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.

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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: Physics Practical (PH – 306)

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 equipment 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.

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 (PH506): Motion in Central Force Field
After successful completion of the course the student will be able to:
CO1: apply the concept of center of mass and mechanics of system of particles, linear and angular momentum to solve dynamics problems;

CO2: 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;
CO3: understand general features of the motion;
CO4: demonstrate an intermediate knowledge of central-force motion;
CO5: explain equation of orbit;
CO6: explain Kepler's three laws of planetary motion and apply Kepler's laws to calculate characteristics of orbits.

Course (PH506): Lagrangian Formulation
After successful completion of the course the student will be able to:
CO1: understand the limitation of Newton's laws of motion;
CO2: understand the concept of constraints, its significance and its classification;
CO3: understand generalized coordinates and their physical significance;
CO4: deduce Lagrange's equation using different methods;
CO5: correlate Hamilton's principle, D' Alembert's principle and Newton's laws of motion;
CO6: derive general expression for kinetic energy;
CO7: understand conservation theorems, symmetry properties, Cyclic or ignorable coordinates;
CO8: understand Velocity-dependent potential of electromagnetic field;
CO9: understand and use Rayleigh's dissipation function.

Course (PH506): Free Electron Fermi Gas
After successful completion of the course the student will be able to:
CO1: derive expression for energy levels for free electron gas in one dimension;
CO2: understand effect of temperature on the Fermi-Dirac distribution;
CO3: derive expression for energy levels for free electron gas in one dimension;
CO4: obtain expression for Heat capacity of the electron gas;
CO5: study electric conductivity, thermal conductivity of metals and Ohm's law;
CO6: study motion of charge particle in magnetic field.

Course (PH506): Energy bands
After successful completion of the course the student will be able to:
CO1: study nearly free electron model, Bloch functions and Kronig – Penny model;
CO2: obtain expression for Wave equation of electron in periodic potential.

Course (PH507): Electric Fields in Matter
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: study modified form of Gauss' law in the presence of dielectric and in turn derive electric field due to the given charge distribution;
CO5: study linear dielectrics and their properties;
CO6: discuss boundary value problems in the presence of dielectrics;
CO7: obtain expressions for energy and forces in the presence of dielectrics.

Course (PH507): Magnetic Fields in Matter
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 the origin of bound currents and its interpretation
CO6: obtain Ampere's law in the presence of magnetized materials;
CO7: define magnetic susceptibility and magnetic permeability;
CO8: study hysteresis cycle of a ferromagnetic substance.

Course (PH507): Multiple Beam Interferometry
After successful completion of the course the student will be able to:
CO1: outline the superposition principle and interference of light;
CO2: study the multiple reflections from thin films;
CO3: discuss the working of Fabry-Perot etalon and Fabry-Perot interferometer;
CO4: obtain the basic idea of resolving power;
CO5: study Lummer-Gehrcke Plate;
CO6: get introduction of interference filters.

Course (PH507): Holography
After successful completion of the course the student will be able to:
CO1: to study the theory of holography and its applications.

Course (PH508): Quantum Theory of Hydrogen Atom
After successful completion of the course the student will be able to:
CO1: apply Schrodinger's equation to the simplest possible atom – hydrogen atom;
CO2: 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;
CO3: compare theoretical data with experimental values of observables;
CO4: understand how naturally quantum numbers get in when one solves Schrodinger's equation;
CO5: come to know about the importance of quantum numbers in quantizing certain physical quantities.

Course (PH508): Quantum Theory of Hydrogen Atom
After successful completion of the course the student will be able to:
CO1: determine the characteristics of atomic spectra;
CO2: study effect of magnetic field on spectral lines (Zeeman Effect);
CO3: will have an understanding on spin motion of electrons;
CO4: have an understanding of symmetric and antisymmetric wave functions and Pauli's exclusion principle.

Course (PH508): Nuclear Models
After successful completion of the course the student will be able to:
CO1: outline various nuclear models, their properties, successes and failures;
CO2: have fundamental ideas on radioactivity, radioactive radiations and their properties;
CO3: get a flavor of artificial radioactivity.

Course (PH508): Radioactivity
After successful completion of the course the student will be able to:
CO1: outline various nuclear models, their properties, successes and failures;

CO2: have fundamental ideas on radioactivity, radioactive radiations and their properties.

Course (PH509): Blackbody Radiation

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

CO1: understand blackbody radiation in greater details;
CO2: learn fundamental laws associated with blackbody radiations;
CO3: develop skills to solve problems based on classical statistical mechanics.

Course (PH509): Basic Concepts of Statistical Mechanics

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

CO1: outline phase space and quantum state;
CO2: learn the significance of the state of the system;
CO3: distinguish between macro-states and microstates;
CO4: study types of ensembles;
CO5: learn entropy and probability.

Course (PH509): The Experimental background of the Theory of Special Relativity

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

CO1: outline Galilean transformations electromagnetism and Newtonian relativity;
CO2: study Michelson-Morley experiment and its outcome;
CO3: learn Lorentz-Fitzgerald contraction Hypothesis;
CO4: study the ether drag hypothesis;
CO5: learn the postulates of the special theory of relativity.

Course (PH509): Relativistic Kinematics

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

CO1: outline the relativity of simultaneity;
CO2: derive Lorentz transformations equations and discuss their consequences;
CO3: learn aberration and Doppler Effect of relativity.

Course (PH510): MOSFET, Thyristor & UJT

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

CO1: outline different types of FETs and MOSFETs;
CO2: study their properties;
CO3: understand working of MOSFET amplifiers;
CO4: have introduction to thyristors and SCFR.

Course (PH510): Differential Amplifier

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

CO1: learn differential amplifiers and their analyses;
CO2: study OP AMPs, their parameters and their applications.

Course (PH510): Digital logic and combinational logic circuit

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

CO1: have introduction to logic gates and understanding of universal gates;
CO2: study Boolean algebra;
CO3: learn how to prepare Karnaugh map and use it;
CO4: understand SOP and POS methods for solving Boolean expressions.

Course (PH510): Digital logic and combinational logic circuit

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

CO1: outline different number systems;
CO2: study multiplexer and demutiplexer, comparators, encoders and decoders;
CO3: learn parity generators and checkers;
CO4: understand binary to decimal and decimal to primary conversions.

Course (PH511): Vector Analysis

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

CO1: establish and verify vector identities which find applications in almost all branches of Physics;
CO2: outline the basic concept of curvilinear coordinates and different coordinate systems;
CO3: deduce the expressions for gradient, divergence, curl and Laplacian in Cartesian coordinate system, spherical polar coordinate system and cylindrical coordinate system;
CO4: learn and use vector calculus in solving problems.

Course (PH511): Numerical Methods

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

CO1: outline algebraic equation and polynomials;
CO2: know different method to solve algebraic equation;
CO3: explain bisection method and false position method to solve algebraic equation;
CO4: explain the iteration method Newton-Raphson method to solve algebraic equation;
CO5: define interpolation and understand different types of interpolation;
CO5: come to know about errors in polynomial interpolation;
CO6: outline various operators and their uses to derive different polynomials;
CO7: understand Newton's difference formulation and solve the algebraic equation.

Course (PH511): C-programming

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.

Course (PH511): C-programming

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

CO1: describe input and output statement, conditional statement and loops;
CO2: implement numerical algorithms into C-program and visualize the results of the computations.

Course (PH-512): 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, Thermodynamics, 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.

Course (Generic Elective): Modern Digital and Analog Communication System-I

Unit 1: Introduction: Communication System

After successful completion of the course the student will be able to:
CO1: learn about communication systems;
CO2: study channel effect, signal-to-noise ratio;
CO3: get introduced to modulation and detection.

Unit 2: Amplitude Modulations and Demodulations

After successful completion of the course the student will be able to:
CO1: understand the distinction between baseband and carrier communications;
CO2: learn amplitude modulation and demodulation;
CO3: study frequency division multiplexing and PLL.

Unit 3: Angle Modulation and Demodulation

After successful completion of the course the student will be able to:
CO1: get introduction to ono-linear modulation;
CO2: learn how to generate FM signals and their demodulation;
CO3: understand super-heterodyne receivers;
CO4: know about the FM broadcasting systems.

Unit 4: Sampling and analog-to-digital conversion

After successful completion of the course the student will be able to:
CO1: understand the sampling theorem;
CO2: study various Pulse Code Modulations and digital multiplexing;
CO3: know about delta modulation;
CO4: study vocoders and video compression.

Course (Generic Elective): Astrophysics-I

Unit 1: Astronomical Instruments

After successful completion of the course the student will be able to:
CO1: learn about Optical telescope;
CO2: study the construction, working and challenges associated with radio telescopes;
CO3: come to know about various detectors on board The Hubble Space Telescope

Unit 2: Star

After successful completion of the course the student will be able to:
CO1: understand the light coming from extraterrestrial objects in different electromagnetic spectrum and their astronomical spectrograph;
CO2: learn about apparent and absolute brightness of the star;
CO3: outline the magnitude of the star determine by radiometer;
CO4: have introduction about the color index and luminosities of the star.

CO5: derive the Boltzmann's formula and Shah's equation o thermal ionization;
CO6: learn importance of ionization theory in astrophysics.

Unit 3: The Sun

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

CO1: know about the Sun in detail;
CO2: understand the phenomenon of the photosphere: limb- darkening;
CO3: understand about solar granulation;
CO4: know in detail about various region like the chromosphere, solar corona, Prominences, etc.;
CO5: understand the 11 year solar cycle and sunspots and solar magnetic field;
CO6: learn theory of sunspots;
CO7: study and understand the difference between solar flare, radio emission from the sun and solar wind;
CO8: explain the solar neutrino puzzle.

Unit 4: Binary and Multiple Stars

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

CO1: understand the idea of binary and multiple stars;
CO2: study visual binary, spectroscopic binary and eclipsing binary;
CO3: know about origin of binary stars;
CO4: study the Steller masses and mass luminosity relation;
CO5: understand the mass transfer in close binary system.

Course (Generic Elective): Measurement and Instrumentation-I

Unit 1: Optoelectronic measurement

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

CO1: learn basics of optoelectronic measurement systems;
CO2: get familiar with the terms relating to photometry and radiometry;
CO3: study the optical sources and detectors.

Unit 2: Electronic Instruments

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

CO1: learn about electronic meters such as VTVM, differential amplifier type voltmeter etc.

Unit 3: Cathode Ray Oscilloscope

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

CO1: learn principle, construction and working of CRT;
CO2: study functions of deflection plates, graticule etc.;
CO3: study basic CRO circuits;
CO4: learn how to measure of voltage, current, frequency and phase using CRO.

Unit 4: Transducers

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

CO1: learn the classification and static characteristics of transducers;
CO2: describe construction, working principle, characteristics and applications of various resistance transducers;
CO3: discuss operation and applications of modern industrial transducers.

Course (PH606): Moving Coordinate Systems

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, effect of Coriolis force on a freely falling particles;

CO4: redefine rigid body, rotational motion, moment of inertia and angular momentum.

Course (PH606): Motion of a Rigid Body

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

CO1: study Euler's theorem

CO2: establish the law of conservation of angular momentum and study its physical significance through some examples;

CO3: mathematically derive expressions for inertia tensor and principal axes of the body;

CO4: derive Euler's equations of motion and Euler's angles;

CO5: study Torque-free motion;

CO6: study the motion of symmetrical top in detail.

Course (PH606): Fermi Surfaces and Metals

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

CO1: study the reduced zone scheme and Periodic zone scheme;

CO2: understand Construction of fermi surfaces;

CO3: know about Electron orbits, Hall orbits and open orbits;

CO4: calculate the energy bands;

CO5: learn Experimental methods in fermi surface studies.

Course (PH606): Superconductivity

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

CO1: study the Experimental Survey, Theoretical Survey of superconductivity;

CO2: understand High Temperature Superconductors.

Course (PH607): Electrodynamics

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

CO1: revise Ohm's law and *emf*;

CO2: study electromagnetic induction;

CO3: learn Faraday's law and inductance.

Course (PH607): Electrodynamics

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

CO1: signify the work of Maxwell by studying displacement current;

CO2: analyze Maxwell's equations in different media;

CO3: understand the nature and the properties of electromagnetic waves;

CO4: study Poynting's theorem.

Course (PH607): Reflection and Refraction of Electromagnetic Waves

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

CO1: study reflection and refraction of electromagnetic waves for various cases;

CO2: study polarization of waves and Brewster's law;

CO3: learn total internal reflection, transmissivity and reflectivity.

Course (PH607): Optical Fiber Basics using Ray Optics

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

CO1: study the basics optical fibers and its properties.

Course (PH608): Many Electron Atoms

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

CO1: outline the basic coupling schemes of spin and orbital motions of electrons in an atom and obtain the outcome as a result;

CO2: 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;

CO3: calculate quantum state of electrons in an atom and establish spectral notation;

CO4: study X-ray spectra and their applications.

Course (PH608): Molecular Physics

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

CO1: study the theory of molecular bonds;

CO2: learn about rotational and vibrational energy levels.

Course (PH608): Particle Accelerators and Radiation Detectors

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

CO1: outline the importance of particle accelerators, their types and applications;

CO2: describe various particle accelerators;

CO3: outline the importance of particle detectors, their types and applications;

CO4: describe various detectors.

Course (PH608): Particle Physics

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

CO1: classify elementary particles;

CO2: understand the quantum numbers of elementary particles;

CO3: explain the various conservation laws.

Course (PH609): Classical and Quantum Statistics

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

CO1: study distinction between classical and quantum statistics;

CO2: learn distribution functions, partition functions and thermodynamic properties of a system;

CO3: obtain some deductions from Maxwell-Boltzmann statistics;

CO4: learn distribution law for molecular speeds

CO5: study specific heat capacity of gases.

Course (PH609): Specific Heat Capacity of Solids

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

CO1: outline the specific heat of solids;

CO2: learn Einstein's theory and Debye's theory;

CO3: study negative temperature and its effects;

CO4: Einstein's formulation of spontaneous and stimulated emission of radiation;

CO5: understand laser action.

Course (PH609): Relativistic Dynamics

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

CO1: learn the reason to redefine momentum;
CO2: study relativistic momentum;
CO3: learn relativistic force law and the dynamics of a single particle;
CO4: study equivalence of mass and energy.

Course (PH609): Relativity and Electromagnetism
After successful completion of the course the student will be able to:
CO1: learn the interpretation of electric field and magnetic field and their transformations;
CO2: study the field of a uniformly moving charge;
CO3: revisit forces and fields near a current carrying wire;
CO4: understand the invariance of Maxwell's equations;
CO5: study the possible limitations of special relativity.

Course (PH610): Operational Amplifiers and Linear Op-Amp circuits
After successful completion of the course the student will be able to:
CO1: learn basics of OP AMP;
CO2: have introduction to IC 741;
CO3: study various applications of OP AMP;
CO4: construction and working of instrumentation amplifier.

Course (PH610): Feedback & Oscillators
After successful completion of the course the student will be able to:
CO1: have introduction to feedback amplifiers and their types;
CO2: learn various oscillators;
CO3: understand the construction and working of IC 555 and its applications.

Course (PH610): Arithmetic Circuits
After successful completion of the course the student will be able to:
CO1: learn clock waveforms;
CO2: study Schmitt trigger;
CO3: understand the construction and working of various multivibrators;

Course (PH610): Flip-Flop
After successful completion of the course the student will be able to:
CO1: learn basics of flip-flops;
CO2: understand difference among various flip-flops;
CO3: learn the need of a master-slave flip-flop and working.

Course (PH611): Differential equations
After successful completion of the course the student will be able to:
CO1: learn about partial differential equation;
CO2: derive series solution of Frobenius method.

Course (PH611): Matrices
After successful completion of the course the student will be able to:
CO1: study matrices, matrix multiplication, diagonal matrices and matrix inversion;
CO2: develop skills to solve orthogonal matrices and diagonalization of matrices.

Course (PH611): C-Programing
After successful completion of the course the student will be able to:
CO1: define array variable and syntax rule for array;

CO2: learn to read and write in multidimensional array in C programing;
CO3: explain logical operators and expression their precision rule.

Course (PH611): C-Programing

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

CO1: study syntax rule for function declaration in C programming;
CO2: learn to declare local and global variable in C programming.

Course (Generic Elective): Modern Digital and Analog Communication System-II

Unit 1: Principles of Digital Data Transmission

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

CO1: outline digital communication systems;
CO2: study line coding and pulse shaping.

Unit 2: Principles of Digital Data Transmission

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

CO1: learn scrambling, digital receivers and regenerative repeaters;
CO2: study PAM: M-ARY baseband signaling for higher data rate and its digital career modulation.

Unit 3: Performance Analysis of Digital Communication Systems

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

CO1: study linear detectors and their signal space analysis;
CO2: understand binary signaling;
CO3: learn vector decomposition of white noise random processes.

Unit 4: Performance Analysis of Digital Communication Systems

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

CO1: learn optimum receiver for while Gaussian noise channels;
CO2: nonwhite channel noise, other useful performance criteria;
CO3: non-coherent detection.

Course (Generic Elective): Astrophysics-II

Unit 1: Structure and Evolution of Stars

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

CO1: derive the equation of state for stellar interior;
CO2: study the mechanical and thermal equilibrium in stars and how the stellar evolution is taking place.

Unit 2: Pulsars, Neutron Stars and Black Holes

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

CO1: come to know about white dwarfs, pulsars, and black holes.

Unit 3: Quasars

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

CO1: learn about the discovery of Quasars, their optical and radio properties and redshift in Quasars.

Unit 4: Cosmology

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

CO1: outline the Redshift and expansion of the universe;
CO2: derive the matter density in the universe and the declaration parameter;
CO3: understand the cosmological principle and fundamental equation of cosmology;
CO4: study the cosmic microwave background radiation.

Course (Generic Elective): Measurement and Instrumentation-II

Unit 1: Primary sensing elements and transducers 1

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

CO1: learn various thermometers and temperature transducers;
CO2: study the construction and the functioning of LVDT and RVDT.

Unit 2: Primary sensing elements and transducers 2

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

CO1: understand capacitive transducers
CO2: learn piezo-electric, Hall Effect and opto-electronic transducers.

Unit 3: Display Devices

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

CO1: learn about various display devices such as electrical, digital, SSD, dot matrix, LCD, LED etc.

Unit 4: Modern sensors and chemical sensors

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

CO1: learn about various types of modern sensors, detectors and filters.

Course (PH-612): 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, Thermodynamics, 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.

M. Sc.

Course: Mathematical Methods of Physics (PH – 411)

Unit 1 Linear spaces:

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

CO1: understand the difference between vector and scalar fields;
CO2: define groups and learn group theory;
CO3: learn about the linear dependence and independence of vectors
CO4: be aware of properties of vector space;
CO5: study linearity of operators and their usefulness in physics.

Unit 2 Matrices and eigenvalues:

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

CO1: learn basic algebraic operations on matrices and study different types of matrices;
CO2: represent linear operator in the matrix notation;
CO3: understand the similarity transformation problems, eigenvalue problems and the diagonalization of matrices using various methods.

Unit 3 Ordinary Differential Equations:

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

CO1: identify order of differential equations, linear and non-linear differential equations;
CO2: understand the methods of solving differential equations;
CO3: solve second differential equations, especially homogenous and inhomogeneous
CO4: become aware of the power series solutions of various functions
CO5: learn WKB approximation methods.

Unit 4 Special functions:

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

CO1: get familiar with Rodrigue's formula, generating functions and recursion relations;
CO2: study orthogonality of Legendre's polynomials.

Unit 5 Integral transforms and Complex integration:

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

CO1: learn method of transforming Fourier series into Fourier transform;
CO2: study properties of Fourier and Laplace transforms;
CO3: obtain the residue of complex functions and learn to evaluate the standard integration by using contour integration.

Unit 6 Probability distributions:

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

CO1: understand the need of distribution functions;
CO2: learn properties of different distribution functions;
CO3: get basic knowledge of groups and importance of group theory in physics;
CO4: learn some applications of group theory.

Course: Classical Mechanics (PH – 412)

Unit 1 Newtonian Mechanics of Many Particle Systems and Motion in a Non-Inertial Reference Frame:

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

CO1: review of Newton's laws of motion;
CO2: study mechanics of system of particles;
CO2: revise conservation laws;
CO4: revise rotating coordinate systems, Coriolis force and motion relative to earth.

Unit 2 Lagrangian Formulation:

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

CO1: outline constraints, their classification and generalized coordinates;
CO2: study Hamilton's principle and Lagrange's equations of motion;
CO3: understand conservation theorems and symmetry properties;
CO4: learn Rayleigh dissipation function.

Unit 3 Central Force Problems:

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

CO1: understand the equation of motion and the first integrals;
CO2: study classification of orbits and differential equation for the orbit;
CO3: revise Bertrand's theorem, Kelper's laws and scattering phenomenon.

Unit 4 Rigid Body Motion:

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

CO1: understand orthogonal transformations; transformation matrix for a rigid body;
CO2: revise Euler-angles and Euler theorem;
CO3: learn Euler's and Lagrangian treatment of rigid body motion
CO4: understand the motion of a top.

Unit 5 Small Oscillations and Hamilton's Equations of Motion:

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

CO1: revise eigenvalue equation and principal axis transformation;
CO2: learn normal modes and normal coordinates for small oscillations;
CO3: study coupled pendulums and double pendulum;
CO4: understand Legendre transformation and Hamiltonian function;
CO5: obtain canonical equations of motion and modified Hamilton's Principle.

Unit 6 Canonical Transformations and Hamilton-Jacobi Theory:

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

CO1: learn generators and equations of canonical transformations;
CO2: understand the integral invariance of Poincaré and Lagrange and Poisson Brackets;
CO3: study onfinitesimal canonical transformation;
CO4: Hamilton-Jacobi equation, Hamilton's principal and characteristic function;
CO5: obtain orbit equation for central force problem and its parameters.

Course: Measurement and Statistical Mechanics (PH – 413)

Unit 1 Measurement Systems:

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

CO1: define and understand the basic terms related to measurements;
CO2: study parameters associated with measurements;
CO3: learn generalized mathematical model of measurement system.

Unit 2 Transducers:

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

CO1: study various transducers and their applications.

Unit 3 Measurements of Different Physical quantities:

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

CO1: understand various techniques for the measurement of different physical quantities.

Unit 4 Quantum Statistical Mechanics:

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

CO1: get basic ideas of the parameters required for quantum statistics;
CO2: study ensembles and their partition functions;
CO3: understand the statistics of occupation numbers.

Unit 5 Ideal Bose and Fermi systems:

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

CO1: understand the thermodynamic behavior of an ideal Bose gas;
CO2: study thermodynamics of blackbody radiation;
CO3: learn thermodynamic behavior of ideal Fermi system.

Unit 6 Interacting systems and phase transition:

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

CO1: understand cluster expansion;
CO2: study virial expansion of equation of state and evaluation of virial coefficients;
CO3: learn Ising model in zeroeth and first order approximation.

Course: General Electronics (PH – 414)

Unit 1 Network analysis:

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

CO1: know about network analysis of ac and dc circuits;
CO2: simplify complex electronic circuits using network theorems.

Unit 2 Bipolar Junction Transistor:

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

CO1: study dc analysis, frequency- response and band-width.

Unit 3 Operational Amplifiers:

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

CO1: understand parameters of OP AMP IC 741;
CO2: study applications of IC 741.

Unit 4 Oscillators and Generators:

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

CO1: study various types of oscillators and generators;
CO2: understand theirs advantages and disadvantages.

Unit 5 Combinational digital circuit design:

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

CO1: learn different combinational circuits, such as encoder, decoder etc.;
CO2: study basics of memories and their types.

Unit 6 Sequential digital circuit design:

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

CO1: learn about the sequential counter in digital electronics;
CO2: study various types of flip-flops and counters;
CO3: understand some basic ideas of display units.

Course: Physics Practical (PH – 415)

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.

Course: Quantum Mechanics – I (PH – 421)

Unit 1 Origin of Quantum Physics and Mathematical Tools of Quantum Mechanics:

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

CO1: revise wave-particle duality and uncertainty principle;

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

CO3: understand the concept of scalar and vector operators.

Unit 2 Postulates of Quantum Mechanics:

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

CO1: revise the postulates of quantum mechanics;

CO2: review Schrodinger's equation and wave packet, expectation values;

CO2: study symmetries and conservation laws.

Unit 3 One-dimensional and three-dimensional Problems:

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

CO1: solve various problems of potential;

CO2: solve harmonic oscillator and hydrogen atom problem.

Unit 4 Angular Momentum:

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

CO1: revise angular momentum and its formalism in operator algebra;

CO2: obtain spherical harmonics in quantum mechanical problems;

CO3: get experimental evidences of spin motion of the particle and learn Puali's spin matrices.

Unit 5 Addition of Angular Momenta:

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

CO1: compare rotation in classical mechanics and quantum mechanics;

CO2: study coupling of orbital and spin angular momenta;

CO3: understand Wigner-Eckart theorem.

Unit 6 Identical Particles:

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

CO1: understand the principle of indistinguishability;
CO2: study spin and statistics of identical particles;
CO3: learn collision of identical particles.

Course: Solid State Physics (PH – 422)

Unit 1 Crystal Physics:

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

CO1: study Crystal classes and system;
CO2: understand the idea of Lattice, Lattice Points and space lattice, unit cells and lattice parameters, 2D and 3D lattices;
CO3: study crystal symmetry and symmetry operations, directions, planes, and Miller indices;
CO4: understand the idea of Reciprocal lattices, Brillion Zones;
CO5: differentiate Ideal crystal and real crystal;
CO6: study Temperature dependence of reflection lines;
CO7: study Elastic scattering from Surfaces and Elastic scattering from amorphous solids.

Unit 2 Crystal Defects:

After successfully completing this course, the student will be able to:
Classify different type of imperfections;

CO1: study Schottky and Frenkel defects;
CO2: study edge and screw dislocation;
CO3: understand Grain boundaries and stacking fault;
CO4: study various methods for crystal structure determination like X-ray diffraction, powder crystal method, rotating crystal method, Laue methods.

Unit 3 Lattice vibrations and thermal properties:

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

CO1: study vibrations of monoatomic lattice;
CO2: study normal modes of frequencies;
CO3: understand dispersion relation;
CO4: study lattice with two atoms per unit cell;
CO5: understand quantization of lattice vibrations;
CO6: study phonon momentum;
CO7: study Inelastic scattering of neutrons by phonons;
CO8: understand Surface vibrations;
CO9: study Inelastic Neutron scattering;
CO10: understand anharmonic crystal interaction;
CO11: understand lattice thermal conductivity.

Unit 4 Diamagnetism and Paramagnetism:

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

CO1: study Langevin diamagnetic equation;
CO2: discuss diamagnetic response;
CO3: learn quantum mechanical formulation;
CO4: study core diamagnetism;
CO5: study quantum theory of paramagnetism;
CO6: describe rare earth ions;
CO7: study Hund's Rule;
CO8: study crystal field splitting and quenching of orbital angular momentum;
CO9: discuss adiabatic diamagnetism of a paramagnetic salt,

CO10: study paramagnetic susceptibility of conduction electrons.

Unit 5 Magnetic ordering:

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

CO1: study Ferromagnetic order- exchange integral;
CO2: discuss Saturation magnetization;
CO3: understand magnons;
CO4: study neutron magnetic scattering;
CO5: learn ferrimagnetic order;
CO6: understand spinels;
CO7: study Yttrium Iron Granets;
CO8: study anti-ferromagnetic order;
CO9: discuss ferromagnetic domains - anisotropy energy;
CO10: understand origin of domains;
CO11: study transition region between domains;
CO12: understand Bloch wall;
CO13: study Coercive force and hysteresis.

Unit 6 Superconductivity:

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

CO1: discuss the history of Superconductors;
CO2: study superconducting materials;
CO3: discuss Josephson Effect;
CO4: derive the London Equation;
CO5: study Ginzburg-Landau theory;
CO6: study the BCS theory;
CO7: learn about HTSC cuprates material characterizations;
CO8: study the properties of HTSC oxides;
CO9: know the potential applications of superconductivity.

Course: Classical Electrodynamics and Plasma Physics (PH – 423)

Unit 1 Multipole expansion:

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

CO1: learn multipole expansions for a localized charge distribution in free space;
CO2: learn about static electric and magnetic fields in material media.

Unit 2 Maxwell's equations:

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

CO1: review the concept of displacement current and Maxwell's equations;
CO2: study Maxwell's equations and their solution in various media;
CO3: discuss Poynting's theorem.

Unit 3 Electromagnetic waves:

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

CO1: review electromagnetic waves, their reflection, transmission and polarization;
CO2: study propagation of electromagnetic waves in different media;
CO3: understand the concept of skin depth.

Unit 4 Potentials and fields:

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

CO1: review the basic concepts of electric field and electric potential;
CO2: get introduced to vector potential;
CO3: understand the gauge transformations and their significance
CO4: study the concept of retarded potential.

Unit 5 Wave Guides:

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

CO1: get introduced to a wave guide, its types and properties;
CO2: study propagation of electromagnetic waves through wave guides and various modes of the electromagnetic waves through them.

Unit 6 Plasma Physics and Magneto-hydrodynamics:

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

CO1: get introduced to plasma physics and magneto-hydrodynamics;
CO2: establish magneto-hydrodynamic equation for studying the motion of plasma;
CO3: learn magnetic diffusion, viscosity and pressure
CO4: understand Pinch effect and instabilities in plasma
CO5: study magneto hydrodynamic waves and plasma oscillations.

Course: Numerical Analysis and Computer Programming (PH – 424)

Unit 1 Numerical Integration and Numerical Solutions of Ordinary Differential Equations:

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

CO1: understand numerical integration;
CO2: obtain numerical solutions of ordinary differential equations using various methods.

Unit 2 Solution of Simultaneous Linear Equations and Eigenvalues and Eigenvectors of a Matrix:

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

CO1: obtain solution of simultaneous linear equations using different methods;
CO2: learn techniques of getting eigenvectors of a matrix.

Unit 3 & 4 Operating systems, higher level compiler languages, algorithm; flow charting, FORTRAN Language:

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

CO1: learn operating systems of FORTRAN, its algorithm, flow charting etc.

Unit 5 & 6 Operating systems, higher level compiler languages, algorithm; flow charting, C-Language:

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

CO1: learn operating systems of C-language, its algorithm, flow charting etc.

Course: Physics Practical (PH – 425)

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.

Course: Quantum Mechanics – II (PH – 531)

Unit 1 Scattering Theory:

After successfully completing this course, the student will be able to:
CO1: learn kinematics of the scattering process, differential and total cross-sections, wave mechanical picture of scattering;
CO2: Green's function and the Born approximation.

Unit 2 Scattering Theory-Phase shifts:

After successfully completing this course, the student will be able to:
CO1: do partial wave analysis in the scattering theory and learn about the phase shift;
CO2: study low energy scattering and scattering by a hard sphere;
CO3: use Yukawa and Coulomb potential.

Unit 3 Approximation Methods for Stationary States:

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.

Unit 4 Time dependent Perturbation Theory:

After successfully completing this course, the student will be able to:
CO1: get introduced to time independent perturbation theory and study its applications;
CO2: understand Fermi's golden rule.

Unit 5 & 6 Relativistic wave equations:

After successfully completing this course, the student will be able to:
CO1: learn generalization of the Schrödinger equation, The Klein-Gordon equation and its plane wave solutions; charge and current densities;
CO2: establish Dirac's relativistic equation and its applications.

Course: Nuclear and Particle Physics (PH – 532)

Unit 1 Brief history, nuclear properties and Nuclear force:

After successfully completing this course, the student will be able to:
CO1: learn brief history of nucleus;
CO2: understand nuclear properties;
CO3: study features of nuclear force.

Unit 2 Nuclear Models:

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

CO1: understand various nuclear models and explain properties of the nuclei based on them.

Unit 3 Gamma transitions, beta decay and alpha decay:

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

CO1: learn radioactivity, radioactive radiations and their properties.

Unit 4 Nuclear Reactions:

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

CO1: understand the theory of nuclear reaction and do the partial wave analysis of reaction cross-section;

CO2: learn about compound nucleus formation and its breakup;

CO3: study resonance scattering and reaction;

CO4: learn the theory of stripping reaction and heavy-ion reactions.

Unit 5 Symmetries:

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

CO1: understand the concept of symmetry and its roll in particle physics;

CO2: learn CPT theorem and its consequences;

CO3: get introduced to the quantum numbers of particle physics;

CO4: study Gell-Mann Nishijima Scheme and its applications.

Unit 6 Standard Model:

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

CO1: get introduced to standard model;

CO2: understand the properties of quarks;

CO3: learn how to draw weight diagram.

Course: Nuclear Physics – I (Basic Nuclear Structure) (PH – 533)

Unit 1 Nuclear Properties:

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

CO1: revise the basic properties of the nucleus;

CO2: review semi-empirical mass formula;

CO3: establish Q-value equation;

CO4: learn techniques of measuring nuclear magnetic moments.

Unit 2 Alpha and Beta Decays:

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

CO1: understand the theory of the emission of the alpha particles;

CO2: understand the Fermi's theory of the emission of the beta particles.

Unit 3 Gamma Decay:

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

CO1: understand the emission of gamma radiations and associated parameters;

CO2: learn the process of internal conversion.

Unit 4 The Deuteron Problem:

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

CO1: understand the experimental data of the deuteron nucleus;

CO2: give explanation to the properties of deuteron nucleus.

Unit 5 Nuclear Forces:

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

CO1: review strong and weak nuclear forces and their properties;

CO2: understand the theory of nucleon-nucleon scattering.

Unit 6 Nuclear Structure Models:

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

CO1: understand various nuclear models and explain nuclear properties based on them.

Course: Nuclear Physics – II (Basic Nuclear Detectors and Detection) (PH – 534)

Unit 1 Nuclear Radiation Detectors - I:

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

CO1: understand in detail interaction of particles with matter;

CO2: learn principles of different detectors;

CO3: study construction and working of some detectors.

Unit 2 Nuclear Radiation Detectors - II:

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

CO1: study construction and working of gamma ray spectrometer and analyze gamma ray spectra;

CO2: understand the working of alpha and beta spectrometers.

Unit 3 General Characteristics of Detectors:

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

CO1: learn general characteristics of detectors such as sensitivity, energy resolution, time characteristics, efficiency etc.

Unit 4 Analysis and Errors in Detection:

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

CO1: understand the errors that arise during detection of the particles;

CO2: analyze data as probability distribution, binomial distribution, The Poisson distribution, The Gaussian distribution etc.;

CO3: learn methods for the measurements of errors and their calculations.

Unit 5 Nuclear Electronics:

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

CO1: understand the basic idea of pulse signal processing technique;

CO2: learn electronics of pre-amplifiers, amplifiers, pulse shaping, discriminators etc;

CO3: study single channel analyzer, multi-channel analyzer, ADC etc.

Unit 6 Experimental Techniques:

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

CO1: understand the experimental techniques for nuclear detection;

CO2: learn basic coincidence technique and associated parameters for nuclear detection.

Course: Nuclear Physics Practical

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

CO1: familiarize with the Nuclear Radiation and Radioactive Sources;

CO2: learn about various Nuclear radiation detectors;

CO3: come to know about how to handle the Beta and Gamma radioactive sources;
CO4: learn C programming language and learn various syntax used in C language.
CO5: interpret relationships in graphed data and also using least square fit analysis and communicate results from laboratory experiments in a written laboratory report;
CO6: perform a quantitative analysis of experimental data including the use of computational and statistical methods where relevant;
CO7: calculate permissible standard error in any physics experiment;
CO8: derive conclusions from the analysis of own data.

Course: Physics of Lasers and Lasers Applications (PH – 541)

Unit 1 LASER:

After successfully completing this course, the student will be able to:
CO1: revise the basic principles of laser;
CO2: obtain Einstein's coefficients;
CO3: derive laser rate equations;
CO4: study two, three and four level systems.

Unit 2 Optical Resonators:

After successfully completing this course, the student will be able to:
CO1: understand modes of a rectangular cavity and open planar resonator;
CO2: learn transverse and longitudinal mode selection, Q- switching, techniques used for Q-switching;
CO3: study the principle and techniques of mode locking in lasers.

Unit 3 Properties of laser beams and types of lasers:

After successfully completing this course, the student will be able to:
CO1: understand laser properties;
CO2: study different types of lasers.

Unit 4 Non-linear optics:

After successfully completing this course, the student will be able to:
CO1: get introduced to non-linear optics;
CO2: understand the concept of phase matching, optical mixing and self-focusing of light
CO3: learn theory and experiments of two photon processes;
CO4: learn of three photon processes.

Unit 5 Laser Spectroscopy:

After successfully completing this course, the student will be able to:
CO1: understand the idea of laser spectroscopy by using different methods.

Unit 6 Applications of LASER:

After successfully completing this course, the student will be able to:
CO1: learn various applications of lasers in different walks of life.

Course: Atomic and Molecular Physics (PH – 542)

Unit 1 One electron Atoms:

After successfully completing this course, the student will be able to:
CO1: solve Schrödinger equation for one-electron atoms and discuss their solutions.

Unit 2 Two-electron atoms:

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

CO1: solve Schrödinger equation for two-electron atoms and discuss their solutions.

Unit 3 Many electron atoms:

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

CO1: solve Schrödinger equation for many-electron atoms and discuss their solutions.

Unit 4 Many electron atoms:

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

CO1: study Born-Oppenheimer approximation - rotational, vibrational and electronics energy levels of diatomic molecules;

CO2: understand the structure of polyatomic molecules.

Unit 5 Molecular Spectra:

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

CO1: study various molecular spectra.

Unit 6 Applications:

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

CO1: study various applications of spectra.

Course: Nuclear Physics – III (Nuclear Reactions and Reactor Physics) (PH – 543)

Unit 1 Nuclear Reactions - I:

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

CO1: understand different types of nuclear reactions;

CO2: study reaction cross-sections

CO3: learn Coulomb scattering and nuclear scattering.

Unit 2 Nuclear Reactions - II:

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

CO1: understand Ghoshal experiment and compound nuclear formation;

CO2: study resonance reactions, direct reaction, heavy-ion reaction and reaction mechanism

CO3: learn complete and incomplete fusion reactions.

Unit 3 Fission and Fusion:

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

CO1: revise the discovery of process of nuclear fission and its characteristics;

CO2: learn the processes of nuclear fusion and thermos-nuclear reaction;

CO3: study techniques of nucleo-synthesis.

Unit 4 Neutron Physics:

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

CO1: classify neutrons based on their energy and learn about neutron sources;

CO2: understand neutron reactions and reaction cross-section

CO3: learn detection and interference of neutrons.

Unit 5 Particle Accelerators:

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

CO1: learn need of particles accelerators, their classifications and types;

CO2: understand the construction and working of various particle accelerators.

Unit 6 Reactors:

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

CO1: learn basics of thermal neutrons, their diffusion and diffusion techniques;
CO2: establish Fermi age equation;
CO3: have in-depth study of nuclear chain reaction.

Course: Nuclear Physics – IV (High Energy Physics) (PH – 544)

Unit 1 Classification of Elementary Particles:

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

CO1: classify the elementary particles based on their various properties;
CO2: learn properties of the particles
CO3: understand parity, its conservation in strong and electromagnetic interactions.

Unit 2 Parity Violation:

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

CO1: understand parity violation in weak interaction;
CO2: learn conservation of charge conjugation, parity and time reversal
CO3: obtain equations of relativistic kinematics.

Unit 3 The Eightfold Way:

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

CO1: get introduced to the concept of eightfold way;
CO2: learn about the unitary groups;
CO3: draw root and weight diagram
CO4: learn Gell-Mann Nishijima scheme.

Unit 4 Quark Model:

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

CO1: study group theory;
CO2: understand the Young tableaux
CO3: establish meson and baryon wave functions.

Unit 5 Deep Inelastic Scattering:

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

CO1: learn elastic and inelastic scattering of a point particle;
CO2: study Resenbluth formula
CO3: understand structure functions.

Unit 6 Parton Model:

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

CO1: learn Bjorken scaling;
CO2: understand parton model;
CO3: study structure functions in terms of PDFs.

Course: Nuclear Physics Practical

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

CO1: familiarize with the Nuclear Radiation and Radioactive Sources;
CO2: learn about various nuclear radiation detectors;

CO3: come to know about how to handle the Beta and Gamma radioactive sources;
CO4: learn C programming language and learn various syntax used in C language.
CO5: interpret relationships in graphed data and also using least square fit analysis and communicate results from laboratory experiments in a written laboratory report;
CO6: perform a quantitative analysis of experimental data including the use of computational and statistical methods where relevant;
CO7: calculate permissible standard error in any physics experiment;
CO8: derive conclusions from the analysis of own data.

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 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 d100, d110, d111 planes, Bragg's equation (X-ray diffraction), Crystal structure of NaCl, KCl. (Numericals based on Bragg's equation and Miller indices)**;**

CO-2: understand basic concepts Arrhenius theory, Lowry Bronsted theory, Lewis theory, Solvent – Solute concept of acidbase, Soft-Hard acid base and its application;

CO-3: learn historical perspective of atomic structure; Rutherford's atomic model, Bohr's theory and its limitation, spectrum of hydrogen atom (Lyman, Balmer, Paschen, Brackett and Pfund), quantum numbers, Auf Bau, Hund and Pauli exclusion principles, penetration and shielding, effective nuclear charge (Slater rule);

CO-4: study 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;

CO-5: define of atomic and ionic radii, ionization energy, electron affinity and electron negativity, S-Block elements: Comparative study, diagonal relationship, salient features of hydrides.

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: Study definition of Electrical conductance, Specific conductance, equivalent conductance, Molar conductance, Effect of dilution on concentration, Cell constant, Determination of Cell constant, Ostwald's dilution law and its limitations, Acid & Basic buffer actions (Henderson-Hasselbach equation), Buffer capacity, Numeric;

CO-2: understand Second law of thermodynamics (in detail), Carnot cycle and its efficiency, Entropy concept, Change of entropy for reversible isothermic, isobaric, isochoric and adiabatic processes. Entropy change for ideal gases (T & V as variables, P & T as variables), Numerical;

CO-3: study [I] Dry Reaction: theory behind borax bead test with equation, Flame test (Theory, structure of non-luminous Bunsen flame) [II] Analysis of Cation: Application of common ion effect, solubility product constant. Complexometric reactions involved in qualitative analysis; 1. 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 ions [Ag-Hg, Zn^{+2}, Mn^{+2}];

CO-4: study shape of d-orbitals, CFT – basic assumption, splitting of d-orbitals in octahedral, tetrahedral, square planer complexes, distribution of dx electrons in octahedral and tetrahedral complexes and CFSE;

CO-5: define chemical bonds (covalent, co-ordinate covalent, ionic, metallic, H-bond, Wan der walls forces of attraction), polarizability (Fajan's rule), molecular orbital theory ; LCAO method, bonding molecular orbital, non-bonding molecular orbital, anti-bonding molecular orbital, bond order, magnetic properties and molecular orbital energy level diagram of hetero diatomic molecule : CO and NO, VSEPR theory;

CO-6: classify physical properties (additive, constitutive, colligative, additive, constitutive), atomic volume, molar volume and chemical constitution, Kopp's law, surface tension, drop number method, parachor, viscosity, determination of viscosity by Ostwald viscometer, define: refraction, specific refraction, molar refraction, solve numericals.

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, rearrangements, addition, and substitution with respect to electrophilic 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; 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: understand physical properties and chemical reactions of nitriles, isonitriles, carbamates, semi carbazides and their application in synthetic organic chemistry;

CO-2: learn structure and nomenclature of amines, preparation of aryl amines, physical properties and chemical reactions. Gabriel-pthalimide reaction, Hofmann Bromamide reaction;

CO-3: learn structure and nomenclature of acid chloride, ester, amides of monocarboxylic acid; method of formation of monocarboxylic acid derivatives and chemical reactions;

CO-4: recall Definition, Classification, IUPAC Nomenclature of heterocyclic compounds with synthesis of some heterocyclic compounds;

CO-5: define, classify and give nomenclature of polynuclear aromatic hydrocarbons with synthesis;

CO-6: study basics of diazonium salt, its mechanism, mole ratio, different salts, preparation of the diazonium salt;

CO-7: give nomenclature of diazonium salts;

CO-8: study reactions of diazonium salts, replacement reactions in which nitrogen is eliminated, its application in the synthesis of aromatic compounds;

CO-9: study laws of coupling, coupling agents, synthesis of diazomino and aminizo compounds;

CO-10:learn to use of reagents: anhydrous aluminium chloride, NBS, selenium oxide, lithium aluminium hydride.

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. Solve numerical problems related to theories of reaction rate;

CO-2: 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, 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, photo-physical processes fluorescence, phosphorescence, chemiluminescene, factors affecting fluorescence, phosphorescence and solve numerical problems related to quantum efficiency;

CO-3: 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 boundry method, 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 and (d) determine ionic product of water, solve numerical problems related to determination of transport number and applications of Kohlrausch law;

CO-4: 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. Solve numerical Problems related to Moment of inertia, Force constant, Redced weight and Bond length.

Industrial Chemistry

At the end of the course student will be able to

CO-1: study manufacturing process of Synthetic fibers with uses;

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

CO-3: study 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: learn manufacturing 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: study industrial uses and manufacturing process of some important dye pigment and dye intermediate;

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 chromatography, 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: write and explain mechanism of Michael reaction Wolf-Kishner reduction, Wittig reaction, Fridel-Craft reaction, Mannich reaction, Dickmann reaction, Reimer-Tiemann reaction, Aldol Condensation;
CO-2: explain the Elimination reactions, stereo chemistry of elimination reaction, elimination reaction vs substitution reaction;
CO-3: learn carbohydrates: (a) General introduction: (b) Disaccharides: Structure elucidation of maltose, lactose and sucrose (c) Methods of methylating sugar;
CO-4: synthesize and study application of compound containing reactive methylene group like malonic ester and aceto-acetic ester, Keto-enol tautomerism: factors affecting Keto-enol tautomerism and its mechanism;
CO-5: study aliphatic sulphur compounds: nomenclature, general methods of preparation and reaction, Aromatic sulfonic acid: nomenclature, preparation, reactions and uses of sulfonic acids of toluene;
CO-6: learn 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. 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: 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; solve numerical problems related to latent heat of fusion, latent heat of vaporization, elevation of boiling point and depression of freezing point;

CO-4: 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-5: 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 of the 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: get 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 and classify metal carbonyls, metal ligandπ–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. differentiate between terminal and bridge carbonyl. Constitution of metal carbonyls $Ni(CO)_4$; $Fe(CO)_5$, $Fe_2(CO)_9$, $Mn_2(CO)_{10}$, $Cr(CO)_6$, $Co_2(CO)_8$;
CO-7: 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-8: 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 labile and inert complexes on the basis of VBT and CFT;
CO-10:define and give importance of corrosion, types of corrosion: uniform, pitting, inter-crystalline 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: get introduction to Aromaticity, Huckel's Rule, Aromatic Character of Arenes, Definition & Examples of Aromatic, Non-Aromatic, Anti-Aromatic Compounds (Benzenoids and Non-Benzenoids);
CO-3: learn structural determinations of Pyriodoxine and Thyroxine and their synthesis, General introduction, structural determination of Ribofllevin (Lactoflavin) & its Synthesis;
CO-4: study basic concept 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 (B) Vitamins and Hormons: 5 Hrs General

Introduction, Classification, Structural determinations and Synthesis of Pyridoxine, Vitamin – C, Thyroxine and Adrenalene;

CO-5: 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-6: introduce drugs, definition of drugs and ideal drugs, classification of drugs based on pharmacological or functions, important synthesis and uses of Amylnitrate, Chloroquine, Pyrimethamine, Sulpha Pyrimidine, Diazepam, Lidocaine, Chlorpropamide, Dapsone, Isoniazide, 5-Fluoro Uracil;

CO-7: define and study structures of Amino Acid (In Tabular Form) 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, determine single electrode potential, calculate standard EMF of cell and determine 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, 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 e.g. linear accelerator, cyclotron, discovery of artificial disintegration, classification of nuclear reaction based on overall energy transformations and - particles used as projectiles, merits and demerits of different projectiles, numerical problems on cyclotron.

Sem-V Paper-IX: Industrial Chemistry

At the end of course, students will able to

CO-1: (A) study manufacture with flowsheet & uses of Acrylonitrile (Sohio Process), Bisphenol-A, Styrene, Industrial manufacture and uses of Polyolifines: Poly ethylene (HDPE & LDPE) and Polypropylene (B) Nomenclature of chlorofluoro derivatives of Methane & Ethane, General Methods of Preparation, Properties, Usesof fluoro carbons;

CO-2: study 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: learn 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, Nitration of Toluene, Artificial perfumes: Musk xylene, Musk ketone, Musk ambrette. Explosives: Trinitrophenol, Trinitrotoluene, Trinitro glycerine, Emitol;

CO-7: define amination, Amination by reduction: Metal - Acid reduction (strong & weak), Metal - Alkali reduction (strong and weak), Catalytic reduction, Sulphide reduction. Amination by ammonolysis: Amination of chlorobenzene, Phenol & Benzene Sulphonic acid, importance of amination in industry in the manufacture of Bismark brown dye from m-Phenylenediammine, Synthetic fibre (Nylon 6,6) from HMDA, Methyl Red Indicator from Anthranilic acid, Cyclonite explosive from Hexamethylenetetramine;

CO-8: define Sulphonation, methods of sulphonation, sulphonating agents, mechanism of sulphonation. Sulphonationof Benzene, Toluene, & Anthracene, preparation of Phenol and Resorcinol from benzene, importance of Sulponation reaction in industry in the manufacture of Saccharine, Chloramine T and Alizarine Red.

Sem-V Paper-X: Analytical Chemistry

At the end of course, students will able to

CO-1: get introduction to chemical and instrumental Analysis, advantages and disadvantages, Overview of methods used in Quantitative analysis, classification of classical and instrumental analysis, factors affecting the choice of Analytical Method (in brief), step in quantitative analysis (Flow diagram), Analytical methods on the basis of Sample size (in brief), Sampling methods. Sampling in different physical states;

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: factors 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 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-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, isomerization, 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, hexamethylenetetramine, chlorinated methanes, per chloroethelene;

CO-4: learn synthesis and uses of H-acid, J-acid, Neville Winther'sacid, DASDA Procian Red dye, Cellitone scarlet-B, Indanthrene Khakhi GG, Blankophor B, Sulphamylon, Chloramphenicol;

CO-5: learn about industrial fuels, Natural fuels, synthetic fuels, hydrogen fuel of tomorrow, fuel for rocket, Intermediates of Pharmaceuticals and Dyes;

CO-6: 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-7: 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 fibres, 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, analyzing, 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 and symmetry operations;

CO-2: enlist 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 hybridization 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, Ozone treatment process for waste water;

CO-9: define, classify learn the structure and bonding in ferrocene, dibenzene chromium, Zeise ion and gaseous dimethyl beryllium, Tetramethyl Lead.

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 on polymers, definition of polymer, and 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: learn conformation, conformational analysis, conformations of ethane, Butane and Cyclohexane. Conformational analysis of cyclohexane. Axial and equatorial Hydrogen in cyclohexane. Stability of mono-substituted cyclohexane;

CO-9: have general discussion about dyes, definition of dyes and pigments;

CO-10: discuss color and constitution – Witt's theory difference between dyes and pigments;

CO-11: classify dyes with example, introduction of various types of dyes;

CO-12: study mechanism of rearrangements involving C to C migrations as illustrated by Wagner – Meerwein and Pinocol-Pinacolone rearrangements;

CO-13: 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 pH 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: understand 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 and 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, sample introduction system, columns: packed column capillary column (WCOT, SCOT), carrier gas and its selection - stationary phases: solid adsorbents, inert supports (selection criteria, diatomaceous earths,) and liquid stationary phases, detectors: FID, TCD, do qualitative and quantitative analysis using GC;

CO-3: know the 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, greenhouse 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: isopropyl 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, and (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 fluorescein, 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, interpret of results of experiments and their correlation with theory;

CO-8: get knowledge of Systematic qualitative analysis of Inorganic mixtures.

Course: M. Sc. (Organic Chemistry)

Goals:

The M. Sc. program in organic chemistry prepares students for Teaching/research-focused professions in the chemical sciences, emphasizing the development of a students' ability to develop experimental approaches that accurately capture information to solve questions and problems in their chemical field of study. Our faculty members conduct research in various fields of chemistry. From the first day of entry into our program, students work closely with their faculty mentor, to target their future goals and professional interests. The program enables them to contribute to the forefront of knowledge in the scientific community, share their knowledge through teaching, or apply it in public service or industry.

Program Outcomes

PO-1: Introduced to advance level of Inorganic, Organic, Physical and Analytical chemistry in first year, useful to PG students;
PO-2: Synthesis of Natural products and drugs by using proper mechanisms;
PO-3: Determine molecular structure by using UV, IR and NMR spectroscopy;
PO-4: Study of Asymmetric synthesis;
PO-5: Study of medicinal chemistry including Drug synthesis and characterization;
PO-6: Determine the aromaticity of different compounds;
PO-7: Solve the reaction mechanisms and assign the final product;
PO-8: Improve the Skill and cultivate interest of student to pursue research in thrust area of organic chemistry.

Program Specific Outcomes

After completing M. Sc. Organic Chemistry, students will be able to
PSO-1: demonstrate knowledge and understanding of molecular spectroscopy formolecular structure determination;
PSO-2: apply theoretical and practical understanding of organic synthesis, green synthesis.

Course Outcomes

Sem – I

Sem I: Paper-I: Inorganic Chemistry

At the end of the course student will be able to
CO-1: learn representation of groups: preparation of matrices and vectors, matrix notations for geometrical transformations;
CO-2: study orthogonality theorem and its consequences, reducible and irreducible representations and their relation.
CO-3: prepare character table for C_{2v} and C_v point group, application of group theory to - transformation properties of atomic crystals.
CO-4: define operators like linear operator, commutator operator, Hermitian operator, Hamiltonian operator, vector operator, Laplacian operator, ladder operator.
CO-5: apply his knowledge of R-S coupling scheme, to find out ground state term symbol as well as to explain microstates with term symbols of the system like p^1, d^1 and d^2 , to solve some theorems of operators.
CO-6: derive formula of energy for one dimensional simple harmonic oscillator and rigid rotator, components of angular momentum.

CO-7: explain Zeeman Effect, meaning and importance of term symbol.

Sem I: Paper-II Organic Chemistry

At the end of the course student will be able to

CO-1: have detailed study of organic reaction intermediates. Generation, structure, stability and reactions of carbocations, carbanions, carbenes and free radicals;

CO-2: define pericyclic reaction, its Characteristics and Classification as Electrocyclic Reactions, Cycloaddition Reactions, Sigmatropic rearrangements;

CO-3: learn Aliphatic Nucleophilic Substitution: The SN_1, SN_2, SN_i mechanisms. Reactions of Allylic halides, neighboring group participation by -OH, -NH_2, -COO-, -RS, -halogen, aromatic ring;

CO-4: study aromatic nucleophilic substitution: The SN_2, SN_1 and benzyne mechanisms, reactivity-effect of substrate structure, leaving group and attaching nucleophile, The Von Richterre arrangement;

CO-5: learn elimination reaction: Hoffmann and Zaitsev's rule of elimination, E_1, E_2 and E_1CB Reaction mechanism and orientation;

CO-6: study stereo chemical principles; Enantiomeric relationships; Distereomeric relationship; R-S and E-Z nomenclature; Dynamic stereochemistry; Chiral-Prochiral relationships; Stereo-selective and Stereo specific reactions; Racemates and racemic modification, Resolution of racemic modification, Optical activity in the absence of chiral carbons biphenyl, allenes, spiranes;

CO-7: learn confirmational analysis: Interconversion of Fischer, Newman and Sawhorse projections. Newer method of asymmetric synthesis (including enzymatic and catalytic nexus), enantio and diastereo selective synthesis. Simple acyclic and cyclic (chair and boat cyclohexanes, Decalins, Perhydrophenanthrene) systems, Effects of conformation on reactivity in acyclic compounds and substituted cyclohexanes.

Sem I: Paper-III Physical Chemistry

At the end of the course student will be able to

CO-1: understand and explain theories of uni-molecular gas reactions: Lindemann theory, Kinetics of some complex reactions like Reversible reactions(only first order opposed by first order), Consecutive reactions ($A \rightarrow B \rightarrow C$); Steady state treatment or approximation, Enzyme catalyzed reactions, kinetics of general chain reaction, kinetics of photochemical reactions using H_2-Cl_2 and H_2-Br_2, kinetics, mechanism, determination of activation energy and chain length of some organic decomposition sing example of decomposition of ethane and decomposition of acetaldehyde, effect of ionic strength on rates of ionic reactions, solve numerical related to this topic;

CO-2: explain laws of thermodynamics, state and path functions and their applications, thermodynamic description of various types of processes, Maxwell's relations, partial molar quantities, calculation of partial molar quantities, determination of partial molar volume and partial molar enthalpy, ideal and non-ideal liquid mixtures, thermodynamics functions like, free energy of mixing, entropy of mixing, volume of mixing and enthalpy of mixing of non-ideal solutions, excess functions (μ^E, G^E, S^E, H^E and V^E for non-ideal solutions and expression for excess thermodynamic functions, solve numerical related to the topic;

CO-3: define terms like assembly, canonical ensemble, occupation number statistical weight factor, probability and discuss basics of statistical thermodynamics, thermodynamic probability, probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Lagrange's methods of multipliers, partition function, thermodynamic properties in term of partition functions (i) internal energy (ii) heat capacity (iii) third law of thermodynamics(iv) Helmholtz free energy (v) enthalpy (vi) Gibb's free energy (vii) chemical potential (viii) equilibrium constant molecular partition functions for an

ideal gas, derive equations for translational, rotational and vibrational partition functions, solve numerical related to various partition functions and amount of energy;

CO-4: explain types of polymers, stereochemistry of polymers, mechanism of free radical, anionic and cationic polymerization, kinetics of free radical polymerization, thermodynamics of polymerization, phase techniques like bulk, solution, suspension and emulsion polymerization, what is number & mass average molecular weight?, molecular weight determination using osmometry and viscometry, thermal transitions in polymer: glass transition temperature and its significance and solve numerical related to average molecular weight of polymers.

Sem I: Paper-IV Instrumental and chemical analysis

At the end of the course student will be able to

CO-1: know in detail about Types of electronic transition, auxochrome, chromophore, Bathochromic effect, Hypso-chromic effect, Hyper chromic effect, Hypo chromic effect, Factor affecting λ_{max} like resonance, hyper conjugation, hydrogen bonding, steric effect, Woodward's rules for a, ß-unsaturated ketones, Diene systems, aromatic system, effect of solvent on absorption bands, law of absorption with derivation, elementary idea of double beam automatic recording, spectrophotometer, applications;

CO-2: discuss thin-layer chromatography: selection of stationary and mobile phase, detection techniques –elementary idea of HPTLC, gas chromatography: selection of mobile phase – selection of stationary phase in GLC and GSC – detectors: FID, TCD and ECD, their comparison, packed column, WCOT, SCOT–temperature programming–derivatisation in GC – quantitative analysis;

CO-3: know in detail about Errors in Chemical analysis, classification of errors, nature and origin of errors, propagation of error, accuracy and precision, average deviation and standard deviation and its physical significance, normal distribution curve and its properties, confidence limit and probability, statistical treatment for error analysis, student 't' test, rejection criteria and Q-test, method of least square;

CO-4: discuss thermosgravimetry, instruments for TGA- thermos-balance and furnace, Calibration of temperature scale, Factors affecting TGA results instrumental and experimental, applications. Thermometric titration (tt), advantages, instrument, applications of TT in neutralization titration, precipitation titration, complexometry titration and redox titration.

Sem I: Inorganic chemistry Practical

At the end of the course student will be able to

CO-1: learn inorganic qualitative analysis including ONE rare element;

CO-2: study inorganic preparation: Hexa-amine nickel (II) chloride, Mohr's salt (Ferrous ammonium sulphate), sodium trioxalato ferrate trihydrate, sodium cobaltinitrite, tetra amine cupric sulphate, Reineek's salt (ammonium tetrathiocyanate diamine chromate).

Sem I: Organic chemistry Practical

At the end of the course student will be able to

CO-1: learn the separation and purification of an organic mixture by chemical/solvent separation methods;

CO-2: study separation of three amino acid mixture by paper chromatography.

Sem I: Physical chemistry Practical

At the end of the course student will be able to

CO-1: determine the CMC of a given surfactant by conductivity meter at given temperature.

CO-2: study kinetics of 2nd order reactions at two different temperatures and determine energy of activation of reaction using $K_2S_2O_8$ and KI practically;

CO-3: determine the dissociation constants of a given dibasic acid pH-metrically;
CO-4: determine the formal redox potential and amount of ferrous sulphate/ferrous ammonium sulphate potentiometrically using cerric salt solution;
CO-5: verify Onsager's equation and determination of equivalent conductance at infinite dilution of strong electrolytes using conductivity meter;
CO-6: study and interpret the phase diagram of a three component system e.g. Water – acetic acid – chloroform;
CO-7: verify Lambert-Beer law for coloured solution using colourimeter/spectrophotometer and determine molar absorptivity of given substance.

M. Sc. Sem-II Chemistry

Sem-II: Paper-I Inorganic Chemistry

At the end of the course student will be able to

CO-1: define polymers and their depiction, types of characteristic of inorganic polymers, characterization of inorganic polymers;
CO-2: learn structural features of polymers: backbone bonding branching and cross-linking chemical and stereo-chemical variability;
CO-3: classify inorganic polymers, synthesis, properties, structures and uses and application of polyphosphazenes, polysiloxanes;
CO-4: define metal carbonyls and metal nitrosyls;
CO-5: explain the difference between metal complexes and metal π-complexes, bonding in CO and NO molecules as per VBT and MOT, structure and bonding in metal carbonyls and metal nitrosyls;
CO-6: discuss properties and preparation of metal carbonyls and nitrosyls with chemical equation, EAN of π-complexes, use of IR spectroscopy for the structure elucidation of metal carbonyls and nitrosyls;
CO-7: classify metal carbonyls and metal nitrosyls on the basis of their structure and number of metal atom.

Sem-II: Paper-II Organic Chemistry

At the end of the course student will be able to

CO-1: define Aromaticity and Aromatic character; structure and stability of benzene, Frost circle diagram, concept of aromaticity; Resonance and chemical stabilization; criteria tocheckaromatic character-IR, NMR, heat of hydrogenation; Huckel's rule; HMO method; Antiaromaticity, homoaromaticity, nonaromaticity; aromaticity in benzanoid compounds:naphthalene, pyrene, acepleialdelene, Aromaticity non-benzenoid compounds: azulene, tropolones, charged rings, annulenes, fullerenes, and mesoionic compounds;
CO-2: study energy of molecules, photochemical energy, electronic excitation, Jablonski diagram, laws of photochemistry, quantum efficiency, photochemistry of carbonyl compounds- a- cleavage of acyclic, cyclic and α-β unsaturated cleavage of carbonyl compounds, β-cleavage of, inter and intramolecular hydrogen abstraction, addition to carbon- carbon double bond, photo reduction of carbonyl compounds. Photo induce rearrangement of enones, dienones and alkenes, photochemistry of alkenes and aromatic compounds- isomerization, dimerization and addition reactions;
CO-3: learn organic name reactions**,** general nature, method, mechanism and synthetic applications of the following reactions: Heck reaction, Dakin reaction, Darzen's glycidic ester synthesis, Suzuki reaction, Willgerodt reaction, Buchwald-Hartwig reaction, H. V. Z. Reaction, Mitsunobu reaction, Sonagashira reaction, Dickmann reaction;

CO-4: get detail knowledge about organic transformation and reagents in organic synthesis. Organic Reagents- Synthesis and applications of the following reagents: Sharplessepoxidation, Umpolung reagent, Dess martin periodinane, DDQ, Tri-n-butyltinhydride, Diisobutylaluminum hydride, Lithium disoprpyl amide, Ozone, Crown ethers, Wilkinson's Catalyst.

Sem-II: Paper-III Physical Chemistry

At the end of the course student will be able to

CO-1: discuss Debye-Huckel theory of strong electrolytes, relaxation effect and electrophoretic effect, Debye Falkenhagen effect, Wein effect, Ionic strength and its determination, Debye-Huckel limiting law. Understand and explain Activity and activity coefficient, determination of activity coefficient by methods namely solubility and EMF method, Determination of dissociation constant of monobasic acid by conductance method and approximate EMF method, Electrolytic polarization, Dissolution and Decomposition potential, Concentration polarization, decomposition potential and its determination, over voltage, determination of over voltage, theories of over voltage: combination of atom as slow process. i.e., Tafel theory. Solve numerical related to activity, activity coefficient, ionic strength;

CO-2: define Adsorption, multilayer adsorption, discuss the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation, derive Langmuir equation from BET equation, explain different adsorption isotherms, change in enthalpy, entropy and free energy of adsorption, adsorption at the surface of liquid, derive Gibbs adsorption isotherms, thermodynamic treatment of adsorption, surface–active substances, orientations of surfactants on the surface of solution , surface inactive substances, surface pressure, insoluble surface films on liquid, solve numerical related to determination of surface area, surface pressure, substance required to form surface film;

CO-3: discuss various types of colloidal systems, have knowledge of preparation of lyophobic colloids, understand electrical properties of Colloidal systems, explain origin of charges on colloidal particles, discuss electrical double layer, Zeta potential and its determination by electrophoresis, factor affecting zeta potential, explanation on DLVO theory of colloid stability, explain electro-kinetic properties like electrophoresis, elecro-osmosis, define and discuss Surface active agents, critical micellar concentration, factors affecting the CMC of surfactants, thermodynamics of micellization: mass action and phase separation model of mixed micelles, solubilisation, define emulsion, types of emulsion, methods for determination of types of emulsion, microemulsion, types of micro emulsion and theories of microemulsions;

CO-4: discuss about molecular spectra, Microwave spectroscopy, rotation of molecules, linear molecule, symmetric tops, spherical tops, asymmetric tops, rotational spectra of rigid diatomic molecule ,intensities of spectral lines, effect of isotopic substitution, explain techniques and instrumentation of rotational spectrum, IR Spectroscopy, discuss classical frequency of harmonic oscillator, classical potential energy of harmonic vibration of a diatomic molecule, quantum expression of potential energy, energy level diagram, relative population of energy levels, explain mechanism of interaction with radiation, selection rule, determination of force constant, amplitude of vibration, anharmonic vibrational oscillator, discuss morse potential, vibrational energy of diatomic molecule following the Morse potential, energy level diagram, vibrational transitions, vibrational–rotational spectra of CO, a diatomic molecule and application of vibrational rotational spectra, solve numerical related to vibrational amplitude, rotational constant etc.

Sem-II: Paper-IV Instrumental and chemical analysis

At the end of the course student will be able to

CO-1: discuss Introduction of IR spectroscopy: theory, instrumentation: single beam, double beam spectrophotometers, radiation sources, sample cells, monochromators, detectors, sample handling, resolution, wave number measurement, useful terms: IR region, types of vibrations: fundamental and overtones, linear and nonlinear molecule, equation for vibrational frequency, selection rule, coupling interactions, hydrogen bonding information, Fermi resonance, IR spectra: group frequency, group frequency region, finger print region, spectra interpretations and structure elucidation, FTIR: principle, instrument design, and function of beam splitter, Advantages of FTIR vs. IR;

CO-2: explain principle of liquid – solid chromatography, comparison with GC, column chromatography, gradient elution, displacement chromatography, principle of HPLC, instrument and significance of each component, pumps, Guard column criteria in selection of mobile phase, stationary phases (solid, liquid), bonded phase supports, detectors: UV absorption, RI detectors – normal phase and reversed phase, method of introducing sample;

CO-3: discuss twelve principles of green Chemistry, green solvents and their applications, ionic liquids, types, properties and applications, ILs as solvents, supercritical fluids, supercritical CO_2, its properties and applications in dry cleaning and decaffeination of coffee, sources of water pollution, sewage and industrial effluents, analysis of water pollutants, sampling, preservation, measurement of parameters such as COD, BOD, DO, TDS, suspended solids, TCC, phenols, fluoride;

CO-4: define and explanation about molarity, molality, normality, ppm, ppb, ppt, %w/v, %w/w, %v/v, formality, primary and secondary standard, acid value, density and specific gravity, numerical. protic and aprotic solvent, solvent system, dielectric constant, titrant, titration curve, determination of equivalence point, Karl Fisher titration, numerical, step on analysis, C and H Analysis, N Analysis, halogen analysis and sulpher analysis, solve numerical based on them.

Sem-II: Inorganic chemistry practical

At the end of the course student will be able to

CO-1: estimate the binary mixtures of metallic ions by volumetric and gravimetric methods;

CO-2: acquire the skill to analyze some common alloys and ores.

Sem-II: Organic chemistry practical

At the end of the course student will be able to

CO-1: gain skill to prepare organic compounds using greener protocols;

CO-2: prepare organic compounds via two step synthetic sequences.

Sem-II: Physical chemistry practical

At the end of the course student will be able to

CO-1: calculate the velocity constant of the hydrolysis of ethyl acetate with sodium hydroxide by conductance measurements;

CO-2: determine the concentration of given component in a Coloured mixture solution using colorimeter;

CO-3: determine the formula of a complex between Cu^{+2} and NH_3 by distribution method.

CO-4: determine CST of phenol -water system [phase rule];

CO-5: determine strength of Borax using pH-meter;

CO-6: determine solubility and solubility product of AgCl using potentiometer;

CO-7: study kinetics of 2^{nd} order reactions at two different temperatures and determine energy of activation of reaction using H_2O_2 and KI practically.

M. Sc. Sem-III Organic Chemistry

Sem-III: PAPER-I Natural Products and Bio-molecules

At the end of the course student will be able to

CO-1: define Steroids, Introduction to Sterols: Structure determination of cholesterol and ergosterol, Bile acids: Introduction, Structural elucidation and Synthesis of Cholanic acids;

CO-2: define sex hormones, classification of hormones: structure and synthesis of androgens, oestrogens and gestrogens, name and structures of adrenocortical hormones, partial synthesis of cortisone;

CO-3: learn nucleic acids & enzymes, nucleic acids, purine and pyrimidine bases of nucleic acids, base pairing via h-bonding, chemical and enzymatic hydrolysis of nucleic acids, structure of nucleosides and nucleotides, DNA, RNA (basics structures only), DNA replication, transcription, translation, protein biosynthesis;

CO-4: classify enzymes, nomenclature and inhibition, factors affecting catalytic activity and specificity in action, regulation of enzyme activity;

CO-5: classify vitamins, discussion of various type of vitamins Structure determination, synthesis and biochemical functions of Vitamin A, Vitamins $B_1$and B_2, Vitamin H;

CO-6: classify terpenoids nomenclature and isolation, Structure determination and synthesis of Farnesol, Zingiberene, Cadinene, Gibrelic acid and Abietic acid.

Sem-III: PAPER-II Selected Topics in Organic Chemistry-I

At the end of the course student will be able to

CO-1: study reagents for organic synthesis**,** introduction, preparation and industrial applications of the following, N-Bromosuccinimide (NBS), Grubbs 1st and 2nd generation catalyst, N,N-dicyclohexyl carbodiimide (DCC), lead tetra-acetate (LTA), Baker's yeast, n- butyl lithium, $K_3Fe(CN)_6$ and DMSO, Grignard reagent, diazomethane, polyphosphoric acid;

CO-2: explain theory and principles of NMR spectroscopy, Theory of Fourier Transform, Proton resonance condition, Aspects of PMR spectra – number of signals, chemical shift, factors influencing chemical shift, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei, effect of deuteration, spin-spin coupling, (n + 1) rule, factors effecting coupling constant "J", Preliminary idea of 2D NMR, Types of ^{13}C NMR Spectra: proton coupled and decoupled ^{13}C spectra, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts;

CO-3: discuss basic concepts of eutrophication, water quality, water contaminants, heavy minerals, organic contaminants, PCBs and other halogens materials, PAH, pesticides, waterborne pathogens, aquatic toxicology, water purification methods, sewage treatment, air pollution sources and emissions- particulates, aerosols, photochemical smog, determination of SOx, NOx, COx and hydrocarbons, air pollution control echnologies of particulate and gaseous pollutants, industrial pollution of sugar, distillery, drug, pulp & paper and their analysis, effluent treatment plants of above industries;

CO-4: study nomenclature of Heterocycic compounds: Hantzsch-Widman nomenclature systems for monocyclic and fused heterocycles and bridged heterocycles;

CO-5: study five and six membered heterocycles with two hetero atoms: synthesis, reactivity, aromatic character and importance of following heterocyclic rings: oxazole, thiazole, pyrazole, imidazole, pyridazine, pyrimidine, pyrazine;

CO-6: learn condensed five membered heterocycles: synthesis, reactivity, aromatic character and importance of following heterocyclic rings: benzoxazole, benzthiazole, benzopyrazole, benzimidazole.

Sem-III: PAPER-III Organic Chemistry in Industry

At the end of the course student will be able to

CO-1: have introduction of dyes and pigments, absorption of visible light, color of wavelength absorbed, complementary color, relation between color and chemical constitution, Witt's theory, Armstrong's theory, Nietzki's theory, valence bond theory, molecular orbital theory, fastness properties, exhaustion and fixation properties. natural dyes, nomenclature of dye intermediates, color index classification of dyes: based on structure, based on mode of application to fibers, non–textile uses of dyes: dyes in medicine, leather, paper, color photography and electro photography, food, cosmetics, displays and laser dyes;

CO-2: classify drugs on the basis of their chemical structure and therapeutic action, nomenclature: proprietary and non-proprietary name, nomenclature of new drugs by who, names of drugs: generic and brand names theories of drug action: occupancy theory, rate theory and induced fit theory biological defense, chemical defenses, Furguson principle absorption of drugs: routes of administration, factors that effect on absorption physico-chemical properties: solubility, partition coefficients, ionization constant, electronic effect, steric effect, stereo-chemical consideration;

CO-3: familiarize with the drug discovery, drug development, preclinical and clinical testing, medicine, future problems and opportunities;

CO-4: define all the terms related to agrochemical industry, classification, biodegradable and persistent pesticides, toxicity, chemical classification of pesticides-herbicides and insecticides;

CO-5: define unit process and unit operation;

CO-6: learn nitrating agents, mechanism of aromatic nitration, industrial chemicals derived from benzene, naphthalene, anthracene using nitration;

CO-7: learn sulphonating and sulfating agents, mechanism of aromatic sulphonation, industrial chemicals derived from benzene, naphthalene, anthracene using sulphonation;

CO-8: study aminating agents, amination by reduction, amination by ammonolysis, industrial chemicals derived from benzene using amination;

CO-9: learn alkylating agents, industrial important alkyl compounds derived by various routs;

CO-10: study halogenation agent's industrial important halogenated compounds derived by various routs.

Sem-III: PAPER-IV Medicinal Chemistry-I

At the end of the course student will be able to

CO-1: have knowledge of medicinal chemistry in terms of structure activity relationship (SAR), pharmacokinetics and pharmacodynamics of drugs, absorption, distribution, metabolism, excretion and toxicity of the drug as well as shows the effect of drugs with receptors, chemical messengers, DNA etc.;

CO-2: get familiarize the general information and classification of drugs;

CO-3: get familiarize the therapeutic uses, synthesis, structural variations and mode of action and classification of anesthetics, sedatives and hypnotics drugs;

CO-4: classify antipyretic analgesics, narcotic analgesics and non-steroidal anti-inflammatory drugs;

CO-5: study structural variations in morphine, morphan and 4-phenylpiperidine analogues;

CO-6: learn about receptors, limitations of opoids;

CO-7: synthesize and learn therapeutic uses of only the following: meperidine (pethidine), ibuprofen, meclofenamate sodium, oxyphenbutazone, diclofenac sodium, mefanamic acid.

Sem-III: Organic Chemistry Practical

At the end of the course student will be able to

CO-1: gain the skill to prepare organic compounds using greener protocols, green synthesis of acetanilide from aniline and acetic acid using Zn dust, base catalyzed aldol condensation using $LiOH.H_2O$ as a catalyst, [4+2] cyclo-addition reaction in aqueous medium at room temperature, benzil benzilic acid rearrangement under solvent free condition;

CO-2: learn preparation of industrially important compounds by following Name reactions, Sandmayer reaction, Fischer indole synthesis, Riemer-Tiemann reaction, Skraup synthesis, Gebrielphthalimide synthesis;

CO-3: study organic estimations of sulphonamides with silver nitrate solution volumetrically, determine aromatic primary amines by either diazotization or indirect diazotisation, estimate benzyl penicillin, determination of coupling value (C. V.) of Dye intermediates, non-aqueous titration of sodium benzoate, estimate isonazid, $-NO_2$ and -OH group.

M. Sc. Sem-IV Organic Chemistry

Sem-IV: PAPER-I Advance Organic Chemistry

At the end of the course student will be able to

CO-1: have introduction to oxidation, oxidation with Cr (VI), Mn (VII), Mn (IV), OsO_4, periodic acid, peroxy acid, oxidation of hydrocarbons-alkenes, aromatic rings, saturated C-H group (activated and unactivated), aldehyde and ketones;

CO-2: have introduction to reduction, different reductive processes, hydrocarbons-alkenes, alkynes and aromatic rings, carbonyl compounds- aldehydes, ketones, ($LiAlH_4$, $NaBH_4$ only for aldehyde and ketone) acids and their derivatives, epoxides, nitro, nitroso, azo and oxime groups, Birch reduction, Shapiro reduction;

CO-3: learn rearrangement involving migration to electron deficient carbon: Expansion and contraction of rings/Demajnov rearrangement, Benzil-benzilic acid rearrangement, rearrangement involving migration to electron rich carbon: Favorskii rearrangement, Sommelet-Hauser, rearrangement, Neber rearrangement;

CO-4: study rearrangement involving migration to electron deficient nitrogen: Schmidt rearrangement, Curtius rearrangement, Aromatic rearrangements: Migration around the aromatic nucleus: Jacobsen rearrangement, Migration of group from the side chain to the nucleus: Orton rearrangement, Hoffmann-Martius rearrangement, rearrangement of N-nitrosoanilines (Fischer-Hepp rearrangement);

CO-5: study rearrangement involving migration from oxygen to ring: Fries rearrangement, Claisen rearrangement;

CO-6: learn general nature, method, mechanism and synthetic applications of the following reactions; Ugi reaction, Noyori reaction, Wittig reaction, Peterson olefination reaction, Mannich reaction, Stille reaction, Ene reaction, Staudinger reaction, Corey-Fuchs reaction, Ritter reaction, Mcmurry reaction, Michael addition.

Sem-IV: PAPER-II Selected Topics in Organic Chemistry-II

At the end of the course student will be able to

CO-1: explain theory and principles of mass spectroscopy; instrumentation; low and high resolution mass spectra; ionization techniques – electron impact (ei) ionization, chemical ionization (ci), field desorption (fd), fast atom bombardment (fab), electronspray ionization (ESI); determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak; Fragmentations – rules governing the fragmentations, McLafferty rearrangement; interpretation of mass spectra of different class of compounds – saturated and

unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens; write possible fragmentation for given compound; identify structure from mass spectral data; identify structure from combined spectral data, learn structure elucidation by suing UV, IR, NMR and mass spectroscopic techniques.

Sem-IV: PAPER-III Advance Organic Synthesis

At the end of the course student will be able to

CO-1: know the utility of protecting group strategy in organic synthesis–protection of alcohols, Carbonyl, Carboxylic acid and amino groups, synthetic equivalent groups and examples on transformations;

CO-2: get familiarize with the students with the basic principles of disconnection approach, concept of synthon, synthetic equivalent and functional group interconversion;

CO-3: be familiarize with the Carbon-metal bonds in organometallic compounds, synthesis and applications of organolithium, organozinc and lithium diorganocuprate and organoboranes. Organometallic reaction mechanisms and its applications;

CO-4: study five and six membered heterocycles with more than two hetero atoms: synthesis, reactivity, aromatic character and importance of following heterocycles: 1,2,3-triazole, 1,2,4-triazole, 1,2,4-oxadiazole, 1,3,4-oxadiazole, 1,2,5-oxadiazole;

CO-5: study synthesis of condensed six membered heterocycles, reactivity, aromatic character and importance of following heterocyclic rings: quinoline, isoquinoline, cinnoline, quinoxaline, phthalazine, naphthyridine, phenoxazine.

Sem-IV: PAPER-IV Medicinal Chemistry-II

At the end of the course student will be able to

CO-1: have introduction to anti-malarials, types, life cycle of plasmodium, drug resistance, general classification, SAR of 4- and 8-aminoquinolines and structure variation in sesquiterpene lactones, mode of action, synthesis and therapeutic uses of only the following: mefloquine, chloroquine, primaquine, pyrimethamine (daraprim), quinacrine;

CO-2: get introduction to cancer, types, causes & treatment of cancer, metastasis, drug resistance, targets of anticancer agents, adverse effects of cancer therapy, general classification of antineoplastic agents, Cell Cycle-Specific (CCS) and Non-Cell Cycle-Specific (CCS) agents, mode of action, synthesis and therapeutic uses of only the following: mechlorethamine, cyclophosphamide, melphalan, 6-mercaptopyrine, trimetrexate, cytarabine;

CO-3: have introduction to antiviral agents, types & classes of viruses, classification of antiviral agents, mechanism of action, antiviral compounds for DNA viruses & selected RNA virus infections other than HIV (influenza A and B viruses, hepatitis C virus);

CO-4: get introduction of anti-HIV drugs, HIV infection and its pathological effects, HIV structure and life cycle, targets for drug design of anti-HIV agents, HIV drugs in clinical use, development of drug resistance, the need for new anti-HIV drugs, introduction of aids, synthesis and therapeutic uses of only the following: amantadine, acyclovir, zidovudine, indinavir, ritonavir;

CO-5: get knowledge about the structure of antibiotics, synthesis, therapeutic uses and classification of antibiotics;

CO-6: learn antihistamines and related anti-allergic drugs: general introduction synthesis and therapeutic uses, mode of action, structure variation of some selected antihistamines and related ant allergic drugs;

CO-7: get general introduction of tuberculosis & leprosy-disease, treatment, mode of action, adverse effect of anti TB agents & anti–leprotic agents;

CO-8: classify mode of action, SAR, synthesis and therapeutic uses of some selected sulfonamides drugs.

Sem-IV: Organic Chemistry Practical

At the end of the course student will be able to

CO-1: study structure interpretation of organic compounds from spectra (UV, IR, NMR and mass);

CO-2: learn preparation of industrially important compounds Sulfanilamide, Acridone, Benzocaine, Eosin, Benzanilide, p-Nitro chloro benzene, p-Chlorobromo benzene, Anthrone, 4-Methyl-7-hydroxy-8-acetyl coumarin;

CO-3: study green approach for preparation of benzopinacolone from bezopinacol using iodine catalyst, Preparation of 1, 1-bis-2-naphthol under grinding at room temperature, three component coupling reaction by green approach.

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. (Mathematics) 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

- **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

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, eigenvalues 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: Mathematics-V (Sem - III)

After successfully completing this course, students will be able to

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

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

CO3: solve examples using Taylor's theorem, Maclaurian's expansion and find Jacobian;

CO4: find the maxima & minima of functions of two variables;

CO5: familiar with the necessary and sufficient conditions for extreme points;

CO6: find the derivatives of vector point function;
CO7: find the gradients, curl, and divergence;
CO8: understand integral and find the line integral.

Course MTH-302: Mathematics-VI (Sem - III)

After successfully completing this course, students will be able to

CO1: 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: Mathematics-VII (Sem - III)

After successfully completing this course, students will be 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 EG: Mathematical Methods (Sem - III)

After successfully completing this course, students will be able to

CO1: be familiar with finite difference operators;
CO2: be 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: Mathematics-VIII (Sem - IV)

After successfully completing this course, students will be able to

CO1: know Beta-Gamma functions, relate Beta and Gamma functions;
CO2: understand the application of Beta-Gamma functions;
CO3: find double and triple integral;
CO4: change the order of double integral and find the area using integration;
CO5: know Laplace transform, understand Laplace transform of some elementary functions;
CO6: know inverse Laplace transform and properties of inverse Laplace transform.

Course MTH-402: Mathematics-IX (Sem - IV)

After successfully completing this course, students will be 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: Mathematics-X (Sem - IV)

After successfully completing this course, students will be able to

CO1: have a knowledge of important mathematical concepts sets, elements, functions;
CO2: understand the concept of countable and uncountable sets;
CO3: find the greatest lower bound and least upper bound;
CO4: understand the concepts of sequences and limit of the sequence;
CO5: understand the concept of convergent sequence and divergent sequence, bounded sequence, monotone sequence, Cauchy sequence;
CO6: understand the concept of divisibility;
CO7: find gcd, lcd and understand the relation between gcd and lcm;
CO8: classify prime and composite numbers;
CO9: understand the theory of congruence and properties of congruence;
CO10:understand equivalence classes.

Course EG: Mathematical Modelling (Sem - IV)

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

CO1: understand the mathematical modelling;
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: explain 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 term
Course Outcomes (CO)
CO7: identify the game w point;
CO8: solve the game with mixed strategies;
CO9: use graphical method to solve $m \times 2$ or $2 \times n$ games.

Statistics

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.

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 its 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: describe 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, its 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 its 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 and 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: connect and apply biological knowledge to other disciplines and to integrate ability to connect and apply biological knowledge to other disciplines and to integrate;
PSO2: 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;
PSO3: illustrate zoological science for its application in branches like medical entomology, apiculture, aquaculture and agriculture etc;
PSO4: understand animal interactions with the environment and identify the major groups of organisms with an emphasis on animals and classify them within aphylogenetic 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: demonstrate anatomical and physiological attributes of each animal group and why these have led to their success;
CO2: identify a range of invertebrate and vertebrate animals;
CO3: describe various phenomena like torsion, metamorphosis, water vascular system, parasitic adaptations etc.in invertebrates;
CO4: describe the morphology, habit and habitat, systematic position and various systems in Liver fluke (Fasciola hepatica);
CO5: list the various animals in a given phylum;
CO6: state the animal classification with reference to vertebrate animals up to class level;
CO7: enlist the examples of the phylum studied;
CO8: comment on the modifications of common animal forms of the groups studied.

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

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

- **CO1:** differentiate prokaryotic and Eukaryotic cells;
- **CO2:** explain the principles of staining;
- **CO3:** describe the structure and functions of cell organelles, label the various cell parts and cell organelles;
- **CO4:** define the terminologies in genetics;
- **CO5:** explain Mendel's principle, its extension and chromosomal basis and determination of gene action from genotype to phenotype and concepts of inheritance;
- **CO6:** describe the chromosome anomalies and associated diseases;
- **CO7:** know different types of ecosystems like desert, marine, wetland, fresh water etc. moreover they will be able to learn about different types of ecological adaptations also;
- **CO8:** study different types of animal behavior e.g. social behavior, nesting behavior etc.

Course: Practical (Z – 101 and Z – 102) Systematics and Animal Diversity, Cytogenetic, Ecology and Ethology

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

- **CO1:** identify various animals based on morphological features of non-chordate and chordate animas;
- **CO2:** identify different animal adaptations, study histology of sponge, ethological study by hornbill, honey bees etc;
- **CO3:** prepare stained slides of mitosis, identify the cell division phases;
- **CO4:** detect human blood group, identify the human genetic traits;
- **CO5:** identify the cell organelles. Study poisonous and non-poisonous snakes by identification key;
- **CO6:** prepare album of animal photographs to study taxa so that students can know some extra details about the local animals.

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

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

- **CO1:** integumentary System: Comparative study of glands and digital tips;
- **CO2:** comparative study of digestive and respiratory systems;
- **CO3:** evolution of heart and sensory organs like eye, ear, tongue and skin;
- **CO4:** human diseases like swine flu, leptospirosis, chikungunya etc;
- **CO5:** applied Zoology- Poultry breeds, bird keeping, egg as food, poultry appliances etc;
- **CO6:** wild life biology- what is wild life?, importance of conservation, causes of depletion of wildlife, difference between Sanctuary and National Park;
- **CO7:** Gir N. P., Marine N. P., Wild Ass sanctuary, Velavadar, Thol bird sanctuary etc. with special emphasis on Gujarat state.

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 and Z – 202) Comparative Anatomy, Applied Zoology, Wildlife Biology, Life Processes, Biochemistry, Immunology and Tissue System

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, the respiratory system with respect to gills, lungs, air sacs and swim bladder, the circulatory system with respect to evolution of vertebrate heart;

CO3: identify and describe different sense organs;

CO4: the human diseases - Dengue, Leptospirosis, Chikungunya and Swine flu;

CO5: poultry appliances- brooder, feeder, water appliances and candling;

CO6: the control of food ingestion and T. S. of intestine of mammals, different salivary glands in human;

CO7: various diseases caused due to vitamin deficiency – night blindness, Xerophthalmia, rickets, scurvy, Beriberi and Pellagra, different types of reproduction;

CO9: 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) Biochemistry and Animal Physiology

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

CO1: explain basic structure of carbohydrates, proteins and lipids;

CO2: describe metabolic activities like Glycolysis, TCA cycle & Oxidative phosphorylation, Gluconeogenesis etc;

CO3: explain the types and structure of muscle fibers and physiology of muscle contraction;

CO4: describe the basic concepts of hematology as well as the composition of blood, Haemopoiesis 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 with physico-chemical properties and zonation;
CO3: describe adaptations in deep sea fishes (bony fish in freezing water), sea birds and general characters of cartilaginous and bony fishes;
CO4: explain Microorganisms: - Phytoplanktons, zooplanktons, red algae, brown algae, green algae, multicellular algae as well as economic importance of algae.

Course: Practical (Z – 301, Z – 302 and Z – 303)

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

CO1: identify and describe the general characters 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 earthworm;
CO3: identify and describe animals showing variation, deep sea and cave dwelling adaptations with suitable examples;
CO4: explain the importance of Vermiculture and Sericulture in details including its economic importance;
CO5: identify anddescribe the general characters of the Protochordata and chordates up to subclass with examples: Urochordata, Cephalochordate, Cyclostomes, Pisces and Amphibia;
CO6: describe Labeo rohita with reference to its structure and functions of various organs of all the systems and mountings;
CO7: explain the histology of mammalian tissues– Stomach, intestine, liver, kidney, ovary, testis, salivary gland and pancreas;
CO8: identify and describe the girdles and skulls in frog, scoliodon, varanus, pigeon and rabbit;
CO9: explain basic structure of carbohydrates, proteins and lipids with the help of atomic models and quantitative tests;
CO10: elaborate the structure of genetic material and types of RNA;
CO11: explain the types and structure of muscle fibers;
CO12: determine the clotting time of human blood;
CO13: estimate Hb content from human blood;
CO14: demonstrate the haemin crystals from human blood.

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 Hemichordates;
CO2: explain the structure and functions of various organs of all systems of Pila;
CO3: describe Homologous organs, analogous organs, vestigial organs and connecting link, atavism, protective coloration and mimicry etc;
CO4: explain the economic importance of Dairy farming- Indian and exotic breeds of cows and buffaloes, milk and milk products etc;
CO5: describe apiculture- life history of honey bees, types and casts of honey bees, structure of honey comb etc.

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

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

CO1: explain general study of the following chordates up to subclass with examples: Reptilians, Aves and Mammals;
CO2: explain the animal type with reference to their structure and functions of various organs of all systems of Uromastix;

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

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

Course: (Z – 403) Biochemistry, Genetics and Animal Physiology

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

CO1: classify carbohydrates, proteins and lipids;

CO2: explain epistasis genes and concept of lethal alleles and pseudo alleles;

CO3: describe synapse and mechanism of nerve impulse conduction;

CO4: describe the structure and function of sense organs (human) eye and ear;

CO5: elaborate the structure of uriniferous tubule, physiological process of excretion (including counter current mechanism) and urine formation; hormonal control (rennin angiotensin system and ADH)

CO6: explain osmoregulation in fresh and marine water organisms, osmosis, diffusion and Donnan's equilibrium.

Course: Marine science (EG)

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

CO1: explain scope of marine science;

CO2: describe the classification of prokaryotes and eukaryotes;

CO3: describe Geology of the ocean with physicchemical properties and zonation;

CO4: describe the adaptations in deep sea fishes (bony fish in freezing water), sea birds, whales and their relatives and general characters of cartilaginous and bony fishes

CO5: explain marine microorganisms-phytoplanktons, zooplanktons, red algae, brown algae, green algae, multicellular algae as well as economic importance of algae, marine sponges, molluscs, arthropods, scoliodon and marine mammals.

Course: Practical (Z – 401, Z – 402 and Z – 403)

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

CO1: identify and describe the general characters of non-chordate phyla up to subclass with examples: Arthropoda, Mollusca, Echinodermata and Hemichordates;

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

CO3: describe Homologous organs, analogous organs, vestigial organs and connecting link as well as importance of atavism, protective colouration and mimicry etc.;

CO4: explain the economic importance of Indian and exotic breeds of cows and buffaloes;

CO5: describe apiculture and its importance in details including life history of honey bees, types and casts of honey bees, structure of honey comb etc.;

CO6: identify and describe the general characters of the following chordates up to subclass with examples: Reptilians, Aves and Mammals;

CO7: explain the animal type with reference to their structure and functions of various organs of all systems of Uromastix;

CO8: demonstrate frog embryology with the help of models, charts, specimen, photographs or permanent slides;

CO9: compare osteology of fore limbs and hind limbs in frog, varanus, pigeon and rabbit;

CO10: perform qualitative test for carbohydrates and proteins;

CO11: explain epistasis genes, lethal alleles and pseudo alleles by chart;

CO12: determine normal and abnormal constituents of urine;

CO13: demonstrate structure and function of sense organs (human) eye and ear and different types of nerve cells.

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 Taxonomy, Animal type

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

CO1: identify and classify the invertebrate animals upto order;

CO2: understand Structural organization of different classes of invertebrates;

CO3: describe the morphology, habit and habitat, Systematic position and various systems in Leech (Hirudinaria granulosa);

CO4: understand the amplification of Protozoa, Porifera, Ctenidia, Helminthes and Annelida;

CO5: to know about phylogenetic relationships of the Ctenophora and Chaetognatha, the minor phyla;

CO6: enlist the examples of the phylum studied;

CO7: to comment on the modifications of common animal forms of the groups studied.

Course: Practical (Z – 501) Non chordates Taxonomy, Animal type

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

CO1: identify various animals based on morphological features of non-chordate animals;

CO2: identify different aquatic animals and able to classify them;

CO3: study permanent slides of spicules and gemmules and animal-Ascaris;

CO4: understand the different system and mountings of Leech.

Course: (Z – 502) Chordates Taxonomy, Animal type and Comparative Anatomy

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

CO1: identify a range of vertebrate animalsupto order;

CO2: classify and describe the vertebrate animals;

CO3: understand the animal type (Scoliodon) with reference to the structure and function of all system;

CO4: describe the amplifications like geological time scale, origin of vertebrates;

CO5: understand about Pisces, types of scale and parental care in fishes;
CO6: learn about origin and evaluation of Amphibia;
CO7: Able to comment on vertebrate animals.

Course: Practical (Z – 502) Chordates Taxonomy, Animal type and Comparative Anatomy

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

CO1: identify various animals based on morphological features of chordates;
CO2: learn to comparative characteristics of animals and able to differentiate them;
CO3: study animal type (Scoliodon), with all system and mounting;
CO4: learn about parental care in fishes;
CO5: identify the types of scale in fishes;
CO6: study comparative anatomy of vertebral column and skulls of various animals.

Course: (Z – 503) Enzymology and Biochemistry

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

CO1: define enzymes and describe its chemical nature along with its properties;
CO2: describe nomenclature and classification of enzymes;
CO3: elucidate the concept of enzyme activation and mechanism of enzyme action;
CO4: explain in detail the factors affecting the enzyme activity;
CO5: describe enzyme inhibition and enzyme kinetics;
CO6: derive Michaelis-Menten equation and Lineweaver-Burk plot;
CO7: discuss the concept of pH and buffers in details;
CO8: describe reaction kinetics and basic principles of thermodynamics;
CO9: demonstrate different types of solutions and colligative properties;
CO10: comment on composition, types, structure and function of DNA and RNA;
CO11: elucidate the composition, structure and formation of vitamins;
CO12: illustrate the reactions, energetics and regulation of glycolysis, glycogenesis, TCA cycle, gluconeogenesis and glycogenolysis with structure of biomolecules;
CO13: explain the electron transport system and oxidative phosphorylation;
CO14: describe with structures deamination, transamination and ornithine cycle;
CO15: illustrate β-oxidation and synthesis of long chain fatty acids and glycerol metabolism.

Course: Practical (Z – 503) Enzymology and Biochemistry

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

CO1: demonstrate the activation of salivary amylase under optimum condition;
CO2: demonstrate the effect of various physical factors like pH and temperature on enzyme activity;
CO3: explain the digestive enzymes from Human Saliva;
CO4: prepare pH, buffer and different solutions as per theory;
CO5: illustrate vitamins structure through model or chart;
CO6: demonstrate DNA with the help of model / chart;
CO7: demonstrate RNA with the help of model / chart;
CO8: illustrate A___, T___, G___, C___ by models;
CO9: explain water soluble vitamins and fat soluble vitamins.

Course: (Z – 504) Embryology and Wildlife Biology

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

CO1: study basics of embryology, developmental biology, scope and branches of embryology. They will also learn the process of gametogenesis;

CO2: know the types of fertilization, capacitation, acrosomal reaction and penetration, estrus and menstruous cycles, pregnancy, parturition and placenta –placentation;

CO3: know different aspects of chick embryology in detail viz. fertilized egg, stages and patterns of cleavage, as well as different hours of chick embryonic development;

CO4: learn what is wildlife biology, status of wildlife in India viz. Threatened, vulnerable, endangered etc., along with that conservation practices, legal aspects of conservation, National parks-sanctuaries, different wildlife conservation projects-tiger, wild ass, blackbuck etc. and recommendations of CITES.

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

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

CO1: learn different types of mammalian placenta;

CO3: study in detail about Unfertilized egg, different stages cleavage, morula, blastula, gastrula, development of Structure of 8, 16, 21, 24, 33, 48 and 72 hrs;

CO3: study the Wild life Illegal trades, practices and its control measures of following: Tiger (Claws, Bones, Skins and Whiskers), Rhino (Horns), Elephant (Tusks), Musk Deer (musk), Turtle (Shells);

CO4: attend the Industrial Workshops/Laboratory Workshops/Training Program/ Symposia/ Seminar/Field visit/Educational Excursion organized by the department/college. So students can have first-hand experience.

Course: (Z – 505) Forensic science and Toxicology

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

CO1: get aware of Forensic science for Zoology students, different international perspectives are taken in consideration. How to study foot print, finger print, etc. is taken in consideration;

CO2: understand about different layer of hair, how to do primary investigation to identify animal hair, what is DNA finger print;

CO3: gain knowledge on toxicology;

CO4: gain knowledge on food contamination.

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

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

CO1: study different types of Finger prints and Tattoo marks;

CO2: study the morphology of different hairs- Man, Dog, Cat, Cow, Buffalo, Horse, Goat;

CO3: study of various samples of food additives/preservatives and their usages (Vinegar, Benzoic acid, Formic acid, Citric acid and Gelatin);

CO4: study of food contaminants on - Bread, Chapati, Curd and Fruits;

CO5: learn tests (only two tests to be performed) of adulterated milk, black pepper, khoya (maava of milk), edible oil, coconut oil, ghee, rabdi;

CO6: study DNA finger printing method.

Course: (Z – 506) Genetics and Molecular Biology

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

CO1: define the basic terms in genetics;

CO2: elucidate gene concept;

CO3: discuss the location, size, its role and numbers of genes;

CO4: explain the chemical composition and ultrastructure of genes;

CO5: define and describe jumping genes, split genes and sex chromatin;

CO6: paraphrase the Central dogma of molecular biology;

CO7: discuss genetic code and the mechanism of DNA replication, transcription and protein synthesis;
CO8: discuss the basics of biotechnology;
CO9: illustrate the mechanism of DNA repair and recombi1nant DNA technology;
CO10: define and explain karyotyping;
CO11: illustrate various chromosomal banding techniques – G, Q, C and R banding;
CO12: explain chromosomal aberrations and syndromes, gene mutations;
CO13: discuss the overview of tumor growth, its development and metastasis.

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

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

CO1: demonstrate Barr body (dosage compensation) from cheek epithelial cells;
CO2: prepare DNA, RNA by models;
CO3: illustrate DNA replication using photographs or charts;
CO4: demonstrate normal human karyotype and syndromes viz. Down syndrome, Patau syndrome, Edward syndrome, Cri du chat, Jacob's syndrome, Klinefelter's syndrome, Turner syndrome, Super female and Philadelphia syndrome;
CO5: enlist types of cancer including blood cancer and skin cancer with charts/photos;
CO6: illustrate transgenic animal (Dolly sheep).

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: (Z – 601) Non-chordates Taxonomy, Animal type

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

CO1: identify non-chordate phylum with its characteristics upto order;
CO2: understand structural organization of different classes of non-chordates;
CO3: describe morphological characteristics of non-chordates;
CO4: describe the structure and function of various organs of all systems of Sepia;
CO5: understand respiration and excretion in Arthropoda;
CO6: explain torsion and detorsion in Gastropods;
CO7: understand autotomy and regeneration and evolutionary significance of Echinodermata;
CO8: describe phylogenetic relationships of endoprocta and ectoprocta as minor phyla.

Course: Practical (Z – 601) Non-chordates Taxonomy, Animal type

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

CO1: identify various animals based on morphological features of non- chordate animals;
CO2: comment on specific non-chordate animals;
CO3: describe animal type study with all systems and mountings;
CO4: explain digestive system and nervous system of Sepia;
CO5: identify and explain permanent slides of different larvae.

Course: (Z – 602) Chordates Taxonomy, Animal type and Histology

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

CO1: demonstrate anatomical and physiological attributes of each animal groups;

CO2: identify a range of vertebrate animals;
CO3: list the various animals in a given phylum;
CO4: explain animal study type with reference to the structure and function of various organs of all system of pigeon;
CO5: describe various phenomenon of reptiles like: rhyncocephalia, temporal fossae and arcades, carapace and plastron;
CO6: describe bird migration and flight adaptation in birds;
CO7: describe dentition, prototheria, metatheria, cetacea and primates;
CO8: identify the mammalian histology and able to describe it.

Course: Practical (Z – 602) Chordates Taxonomy, Animal type and Histology

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

CO1: identify various animals based on morphological features of chordate animals;
CO2: identify chordate animals and able to comment on them;
CO3: describe animal type study of pigeon with digestive system, Urinogenital system, Circulatory system and Brain;
CO4: explain mountings, pectin and hyoid apparatus;
CO5: identify Mesozoic reptiles;
CO6: describe types of feather;
CO7: describe and differentiate dentition in various animals;
CO8: study mammalian histology and able to explain the histological structure of various glands.

Course: (Z – 603) Animal Physiology and Endocrinology

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

CO1: explain aquatic & terrestrial respiratory mechanism;
CO2: illustrate O2 dissociation curve;
CO3: describe respiratory quotients, BMR and hypoxia;
CO4: diagrammatically represent the mechanism of respiration, gas exchange and transport of O2 and CO2;
CO5: explain various respiratory pigments;
CO6: describe the neural and chemical regulation of respiration;
CO7: diagrammatically explain the structure of mammalian heart and properties of cardiac muscles;
CO8: explain different types of internal circulation viz. systematic, pulmonary and coronary circulation;
CO9: illustrate blood pressure, ECG and blood coagulation;
CO10: elucidate the regulatory mechanism of heart beat including hormonal, ionic and nervous regulation;
CO11: describe cardiac cycle, cardiac output and stroke volume;
CO12: justify hormones as coordination molecules;
CO13: discuss the roles of hormones of pineal gland, hypothalamus, pituitary gland, thyroid gland, parathyroid gland, thymus, pancreas, adrenal gland, ovary and testes;
CO14: illustrate the chemical nature and mechanism of hormone action.

Course: Practical (Z – 603) Animal Physiology and Endocrinology

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

CO1: demonstrate principle and applications of various analytical instruments like pH meter, sphygmomanometer, stethoscope, Thoma's pipette and haemocytometer;
CO2: count total RBC in human blood;
CO3: estimate differential count of WBC in human blood;

CO4: demonstrate the measurement of systolic blood pressure, diastolic pressure, pulse pressure and mean pressure of an individual with the help of sphygmomanometer and stethoscope;
CO5: illustrate Electrocardiogram (ECG);
CO6: demonstrate the control, regulation and role of hormones of pituitary gland, thyroid gland, parathyroid gland, pancreas, adrenal gland, ovaries and testes.

Course: (Z – 604) Entomology

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

CO1: demonstrate insects and their body parts;
CO2: learn history, development, scope and applications of entomology;
CO3: explain branches of entomology;
CO4: classify insects;
CO5: identify pest of sugarcane, cotton and vegetables;
CO6: learn about management of agriculture pest;
CO7: identify stored grain insect pest and able to do their management;
CO8: explain morphology, vectorship, pathogenicity and control of mosquito, housefly, rat fleas, head louse, dog, cats and cattles;
CO9: learn about beneficial insects;
CO10: identify household insects and able to manage them;
CO11: describe insect pest control methods;
CO12: learn about appliances used for pest management.

Course: Practical (Z – 604) Entomology

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

CO1: know about branches of entomology at length;
CO2: learn about scope, development and applications of entomology;
CO3: identify pests, its pathogenicity and control of pests of: cereals, cotton, sugarcane and vegetables;
CO4: study morphology, vectorship, pathogenicity and control of anopheles, Culex and aedes mosquitos;
CO5: study and describe different pests of domestic animals;
CO6: learn in detail about economic importance of arthropods
CO7: differentiate beneficial insects, harmful insects, pollinators, scavengers, etc;
CO8: study usefulness of pest management appliances and their uses;
CO9: learn about biological pest controller.

Course: (Z – 605) Cell biology and Bioinstrumentation

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

CO1: Explain the basics of microscopy;
CO2: describe magnification and resolution of various microscopes;
CO3: demonstrate light microscope including simple and compound microscope;
CO4: demonstrate electron microscope and phase contrast microscope;
CO5: elucidate the basics of various cytological techniques;
CO6: demonstrate the examination of living cells through various cytological techniques like teasing, smear preparation, squash preparation, whole mount and microtomy;
CO7: justify the selection of various fixatives and cytological stains for histological procedures;
CO8: illustrate the process of fixation and cytological staining;
CO9: explain the importance and applications of different techniques in biochemistry;
CO10: demonstrate the principle and application of paper chromatography technique;

CO11: demonstrate the principle, working, applications of centrifugation;
CO12: explain the principle, working, materials used and applications of electrophoresis;
CO13: demonstrate the principle, working, applications of PCR;
CO14: describe the concept of light, electromagnetic spectrum and its application in absorption spectroscopy;
CO15: illustrate cell cycle and diagrammatically represent the phases of division of mitosis and meiosis respectively;
CO16: describe the composition, structure and functions of the plasma membrane;
CO17: elucidate the process of lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport and ion pumps;
CO18: Describe the mechanism of sorting and regulation of intracellular transport.

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

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

CO1: identify and describe various types of microscopes;
CO2: perform the micro techniques to prepare permanent slides of different organs;
CO3: perform paper chromatography for separation of amino acids;
CO4: demonstrate meiosis and mitosis in given permanent slides;
CO5: prepare different stages of mitosis from onion root tip through squash method;
CO6: demonstrate principle, working and applications of various bio-instruments viz. electrophoresis, centrifuge, PCR and spectrophotometry through charts/models.

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

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

CO1: know Animal Inter relationship in detail;
CO2: learn what is Biogeography? What is Zoogeography? And Zoogeographical Regions of world as well as diverse fauna of India;
CO3: describe Social behaviour in animals-Costs and Benefits of group living, will know Evolutionary Advantages and disadvantages of group living, Characteristics of Social Insect;
CO4: learn and explain Bioluminescence, Biological Clock and Insect Pheromones in depth;
CO5: study in detail about Direct Evidences of Evolution;
CO6: explain what the fossils are, Introduction, Different Branches of Paleontology, How Fossils formation takes place etc;
CO7: study in detail about different Conditions of Fossilization, Determination of age of Fossils, Nature of Fossils, Types of Fossils, Significance of Fossils and Conclusions drawn from Fossils

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

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

CO1: learn the methodology of Estimation of Alkalinity and Hardness as well as the amount present in the sample water;
CO2: study the method of Estimation of free CO2 and dissolved O2 and its amount present in sample water;
CO3: study of Habituation of mosquito larva;
CO4: study of Antennal grooming behavior (Chemotoxis);
CO5: study of alarming, attractant, aggression behavior;
CO6: know the different Types of Fossils with the help of photo graphs/charts.

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.

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.