat, and various systems in *Fasciola hepatica*;
CO3: describe the salient features in different chordates (Pisces to Mammals) with examples;
CO4: identify and describe the difference between chondrichthyes and osteichthyes and osmoregulation in Pisces with suitable examples;
CO5: explain the different methods of parental care in Amphibian;
CO6: identify and explain the poisonous and non-poisonous snakes;
CO7: describe different types of flight adaptations in Aves;
CO8: explain the origin of mammals by different theories.

Course: (Z – 102) Cytogenetics, Ecology and Ethology

After successfully completing this course, students will be able to:

CO1: explain the structural organization of Prokaryotic and Eukaryotic cells;
CO2: describe the structure and functions of cell organelles;
CO3: explain the types, structure and function of chromosomes;
CO4: explain Mendel's principles and concepts of inheritance;
CO5: describe various terminologies in genetics;
CO6: explain the basic concepts of ecology and different types of ecosystems;
CO7: explain the ecological adaptations with suitable examples;
CO8: describe the basic concept and patterns of behavior;
CO9: explain nesting behavior in weaver bird and hornbill and social behavior in honeybee;
CO10: describe the behavioral disorders Alzheimer's and Dementia.

Course: Practical (Z – 101) Systematics and Animal Diversity

After successfully completing this course, students will be able to:

CO1: identify, enlist, categorize and draw various non-chordate animals from phylum Protozoa to Hemichordata;
CO2: identify, enlist, categorize and draw various chordate animals from protochordate to mammals;
CO3: identify and describe different larval stages of liver fluke and T. S. and L. S. of Sycon with labeled diagrams;
CO4: identify and explain the poisonous and non-poisonous snakes;
CO5: acquire the knowledge of the animal diversity with the help of animal album.

Course: Practical (Z – 102) Cytogenetics, Ecology and Ethology

After successfully completing this course, students will be able to:

CO1: explain the modifications and adaptations in animals;
CO2: describe the structure and functions of cell organelles;
CO3: describe the nesting behaviour in Weaver bird and Hornbill and social behavior in Honeybee;
CO4: explain and identify different blood groups and Rh factor;
CO5: define and describe different types of genes, with suitable examples.

Course: (Z – 201) Comparative anatomy of Chordates, Applied Zoology, Wildlife Biology

After successfully completing this course, students will be able to:

- **CO1:** explain the integumentary system in vertebrates with respect to glands and digital tips;
- **CO2:** describe the comparative anatomy of digestive, respiratory and circulatory system in vertebrates;
- **CO3:** describe the types of receptors including eyes, ears, tongue, skin and nose;
- **CO4:** describe different human diseases like Dengue, Leptospirosis, Chikungunya and Swine flu;
- **CO5:** explain the importance, management and application of poultry farming;
- **CO6:** describe the importance of wild life conservation;
- **CO7:** explain the basic concepts of national parks and sanctuaries with emphasis on national parks and sanctuaries of Gujarat.

Course: (Z – 202) Life Processes, Biochemistry, Immunology and Tissue System

After successfully completing this course, students will be able to:

- **CO1:** describe nutrition and digestion in human and reproduction and its types in different animals;
- **CO2:** explain pH and buffers in biological systems;
- **CO3:** describe control and regulation of metabolism at cell, gene and hormonal level;
- **CO4:** explain constituents, sources, functions and deficiency status of balanced diet;
- **CO5:** describe basic concepts of immunology and types of immune responses;
- **CO6:** explain the types, structure and functions of different types of tissues.

Course: Practical (Z – 201) Comparative Anatomy of Chordates, Applied Zoology, Wildlife Biology

After successfully completing this course, students will be able to:

- **CO1:** describe the integumentary system in vertebrates;
- **CO2:** explain, compare and draw labeled diagrams of the digestive system with respect to alimentary canal and digestive glands;
- **CO3:** explain, compare and draw labeled diagrams of the respiratory system with respect to gills, lungs, air sacs and swim bladder;
- **CO4:** explain, compare and draw labeled diagrams of the circulatory system with respect to evolution of vertebrate heart;
- **CO5:** identify and describe different sense organs;
- **CO6:** explain the human diseases - Dengue, Leptospirosis, Chikungunya and Swine flu;
- **CO7:** describe different poultry appliances – brooder, feeder, water appliances and candling.

Course: Practical (Z – 202) Life Processes, Biochemistry, Immunology and Tissue System

After successfully completing this course, students will be able to:

- **CO1:** describe the control of food ingestion and T.S of intestine of mammals;
- **CO2:** explain different salivary glands in human;
- **CO3:** explains various diseases caused due to vitamin deficiency – Night blindness, xeropthalmia, rickets, scurvy, beri beri and pellagra;
- **CO4:** describe different types of reproduction;
- **CO5:** explain the types, structure and functions of different types of tissues.

S. Y. B. Sc.

Course: (Z – 301) Non-chordates, Evolution and Economic Zoology

After successfully completing this course, students will be able to:

- **CO1:** describe the general study of Non-Chordate Phyla up to Subclass with examples: - Protozoa, Porifera, Coelenterata (Cnidaria), Helminthes and Annelida.
- **CO2:** explain the structure and functions of various organs of all systems of Leech.
- **CO3:** describe variation, fossorial, cursorial, deep sea and cave dwelling adaptations with suitable examples.
- **CO4:** explain the importance of sericulture and apiculture in details.

Course: (Z – 302) Chordates, Histology and Osteology

After successfully completing this course, students will be able to:

- **CO1:** explain the general study of the protochordates and chordates up to subclass with examples: Urochordata, Cephalochordate, Cyclostomes and Pisces;
- **CO2:** describe the study of scoliodon (Dog Fish) with reference to its structure and functions of various organs of all the systems;
- **CO3:** explain the histology of mammalian tissues– stomach, intestine, liver, salivary gland, pancreas, kidney and gonads;
- **CO4:** describe the girdles in frog, scoliodon, varanus, pigeon and rabbit.

Course: (Z – 303) Animal Physiology

After successfully completing this course, students will be able to:

- **CO1:** explain the types and structure of muscle fibers and physiology of muscle contraction;
- **CO2:** describe the structure of nerves and mechanism of nerve impulse;
- **CO3:** describe and label various parts of human sense organs – eye and ear;
- **CO4:** explain the structure of uriniferous tubules and counter current mechanism;
- **CO5:** describe the urine formation and its hormonal control, rennin-angiotensin system;
- **CO6:** explain osmoregulation in freshwater and marine animals;
- **CO7:** explain osmosis, diffusion and Donnan's equilibrium;
- **CO8:** describe the basic concepts of haematology;
- **CO9:** describe the composition of blood, haemopoesis and types of blood groups.

Course: Marine science (EG)

After successfully completing this course, students will be able to:

- **CO1:** explain Scope of marine science:
- **CO2:** describe Geology of the ocean:
- **CO3:** describe Types of seashores and their fauna
- **CO4:** explain Microorganisms: - phytoplanktons, zooplanktons, red algae, brown algae, green algae, multicellular algae, Economic importance of algae, 2) Macro organisms: - Invertebrates-commercial importance of marine sponges, Mollusca, arthropods (crab and prawns), Vertebrate: economic importance of Scoliodon (sharks) and marine mammals.

Course: Practicals (Z – 301) Non-chordates, Evolution and Economic Zoology

After successfully completing this course, students will be able to:

- **CO1:** identify and classify the following animals up to--sub-class: Amoeba, Euglena, Monocystis, Paramoecium, Leucosolenia, Hyalonema, Spongilla, Hydra, Porpita, Aurelia, Gorgpnia, Sea- anemone, Planaria, taenia, Liver-fluke, Ascaris, Earthworm, Leech, Nereis;

CO2: describe and draw labeled diagrams of digestive system and mounting of salivary gland, reproductive system and mounting of jaws, nervous system and mounting of testicular nephridia of Leech;

CO3: identify and describe fossorial adaptations in Arenicola and Talpa; deep sea adaptations in Giant squid, Octopus, Flat fish and Arrow fish; cave dwelling adaptations in Troglobite, Proteus (*Proteus anguinus*); cursorial adaptations in Cheetah, Horse, Wolves, Deer and variation - digits in man and giraffe;

CO4: identify and describe life history of Indian mulberry silk wrom (Bombyx mori);

CO5: identify and describe life history, queen, drones, workers, wax and modern movable beehive.

Course: Practicals (Z – 302) Chordates, Histology and Osteology

After successfully completing this course, students will be able to:

CO1: identify and classify the following animals up to--sub-class: ascidian, amphioxus, lamprey, myxine, Scoliodon, electricray, protopterus, clarius, seahorse, ophiocephalus, labeo;

CO2: describe and draw labeled diagrams of digestive system and temporary mounting of placoid scales, urino-genital system and mounting of ampulla of Lorenzinii, circulatory system, brain-dorsal and ventral view of Scoliodon;

CO3: describe and draw labeled diagrams of mammalian histology of salivary gland, liver, stomach, pancreas, intestine, kidney and gonads;

CO4: identify and describe girdles in Scoliodon, frog, varanus, pigeon and rabbit.

Course: Practical (Z – 303) Animal Physiology

After successfully completing this course, students will be able to:

CO1: describe and perform the experiment of haemin crystals from human blood and its significance;

CO2: describe and perform total count of WBC from human blood;

CO3: estimate hemoglobin from human blood;

CO4: determine normal and abnormal constituents of urine;

CO5: describe and draw labeled diagrams of different types of muscle fibers- striated, nonstriated, medulated, non modulated and cardiac; sensory organs – human eye and ear and different types of nerve cells.

Course: (Z – 401) Non-chordates, Evolution and Economic Zoology

After successfully completing this course, students will be able to:

CO1: describe general study of non-chordate phyla up to subclass with examples: Arthropoda, Mollusca, Echinodermata and Hemichordata;

CO2: explain the structure and functions of various organs of all systems of cockroach;

CO3: describe isolation, speciation, protective coloration and mimicry;

CO4: explain the economic importance of Lac culture and vermiculture.

Course: (Z – 402) Chordates, Embryology and Osteology

After successfully completing this course, students will be able to:

CO1: explain general study of the following protochordates and chordates up to subclass with examples: Amphibians, Reptilians, Aves and Mammals;

CO2: explain the animal type with reference to their structure and functions of various organs of all systems of Pigeon;

CO3: describe different types of eggs and cleavage patterns, development in amphioxus (up to tabulation);

CO4: explain comparative osteology of fore limbs and hind limbs in frog, varanus, pigeon and rabbit.

Course: (Z – 403) Cytogenetics and Biochemistry

After successfully completing this course, students will be able to:

CO1: describe different tools and techniques used in cytology;
CO2: explain Cell cycle and cell division;
CO3: describe structure and function of genetic material;
CO4: describe control of gene expression in prokaryotes and eukaryotes;
CO5: explain chromosome mapping, linkage, crossing over, types of RNA;
CO6: describe sex determination and dosage compensation (Heteropycnosis), sex-linked inheritance and cytoplasmic inheritance and modified Mendelian ratios with suitable examples;
CO7: Explain general introduction and structure of carbohydrates, proteins and lipids.

Course: Marine science (EG)

After successfully completing this course, students will be able to:

CO1: describe Adaptations- bony fish surviving in near freezing water, sea birds, whales and their relations, Voyage of green sea turtle, general characters of bony and cartilaginous fishes, Coral and coral reefs: types, economic importance and threats;
CO2: explain Marine Pollution -Causative factors and impacts;
CO3: describe Introduction to aqua culture-History, scope and present status;
CO4: explain general idea of different aquaculture practices-mono culture, poly-culture, extensive culture and intensive culture.

Course: Practical (Z – 401) Non-chordates, Evolution and Economic Zoology

After successfully completing this course, students will be able to:

CO1: identify and classify the following animals up to--sub-class: Peripetus, Crab, Palaemon, Lobster, Grasshopper, Termite, Silverfish, Centipede, millipede, Spider, Scorpion, Butterfly, Chiton, Unio, Aplysia, Sepia, Starfish, Brittle star, Sea cucumber, Feather star, Balanoglossus;
CO2: describe and draw labeled diagrams of digestive system and mounting of 1st and 2nd thoracic spiracles; Reproductive system and mounting of gizzard; Nervous system and mounting of abdominal spiracle;
CO3: identify and describe protective coloration and mimicry Leaf insect, Stick insect, Lantern fly, Eyespot butterfly, Australian seahorse and rattle snake;
CO4: identify and describe life history of Lac insect;
CO5: identify and describe vermiculture, types of earthworms and vermicompost practices.

Course: Practical (Z – 402) Chordates, Embryology and Osteology

After successfully completing this course, students will be able to:

CO1: identify and classify the following animals up to sub-class: Frog, hyla, bufo, salamander, amblystoma, caecilian, calotes, varanus, turtle, dhaman, Russel's viper, cobra, krait, pigeon, koel, sparrow, platypus, bat and rat;
CO2: describe and draw labeled diagrams of digestive system and mounting of hyoid apparatus; Circulatory system; Urino-genital system and mounting of pectin and brain and air sacs of Pigeon;
CO3: identify and describe amphioxus embryology: Uncleaved egg, 2, 4, 8, 16 and 32 cell stage, blastula, gastrula, T. S. passing through pharynx, intestine, testis, ovary and caudal region;

CO4: describe the osteology of fore limbs and hind limbs in Frog, varanus, pigeon and rabbit

Course: Practical (Z – 403) Cytogenetics and Biochemistry

After successfully completing this course, students will be able to:

CO1: demonstrate microtome and microtechniques;
CO2: prepare and study different stages of mitosis from onion root tip;
CO3: prepare and study different stages of meiosis from cockroach testis;
CO4: identify and describe cell division from permanent slides;
CO5: describe Cytoplasmic inheritance with example of coiling of shell in Lymnaea;
CO6: describe structure of carbohydrates- triose, pentose, hexose sugar, lipid and glycerol.

T. Y. B. Sc.

Course: (Z – 501) Non-chordates

After successfully completing this course, students will be able to:

CO1: explain the taxonomy of non-chordates phyla to up to order and structural organization of different classes of non-chordates. (Protozoa to Annelida);
CO2: describe structure and functions of various organs of all systems of scorpion;
CO3: explain locomotion, nutrition and economic importance in protozoa;
CO4: describe canal system, skeletal system and reproduction in porifera;
CO5: explain polymorphism, coral and coral reefs in coelenterate;
CO6: explain parasitism and morphological adaptations in helminthes;
CO7: describe metameric segmentation, coelomoducts and nephridia in annelid;
CO8: describe phyllogenetic relationships of the minor phyla Brachiopoda and Chaeto-gnatha and their general organization.

Course: (Z – 502) Chordates

After successfully completing this course, students will be able to:

CO1: describe taxonomy of chordate up to order including protochordata, cyclostomes, pisces and amphibian;
CO2: describe structure and functions of various organs of all systems of Labeo;
CO3: explain comparative anatomy of aortic arches, vertebral column and heart;
CO4: describe origin of chordates, phylogeny and affinities in cyclostomes, dipnoi, types of scales and air bladder in pisces;
CO5: explain origin and evolution, parental care and neoteny in amphibia.

Course: (Z – 503) Biochemistry

After successfully completing this course, students will be able to:

CO1: define and classify the enzymes with various examples;
CO2: describe the mechanism of enzyme action, factors affecting it and enzyme inhibition.
CO3: define and classify the carbohydrates with examples;
CO4: illustrate the reactions, energetics and regulation of glycolysis, gluconeogenesis, glycogenesis, glycogenolysis, Krebs cycle, electron transport chain and oxidative phosphorylation;
CO5: explain hormonal control of carbohydrate metabolism and disorders related to it;
CO6: describe classification, structure, metabolism and hormonal control of proteins;
CO7: describe classification, structure, metabolism and hormonal control of lipids.

Course: (Z – 504) Embryology and Wildlife Biology

After successfully completing this course, students will be able to:

CO1: explain the nature and scope of embryology, importance of developmental Zoology, branches of embryology and its applications.
CO2: describe gametogenesis, fertilization, estrous and menstruous cycles, placenta and placentation.
CO3: explain fertilization, cleavage, blastulation, gastrulation, formation of germ layers and primitive streak in chick embryo.
CO4: describe structure of 24, 36, 42, 48, 50, 60 and 72 hours of chick embryo
CO5: explain wild life conservation and management, conservation projects: wild ass, tiger, crocodile and black buck and endangered, vulnerable and threatened species.

Course: (Z – 505) Forensic science and Toxicology

After successfully completing this course, students will be able to:

CO1: explain scope, history and development of forensic science, its basic principles, dactylography, foot prints, tattoo marks, occupational marks, speech and voice;
CO2: describe the morphology and biochemistry of human and other animal hair, DNA fingerprinting, wildlife and forensic science;
CO3: explain concept and scope of toxicology, disciplines of toxicology and toxicants and their classification;
CO4: describe incidental and intentional food additives, terms related to adverse reactions to food, food-borne molds and mycotoxins (food contaminants) and testing of food additives.

Course: (Z – 506) Genetics and Molecular Biology

After successfully completing this course, students will be able to:

CO1: explain the gene structure and functions in details;
CO2: describe human cytogenetics, techniques in human chromosomal analysis, human karyotype, chromosomal aberrations and syndromes, metabolic disorders, gene mutations, genetic code and protein synthesis;
CO3: explain structure of atoms, molecules and chemical bonds, composition, structure and formation of bio-molecules (proteins, nucleic acids, vitamins);
CO4: explain the principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, catalysis, mechanism of enzyme and isoenzymes;
CO5: describe the principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics and colligative properties).

Course: Fisheries (EG)

After successfully completing this course, students will be able to:

CO1: describe natural and cultivated pond construction, layout, management and productivity;
CO2: explain induced breeding methods in major carp;
CO3: describe fish seed collection and transportation;
CO4: explain aquarium fishes and its management;
CO5: identify and describe crafts and gears used in fresh and marine water fisheries;
CO6: describe marine pollution in details.

Course: Practical (Z – 501) Non-chordates

After successfully completing this course, students will be able to:

CO1: identify and classify the following animals up to order: Volvox, ceratium, entamoeba, polystomella, plasmodium, opalina, balantidium, leucosolenia, hyalonema, euspongia, obelia, millipora, physalia, valella, rhizostoma, tubipora, alcyonium, cerianthus,

pennatula, virgularia, adamsia, zoanthus, favia, fungia, astrea, clinorches, trichinella, sabella, serpula, arenicola, eurythoe, polynoe, acanthobdella;

CO2: identify and describe some aquatic invertebrates like euglena, paramoecium, vorticella, hydra, daphnia and Cyclops from the culture;

CO3: describe and draw labeled diagrams of L. S. and T. S. of sycon and leucosolenia, sponge spicules and gemmules;

CO4: describe and draw labeled diagrams of digestive system, nervous system, reproductive system and mounting of pecten of Scorpion.

Course: Practical (Z – 502) Chordates

After successfully completing this course, students will be able to:

CO1: identify and classify following animals up to order. Oikopleura, Salpa, Doliolum, Lamprey, Myxine. Pristis, Anabas, Polyodon, Eel, Pterois, Siren, Uraeotyphlus and Bufo;

CO2: describe and draw labeled diagrams of digestive system, urinogenital system and brain of bony fish;

CO3: prepare temporary mounting of scales from scoliodon (placoid), Labeo (cycloid), mullet (ctenoid);

CO4: describe parental care in Amphibia (charts/models/photographs);

CO5: describe and draw labeled diagrams of vertebral column in Shark, Frog, Varanus, Pigeon and Rabbit.

Course: Practical (Z – 503) Biochemistry

After successfully completing this course, students will be able to:

CO1: perform qualitative test for organic compound. a) carbohydrates - glucose, fructose, maltose, lactoseand sucrose b) proteins: - albumin and casein;

CO2: prepare atomic models of glucose, fructose, galactose, maltose, lactose, sucrose, valine, threonine, glycine, alanine and glycerol;

CO3: demonstrate factors affecting enzymes activity (temperature and pH);

CO4: demonstrate the digestive enzymes from Human Saliva;

CO5: detect amino acid by paper chromatography.

Course: Practical (Z – 504) Embryology and Wildlife Biology

After successfully completing this course, students will be able to:

CO1: identify and describe different types of mammalian placenta;

CO2: identify and describe chick embryology: Unfertilized egg, different stages cleavage, morula, blastula, gastrula, primitive streak, development of 24, 36, 42, 48, 50, 60 and 72 hrs;

CO3: describe the following projects: wild ass, lion, tiger, crocodile, and black buck-their locations in map of India, present status and significance.

Course: Practical (Z – 505) Forensic science and Toxicology

After successfully completing this course, students will be able to:

CO1: identify and describe different types of finger prints and tattoo marks;

CO2: identify and describe the morphology of different hairs- man, dog, horse, cow, buffalo and goat;

CO3: identify and describe various samples of food additives/preservatives and their usages (vinegar, benzoic acid, formic acid, citric acid and gelatin);

CO4: identify and describe food contaminants on - bread, chapati, curd, fruits;

CO5: demonstrate Tests of adulterated milk, black pepper, khoya (maava of milk), edible oil, coconut oil, ghee, rabdi and butter;

CO6: describe DNA finger printing method through chart.

Course: Practical (Z – 506) Genetics and Molecular Biology

After successfully completing this course, students will be able to:

CO1: identify and describe Karyotyping (Aberrations in human chromosomes by charts. (Klinefelter'syndrome, Down's syndrome, Philadelphia's syndrome, Turner's syndrome, Cri-du-chat syndrome);
CO2: prepare adenine, thymine, guanine and cytosine by models;
CO3: prepare DNA and RNA by models;
CO4: prepare triose, tetrose, pentose, hexose, triglycerides, caesin, mucin, water soluble vitamins and fat soluble vitamins;
CO5: identify and describe transgenic animal (Dolly sheep).

Course: (Z – 601) Non-chordates

After successfully completing this course, students will be able to:

CO1: explain the taxonomy of non-chordates phyla to up to order and structural organization of different classes of non-chordates (Arthropoda to Echinodermata);
CO2: describe structure and functions of various organs of all systems of sepia and sea star;
CO3: explain respiration, excretion, neurohormonal regulation of moulting and ecdysis, crustacean larvae and its significance, social insects Honey Bee, Termite, Ant and Wasp;
CO4: explain the economic importance of mollusca;
CO5: describe torsion and detorsion in gastropoda;
CO6: describe water-vascular system, larval forms and evolutionary significance in echinodermata.
CO7: describe phyllogenetic relationships of the minor phyla Endoprocta and Ectoprocta and their general organization.

Course: (Z – 602) Chordates

After successfully completing this course, students will be able to:

CO1: explain taxonomy of chordate up to order, including Reptilia, Aves and mammalian;
CO2: describe structure and functions of various organs of all systems of calotes;
CO3: explain mesozoic reptiles, rhyncocephalia and its phylogenetic importance, poisonous and non poisonous snakes;
CO4: describe bird migration, types and development of feathers, modifications of beak and feet and Ratitae in aves;
CO5: explain dentition, structure and development of tooth, Metatheria, Cetacea, Proboscidea, Primates in mammals;
CO6: describe the mammalian histology of pituitary, thyroid, parathyroid, adrenal, thymus and gonads.

Course: (Z – 603) Animal Physiology

After successfully completing this course, students will be able to:

CO1: describe aquatic and terrestrial respiratory mechanism;
CO2: explain hypoxia, O_2 dissociation curve. Respiratory quotients, BMR, transport of gases, exchange of gases, respiratory pigments, neural and chemical regulation of respiration;
CO3: explain structure of mammalian heart, properties of cardiac muscles and internal circulation, (systematic, pulmonary and coronary) cardiac-cycle and cardiac output;
CO4: describe stroke volume, blood pressure, ECG, blood coagulation, hormonal, ionic and nervous regulation of heartbeat;

CO5: explain chemical nature and kinds of hormones, mechanism of hormone action, regulation of hormone and secretions;

CO6: describe endocrine, paracrine and autocrine system and significance of endocrine and neuro-endocrine system;

CO7: describe hormones of pituitary gland, thyroid gland, parathyroid gland, pancreas, adrenal gland, gastrointestinal hormones, testis and ovary;

CO8: explain thermoregulation, heat production and heat loss and temperature regulating mechanism.

Course: (Z – 604) Entomology

After successfully completing this course, students will be able to:

CO1: describe introduction to entomology, history, development, scope, applications and branches of entomology, evolution of insects and their position in animal kingdom and general characteristics of phylum Arthropoda;

CO2: explain agricultural entomology with respect to pests of field crops (sugarcane, cotton and oilseed) and their management;

CO3: explain pests of horticultural crops (fruits and vegetables) and their management.

CO4: describe insect pests of stored grains and their management (rice weevil, saw toothed grain beetle, Khapra beetle, rice moth, lesser grain borer);

CO5: explain morphology, vectorship, pathogenicity and control of: mosquito, housefly, ratfleas, and head louse;

CO6: explain morphology, vectorship, pathogenicity and control of: pests of domestic animals, horse and cattles;

CO7: describe beneficial insects (economic importance of honey bee, silkworm, lac insect, pollinators, scavengers, Insect as a source of drugs and dyes);

CO8: describe household pests: morphology, damage caused and control measure of: cockroach, ants and termites and bed bugs.

CO9: explain insect pest control methods (bio control, integrated pest management, insecticides and pesticides);

CO10: describe appliances used for pest management.

Course: (Z – 605) Cell biology and Bioinstrumentation

After successfully completing this course, students will be able to:

CO1: describe tools and techniques: electron microscope, fluorescence microscope, phase contrast microscope, paper chromatography, electrophoresis, centrifugation and DNA staining;

CO2: explain methods for cytology and cytochemical analysis: examination of living cells, fixation, embedding and sectioning and cytological staining;

CO3: describe cell membrane structure and function: structure of cell membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport;

CO4: explain ultra structure and function of intracellular organelles: nucleus, mitochondria, golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids and vacuoles;

CO5: describe ageing in cells, mechanism of cell death and purpose of cell death.

Course: (Z – 606) Ecology, Evolution and Ethology

After successfully completing this course, students will be able to:

CO1: describe species interactions: types of interactions, interspecific competition, herbivory, carnivory and symbiosis;

CO2: explain biogeography: major terrestrial biomes, theory of island biogeography and biogeographical zones of India;

CO3: explain emergence of evolutionary thoughts: Lamarck; Darwin-concepts of variation, adaptation, struggle, fitness and natural selection;

CO4: describe approaches and methods in study of behavior, insect pheromones, bioluminescence, biological clocks, development of behavior, social communication and social dominance.

Course: Fisheries (EG)

After successfully completing this course, students will be able to:

CO1: explain fish migration;

CO2: describe parental care in fishes;

CO3: explain electric organs in fishes;

CO4: explain preservation, processing and by-products of fishes;

CO5: describe fish pathology: bacterial, fungal, ectoparasitic and protozoan diseases of fishes;

CO6: describe dangerous and venomous fishes.

Course: Practical (Z – 601) Non-chordates

After successfully completing this course, students will be able to:

CO1: identify and classify following animals up to order: Apus, Daphnia, Cyclops, Cypris, Squilla, Hippa, Sacculina, Limulus, Mantis, Dragon fly, Ear-wig, Mosquito, Ant, Beetle, Tick, Mite, Dentalium, Heliotis, Patella, Nautilus, Oyster, Mytilus, Doris, Cyprea, Teredo, Solen, Octopus, Loligo, Astropecten, Strongylocentrotus, Synapta, Sand-dollar, Holothurian, Sagitta, Bugula;

CO2: describe and draw labeled diagrams of digestive system, nervous system and mounting of chromatophores, spermatophores, jaws and radula;

CO3: explain Crustacean larvae and Echinoderm larvae.

Course: Practical (Z – 602) Chordates

After successfully completing this course, students will be able to:

CO1: identify and classify following animals up to order: Tortoise, Uromastix and Sphenodon, Kite, Robin and Kiwi, Scaly anteater, Porcupine and Loris;

CO2: describe and draw labeled diagrams of cranial nerves, internal ear and eye muscles of Scoliodon;

CO3: explain Mesozoic reptiles like Brontosaurus, Stegosaurus, Iguanodon, Dimetrodon, Allosaurus and Rhamphorhynchus;

CO4: describe poisonous and nonpoisonous snakes;

CO5: explain types of feather and Dentition in Dog, Cat, Horse, Rabbit, Rat and man;

CO6: identify and describe the histology of mammalian glands: pituitary, thyroid, thymus, parathyroid, adrenal, ovary and testis.

Course: Practical (Z – 603) Animal Physiology

After successfully completing this course, students will be able to:

CO1: describe the analytical instruments, principle and applications of pH meter, Colorimeter, Centrifuge, Waterbath, lactometer, sphygmomanometer, Thomas pipette of haemocytometer, RBC count, microtome, balance;

CO2: perform total RBC count in human blood;

CO3: perform WBC differential count;

CO4: perform measurement of systolic blood pressure, diastolic pressure, pulse pressure, mean pressure of an individual with the help of sphygmomanometer and stethoscope;

CO5: perform measurement of pH of acid, milk, water, Iso Electric point of casein.

Course: Practical (Z – 604) Entomology

After successfully completing this course, students will be able to:

- **CO1:** explain branches of entomology, its scopes, applications, development;
- **CO2:** identify and describe pathogenicity and control of pests;
- **CO3:** explain morphology, vectorship, pathogenicity and control of – anopheles (male – female), culex (male-female) and aedes (male-female);
- **CO4:** describe Pests of domestic animals: dogs- dog flea (Ctenocephalidies canis), Trichodectes canis. Cats- cat flea (Ctenoce felis). Cattles – Cattle tick (Boophilus microplus), Haemaphysalis cuspidate, H.minuta;
- **CO5:** explain economic importance of arthropods /insects;
- **CO6:** describe pests management appliances.

Course: Practical (Z – 605) Cell Biology and Bioinstrumentation

After successfully completing this course, students will be able to:

- **CO1:** identify, describe and draw labeled diagram of cell organelles by microphotographs: nucleus, mitochondria, golgi bodies, endoplasmic reticulum, chloroplasts;
- **CO2:** perform microtechnique preparation of permanent slides of different organs;
- **CO3:** perform whole mounting of invertebrates and vertebrates;
- **CO4:** perform paper chromatography.

Course: Practical (Z – 606) Ecology, Evolution and Ethology

After successfully completing this course, students will be able to:

- **CO1:** estimate of Alkalinity and Total hardness of water sample;
- **CO2:** estimate of free CO2 and dissolved O2 of water sample;
- **CO3:** explain habituation of mosquito larva;
- **CO4:** explain antennal grooming behavior (chemotoxis);
- **CO5:** describe alarming, attractant, aggression behavior.

Department of Statistics

Course Outcomes (CO)

F. Y. B. Sc.

Course: (Paper 101) Descriptive Statistics

- **Collection of Data:**

After successfully completing this course, students will be able to:

CO1: distinguish between different types of data and learn level of measurement of data;
CO2: understand the meaning and purpose of data collection;
CO3: know different methods of collection of data;
CO4: distinguish between primary and secondary sources.

- **Classification and tabulation of data:**

After successfully completing this course, students will be able to:

CO1: classify the data for further statistical analysis;
CO2: find the difference between quantitative and qualitative classification;
CO3: prepare a frequency distribution table;
CO4: know the technique of forming classes;
CO5: differentiate between univariate and bivariate frequency distributions;
CO6: present data using table.

- **Diagrammatic and graphic presentation of data :**

After successfully completing this course, students will be able to:

CO1: learn importance of diagrammatic presentation of data;
CO2: distinguish between diagram and graph;
CO3: learn how to visualize your data;
CO4: create bar diagram, pie chart, stem and leaf chart, box plot chart etc;
CO5: construct and interpret a graph like histogram, frequency polygon and frequency curve for numerical data.

Course: (Paper 102) Different Measures of Statistics

- **Measures of central tendency:**

After successfully completing this course, students will be able to:

CO1: state the need for summarizing a set of data by a single number;
CO2: distinguish between different types of averages;
CO3: learn to compute different averages;
CO4: draw meaningful conclusions from a set of data.

- **Measures of dispersion:**

After successfully completing this course, students will be able to:

CO1: know the limitations of average;
CO2: encourage the need of measures of dispersion;
CO3: understand various types of measures of dispersion;
CO4: obtain the measures and then compare them;
CO5: differentiate between absolute and relative measures.

- **Moments:**

After successfully completing this course, students will be able to:

CO1: know the purpose of moments;
CO2: obtain various types of moments;
CO3: understand different characteristics of data.

Practical:

After successfully completing this course, students will be able to:

CO1: prepare frequency distribution for univariate and bivariate variable;
CO2: construct table from given data;
CO3: represent statistical data diagrammatically;
CO4: analyze statistical data graphically, using frequency distributions and cumulative frequency distributions;
CO5: obtain and interpret different measures of central tendency;
CO6: compute and interpret different measures of dispersion;
CO7: obtain different types of moments and interpretation of it.

Course: (Paper 201) Skewness, Kurtosis, Probability

- **Skewness and Kurtosis:**

After successfully completing this course, students will be able to:

CO1: know the complementary relationship of skewness with measures of central tendency and dispersion in describing a set of data;
CO2: know whether the distribution is normal or not;
CO3: tell the direction and extent of asymmetry in a data series;
CO4: learn the importance of kurtosis;
CO5: evaluate and interpret types of kurtosis;
CO6: distinguish difference between skewness and kurtosis.

- **Probability - I:**

After successfully completing this course, students will be able to:

CO1: be familiar with some basic concepts of probability;
CO2: distinguish between random and non-random experiments;
CO3: understand axioms of probability and various theorems on probability;
CO4: find the probabilities of various events.

- **Probability - II:**

After successfully completing this course, students will be able to:

CO1: understand the concepts of conditional probability and independence of events;
CO2: know about Bayes' theorem and its applications;
CO3: find probabilities of various events.

Course: (Paper 202) Univariate and Bivariate Probability functions and Moments

- **Random Variables, Probability functions and Mathematical expectation:**

After successfully completing this course, students will be able to:

CO1: know the basic concept of random variables;
CO2: understand events associated with random variables, probabilities of events and how they are related;
CO3: understand the difference between a discrete and a continuous random variable, recognize when an experiment should be modelled by a discrete or a continuous random variable;

CO4: know about p.m.f., p.d.f. and c.d.f.;
CO5: obtain probability functions;
CO6: interpret the expectation, variance and standard deviation of a discrete and continuous random variable.

- **Bivariate Random Variables:**

After successfully completing this course, students will be able to:
CO1: distinguish between univariate and bivariate random variables;
CO2: understand joint, marginal and conditional p.m.f. and p.d.f. of two random variables;
CO3: compute of probabilities of events in bivariate probability distribution.

- **Moments, Measure of central tendency and dispersion for discrete and continuous random variables:**

After successfully completing this course, students will be able to:
CO1: understand measure of central tendency related to random variables;
CO2: understand measure of dispersion related to random variables;
CO3: obtain different moments of a probability distribution.

PRACTICAL:
After successfully completing this course, students will be able to:
CO1: find skewness using an appropriate method for a given frequency distribution and interpret the result;
CO2: obtain kurtosis for a given frequency distribution and interpret result;
CO3: solve examples of probability;
CO4: construct bivariate frequency distribution;
CO5: calculate probabilities and derive marginal and conditional distributions of bivariate random variables.

S. Y. B. Sc.

Course: (Paper 301) Correlation, Regression and Association of Attributes

- **Linear Correlation Analysis:**

After successfully completing this course, students will be able to:
CO1: comprehend the meaning of the term ‘correlation’;
CO2: interpret the nature of relationship between two variables;
CO3: compute correlation coefficient and interpret its value;
CO4: critically examine the degree and direction of the relationships between two or more variables;
CO5: understand applications of correlation theory in various fields, viz., agriculture, business, medical science, industry etc.

- **Linear Regression Analysis:**

After successfully completing this course, students will be able to:
CO1: describe the difference between ‘correlation’ and ‘regression’;
CO2: understand the purpose of a linear regression equation;
CO3: calculate and interpret linear regression equation;
CO4: understand and interpret coefficient of determination;
CO5: understand applications of regression analysis in various fields, viz., agriculture, business, industry etc.

- **Measures of association of attributes (for two attributes):**

After successfully completing this course, students will be able to:

CO1: learn about importance of measures of association;
CO2: understand different types of measures of association;
CO3: learn the concepts of independence and association of two attributes;
CO4: calculate measures of association using different methods.

Course: (Paper 302) Numerical Analysis

- **Finite Differences**
- **Interpolation**
- **Numerical Integration and Differentiation**

After successfully completing this course, students will be able to:

CO1: understand basics of numerical analysis;
CO2: understand the difference operators and the use of interpolation;
CO3: understand numerical differentiation and integration;
CO4: develop problem solving skills through numerical methods.

Course: (Paper 303) Sampling techniques

- **Terminology and Simple random sampling**
- **Stratified random sampling**
- **Systematic random sampling**

After successfully completing this course, students will be able to:

CO1: know about the concept of sampling;
CO2: understand about sample survey;
CO3: distinguish between a population and a sample and between parameters and statistics;
CO4: recognize some common types of sampling design, such as simple random sampling, stratified sampling and systematic sampling.

PRACTICAL:

After successfully completing this course, students will be able to:

CO1: find and interpret the correlation between two variables;
CO2: obtain simple linear regression equation for a set of data;
CO3: employ the principles of linear regression and correlation, including least square method, predicting a particular value of Y for a given value of X and understand the significance of the correlation coefficient;
CO4: know the association between two attributes;
CO5: learn how to select as SRS with and without replacement;
CO6: obtain estimated mean and standard error for various sampling techniques.

Course: (Paper 401) Generating function and discrete probability distribution

- **Generating functions, Bernoulli distribution and Binomial distribution**
- **Poisson distribution and discrete uniform distribution**
- **Hypergeometric, Geometric and Negative binomial distribution**

After successfully completing this course, students will be able to:

CO1: obtain moment generating function, cumulative generating function etc. of a probability function;

CO2: define discrete variables and study their distributions;
CO3: know the applications of discrete probability distribution in different situations;
CO4: understand some standard discrete probability distributions such as Binomial, Poisson, Geometric, Hyper geometric, Negative binomial, Uniform with real life situations.

Course: (Paper 402) Continuous probability distribution

- **Normal distribution**
- **Rectangular distribution and Exponential distribution**
- **Gamma distribution, Beta distribution of first kind and second kind**

After successfully completing this course, students will be able to:
CO1: understand various continuous probability distributions theoretically;
CO2: know the applications of normal distribution in different fields;
CO3: relate gamma and beta distribution;
CO4: obtain properties of exponential distribution.

Course: (Paper 403) Testing of hypothesis

- **Terminology**
- **Test of significance - I (Large sample test)**
- **Test of significance - II (Small sample test)**

After successfully completing this course, students will be able to:
CO1: understand the concept of hypothesis and its testing and applications in various fields;
CO2: identify the components of a classical hypothesis test, including the parameter of interest, the null and alternative hypotheses, type I error and type II error, Critical region, the test statistic etc;
CO3: understand the difference between large and small sample and tests based on it;
CO4: use the p-value decision rule to make a statistical decision;
CO5: carry out appropriate statistical test of significance;
CO6: obtain different large and small sample tests;
CO7: relatet, F and chi-square variates.

PRACTICAL:

After successfully completing this course, students will be able to:
CO1: know the application problems based on Normal distribution;
CO2: compute probabilities of normal distribution;
CO3: learn testing of hypothesis based on small sample tests;
CO4: fit various probability distributions;
CO5: learn testing of hypothesis based on large sample tests.