Program Name: **B.Sc. (Hons) Physics**

Program Code: **PHY3303**

Offered by Department of Physics, School of Basic and Applied Sciences, Adamas University

Duration: 3 Years

Academic Year: 2022-23

The **B.Sc. (Hons) Physics** program is open to students with 10+2 passed in Science with Physics and Mathematics as compulsory papers. There is a variety of Core-courses that emphasize the fundamentals while keeping in mind the evolving nature of the subject. A strong laboratory component allows the students to explore a range of experiments from classic ones to those that are more recent and advanced. A platter of advanced discipline specific elective offer a glimpse into frontier areas of research and allow students to choose a field of specialization for higher study and socially as well as globally relevant foundation courses will help them to become more competent and confident in their professional career.

Department of Physics is following the UGC recommended CBCS curriculum from 2016-17 AY. In addition to that a few courses have been added to make the overall teaching learning experience comprehensive and updated. The type of the courses are as follows-

- Core Theory courses
- Core Lab based courses
- Discipline Specific Elective courses
- Discipline specific Lab based courses
- Generic Elective Theory courses
- Generic Elective Lab based courses
- Ability Enhancement compulsory courses
- Skill enhancement elective course
- Value added foundation courses
- Internship
- Dissertation

CORE COURSES (THEORY & LAB)

Paper Name: **MATHEMATICAL PHYSICS I**
Paper Code: **PHY11001**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To demonstrate the concept of different physical aspects by organizing and comparing data, and interpreting mathematical concepts.
2. To build the capability of solving problems quantitatively.
3. To examine the behavior of a physical system under different conditions.

Course Outcomes

On completion of this course, the students will be able to

CO1: Apply the basic techniques of solution of Differential Equations, Complex Numbers and Calculus of multivariate functions in real life problems.

CO2: Apply the concepts of Vector Differentiation, Vector Integration and Orthogonal Curvilinear Coordinates.

CO3: Explain the basic concepts of Matrix operation in real physical problems.

CO4: Examine the application of Beta and Gamma Functions.

CO5: Demonstrate the concept of Systematic and Random Errors.

Catalog Description

Mathematical Physics deals with the physical aspects that can be analyzed based on mathematical expressions, which need regular exercise of different areas. They include Differential Equations, Multivariate calculus, Vector calculus, Orthogonal Curvilinear Coordinates, Matrix operation, Some Special Integrals like Beta and Gamma Functions. While handling experimental data, Error calculation is very important. This is also included in the course design.

Course Content

Unit-1: Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only)

(4L)

Brief recapitulations of Complex numbers, Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers.

(4L)

Differential Equations: Differential equations of first order, separation of variables and homogeneous equations, Linear Differential equation, Bernoulli's equation, Exact differential equation, integrating factor, second order differential equation, homogeneous and inhomogeneous equations, Complete solution = C.F + P.I. Different methods of finding Particular Integral.

(8L)

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers, Multiple integrals.

(4L)

Unit-2: Vector:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

(2L)

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities

(6L)

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications.

(6L)

Theory of Orthogonal Curvilinear Coordinates: Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

(4L)

Unit-3: Matrices:

Definition, Various types of matrices, addition, subtraction and multiplication of matrices, Adjoint and Inverse of a matrix, Solution of simultaneous equations, Determination of Eigen Value and Eigen Vectors, Diagonalization of a real, symmetric matrix, Cayley-Hamilton's Theorem.

(10L)

Unit-4: Some Special Integrals:

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

(6L)

Unit-5: Theory of Errors:

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

(2L)

Reference Books:

1. Mathematical Methods for Physicists, G.B.Arfken,H.J.Weber,F.E.Harris,2013,7thEdn.,Elsevier.
2. Mathematical Methods in Physical Sciences, Mary L. Boas,2006, 3rdEdn., Wiley.
3. Mathematical Physics, H K Dass, 2014, 6thEdn., S Chand Publisher.
4. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
5. Differential Equations, George F. Simmons, 2007, McGraw Hill.
6. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
7. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
8. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson, S. J. Bence, Cambridge UniversityPress.
9. Differential and Integral Calculus, N. Piskunov, Mir Publisher.
10. Calculus, Apostol, Wiley.
11. Vector Analysis, Murry R. Spiegel, Schuam Series.

Paper Name: **MECHANICS**
Paper Code: **PHY11002**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To understand the principles of Newtonian Mechanics for single particle system and generalize it for many particle systems or bodies with continuous distribution of masses.
2. To apply the Newtonian principles in different industry and related sectors.
3. To analyze different problems with scientific aptitudes and design the solution accordingly.
4. To explore every day phenomena of the macroscopic world from a scientific point of view.

Course Outcomes

On completion of this course, the students will be able to

CO1: **Illustrate** the dynamical principles of single particle system and system of particles and **apply** it in real life problems.
CO2: **Determine** the Gravitational field and potential for different objects and **Illustrate** the concepts of central forces to understand planetary motion, and basic principle of Global Positioning System.

CO3: **Analyse** the fundamentals of rotational dynamics of a rigid body, and **estimate** the Moment of Inertia of different objects, explain Coriolis and Centrifugal forces.

CO4: **Explain** the basic concepts of Elasticity and Fluid Mechanics and apply it in different relevant areas.
CO5: **Explain** the concept of inertial, non-inertial, rotating frames, centrifugal and Coriolis forces and **analyze** them in different real life scenarios.

Catalog Description

Mechanics is a fundamental area of Physics that deals with the understanding of Newtonian principles and its applications in different areas like Mechanics of single particle and many particle systems, Rotational Mechanics, Gravitation, Central Force and Planetary Motion, Fluid Dynamics, Elasticity etc. It basically teaches how things having a different state of motion or their state of equilibrium by analyzing the forces and torques applying on it.

Course Content

Unit I: Fundamentals of Dynamics

(14L)

Reference frames. Review of Newton's Laws of Motion. Dynamics of a system of particles, Work-Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Law of conservation of Energy. Velocity and Acceleration in Polar coordinates, Analysis of Central forces, Equation of motion of trajectory of a particle moving under central force, Elastic and inelastic collisions between particles. Centre of Mass. Determination of centre of mass for different geometrically symmetric objects, Principle of conservation of momentum. Impulse. Momentum of variable-mass system: Motion of rocket. Centre of Mass and Laboratory frames.

Unit II: Gravitation and Central Force Motion:

(10L)

Laws of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to disc, spherical shell, solid sphere cylinder, conic etc. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.

Unit IV: Rotational Dynamics of rigid bodies

(18 L)

Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. Calculation of moment of inertia for simple symmetric systems; Ellipsoid of inertia and inertia tensor; Setting up of principal axes in simple symmetric cases.

Unit V: Elasticity and Fluid Motion:

(8L)

Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit VI: Non-Inertial Systems:

(6L)

Reference frames, Galilean transformations, Galilean invariance, Inertial and Non-inertial frames and fictitious forces. Uniformly rotating frame. Centrifugal force. Coriolis force and its applications.

Reference Books

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.

2. Introduction to Classical Mechanics, David Morin, Cambridge University Press

3. Classical Mechanics, Douglas Gregory, Cambridge University Press.

4. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

5. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

6. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

7. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

Paper Name: **MATHEMATICAL PHYSICS LAB I**
Paper Code: **PHY12003**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

1. To understand computer architecture - the concept of binary and decimal numbers, algorithms, precisions and the other necessary details.
2. To solve problems using Python programming -by identifying the declarations, operators, functions etc.
3. To interpret and use Conditional statements, loops, function and arrays.
4. To understand file handling and formatting.
5. To develop the art of program writing

Course Outcomes:

On completion of this course, the students will be able to

On completion of this course, the students will be able to

CO1: **Explain** the basic computer architecture and various form of representation of numbers.
CO2: **Analyze** algorithms and flowchart.
CO3: **Develop** the idea of basic structure and concepts of Python programming.
CO4: **Develop** the idea of simple graph plotting using Python module
CO5: **Utilize** the knowledge of Python programming to write basic programs like curve fitting, root finding, sorting, matrix manipulations etc.

Catalog Description:

This course introduces basic concepts of Python programming language to solve numerical problems. All the lectures will be devoted on discussions of basic theories, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as audio visual virtual lab session. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Unit 1:

Introduction to computer architecture, organization and Input/Output devices. Concepts of binary and decimal numbers, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow, Iterative methods, Flowchart.

Unit 2:
Introduction to Programming: (Python 3/ Mathematica)

Constants, Variables and Statement, Intrinsic functions. Conditional Execution, Functions, Iterations, Strings, Files, Lists, Introduction to Numpy, Scipy (for Python)

Unit 3:
Introduction to plotting graphs with Python using Matplotlib

(a) Plotting 2D graphs: using both functions and data files. Changing plot range, plot style:

(b) User defined functions

(c) Polar and parametric plots.

Unit 4:

Problem 1.Linear Curve Fitting (basic theory, algorithm, flowchart and code)
• Least Square Method

Problem 2.Root finding for a single variable (basic theory, algorithm, flowchart and code)
- Bisection method
- Newton-Raphson Method Problem

Problem 3. Sorting of lists (algorithm, flowchart and code)
- Bubble sort
- Selection sort Problem

Problem 4. Matrix operations using list of lists
- Matrix addition
- Matrix multiplication
- Transpose of Matrix
- Solution of simultaneous equations

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
2. A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
3. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , 2007, Wiley India Edition.
4. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
5. Scientific Computing in Python. Abhijit Kar Gupta, Techno World
6. Physics in Laboratory including python Programming (Semester I), Mandal, Chowdhury, Das, Das, Santra Publication

Paper Name: **MECHANICS LAB**
Paper Code: **PHY12004**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

To provide students with computing knowledge in Numerical and Statistical problems using programming language.

Course Outcome:

On completion of this course, the students will be able to

CO1. **Estimate** the rigidity modulus by dynamic method.
CO2. **Determine** the Young's modulus by Flexure method.

CO3. **Estimate** the Coefficient of Viscosity for a given liquid.
CO4. **Determine** Surface Tension of a given substance.
CO5. **Estimate** the value of gravitation constant using compound pendulum.
CO6. **Determine** the frequency of tuning fork using tuning fork.

Course Description:

This course introduces basic concepts in mechanics and its application in real life problem. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

List of experiments

Write and execute C-code for the following programs:

Name of the experiment

1. Determination of Rigidity modulus by Dynamic method.
2. Determination of Young's Modulus by Flexure method.
3. Determination of coefficient of viscosity by Poiseuille's capillary flow method.
4. Determination of Surface Tension of a given liquid by Jurin's Law.
5. To determine the value of 'g' using Compound Pendulum.
6. Determination of frequency of a tuning fork by using a Sonometer.
7. To determine the Moment of Inertia of a Flywheel.

SEM II

BSC PHYSICS (HONS)

Paper Name: **Mathematical Physics II**
Paper Code: **PHY11005**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To understand the Dirac Delta function and its properties.
2. To understand the properties of periodic functions, and to apply them to expand in Fourier series.
3. To analyze differential Equation and their application in different problems in physics, to solve them using Frobenius Method and to define some Special Functions.
4. To solve Partial Differential Equations.
5. To explore every day phenomena of the physical world in terms of probability.

Course Outcomes

On completion of this course, the students will be able to

CO1: Apply the understanding of Dirac Delta function and **analyze** Fourier Series for different problems.

CO2: **Understand** the concept of Wronskian to solve differential equations.
CO3: **Solve** Differential equations by using Frobenius method; relate and illustrate Special functions from that.
CO4: **Solve** partial differential equation and analyse Laplace equation and wave equation using various symmetries.
CO5: **Adapt** the concepts of probability and statistics and apply conditional probability and distribution functions in different problems of physics.

Catalog Description

Mathematical Physics II is a fundamental Branch of Physics that deals with the understanding of mathematical analysis that emphasizes tools and techniques of particular use to physicists. It focuses on vector-spaces, matrix algebra, differential equations (especially, for boundary value problems),integral equations, integral transforms, infinite series, and complex variables. Its approach can be tailored to applications in electromagnetism, classical mechanics, and quantum mechanics etc.

Course Content

Unit I: Dirac Delta function and its properties: **3 Lecture Hours**

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Unit II: Fourier Series: **8 Lecture Hours**

Periodic functions. Orthogonally of sine and cosine functions, Dirichlet's Conditions (Statement only).Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

Unit III: Differential Equation: **8 Lecture Hours**

Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Cauchy-Euler Equations, Legendre's equations, Method of variation of parameters, Method of undetermined coefficient.

Unit IV: Frobenius Method and Special Functions: **12 Lecture Hours**

Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.

Unit V: Partial Differential Equations: **10 Lecture Hours**

Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes.

Unit VI: Probability:

8 Lecture Hours

Basic concepts of probability distribution. Permutations and Combinations, Conditional Probability, Conditional Probability, Binomial distribution, Poisson's distributions, Multinomial distributions. Problems on probability calculation.

Reference Books

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
6. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
7. Mathematical Methods in Physical Sciences, Mary L. Boas, Wiley
8. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson, S. J. Bence, Cambridge UniversityPress
9. Differential and Integral Calculus, N. Piskunov, Mir Publisher
10. Vector Analysis, Murry R. Spiegel, Schuam Series.
11. Mathematical Physics, H K Dass, S Chand Publisher
12. Differential Equations, S. L. Ross, Wiley

Paper Name: **WAVE AND OPTICS**
Paper Code: **PHY11006**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To build the fundamental concept on oscillations (Simple Harmonic) and acquire the knowledge of superposition of Collinear and perpendicular Harmonic oscillations
2. To acquire knowledge on wave motion and velocity of wave, wave in a string and real application
3. To develop the capability of problem analysis through analytical approach and real application
4. To develop clear perception on wave-front, Huygens Principle. Temporal and Spatial Coherence.
5. To understand the concept of interference and understand it’s application.
6. To understand the concept of diffraction and understand it’s application.
7. To understand the concept of polarization and it’s application.

Course Outcomes

On completion of this course, the students will be able to

CO1: **Explain** the concept of oscillations and acquire the knowledge of superposition of collinear and perpendicular harmonic oscillations.

CO2: **Develop** the concept of wave motion and analyze waves generated in a String.

CO4: **Develop** clear perception on Concepts and applicability of Interference, and apply the concepts on real life phenomena.
CO5: **Outline** the concepts and applicability of diffraction phenomena, can apply the concepts on real life phenomena.
CO6: **Understand the** polarization phenomena and apply the concept on real life.

Catalog Description

Wave and Optics is a fundamental Branch of Physics that deals with the behavior of wave's and light. In Wave and Optics course noteworthy aspects of Physics is enlisted to explain phenomena in the natural world. This information is then can be used for practical endeavors through a controlled Laboratory environment. In this course the focus will be on improving the logical learning moved into a physical environment. Wave is the most fundamental topic of Physics where various kind of oscillation, superposition of wave, wave motion, standing wave, travelling wave, wave in a string are described. Optics is the branch of physics that studies the behavior and properties of light, including its interactions with matter and the construction of instruments that use or detect it. It focuses on Interference, Diffraction, and Polarization etc. Wave and Optics course also comprises of solving different real-life phenomena. Its approach can be tailored to applications in various domains of physics.

Course Content

Wave

Unit I: **(10L)**

Oscillations:

Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor

Superposition of Collinear Harmonic oscillations:

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations:

Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Unit II: (15L)

Wave Motion:

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

Velocity of Waves:

Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Superposition of Two Harmonic Waves

Standing (Stationary) Waves in a String: Fixed and free ends. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Optics:

Unit III: (10L)

Wave Optics:

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Interference:

Division of amplitude and wave front. Young's double slit experiment. Lloyd's Mirror and Fresnel's Bi-prism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Unit IV: **(10L)**

Diffraction:

Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit. Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Unit V: **(10L)**

Polarisation:

Different states of polarisation; double refraction (Explanation from Electromagnetic theory), Huygen's construction for uniaxial crystals; polaroid and their uses. Production and analysis of plane, circularly and elliptically polarised light by retardation plates and rotatory polarisation and optical activity; Fresnel's explanation of optical activity; Bi-quartz and half shade polarimeter.

Reference Books

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, AjoyGhatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Optics, B. Ghosh.

Paper Name: **MATHEMATICAL PHYSICS LAB II**
Paper Code: **PHY12007**
Credit: **2**

LTP: **0-0-4**

Course Objectives:

1. To analyze computationally the root finding of an equation using bisection, Newton Raphson, regular false method.
2. To obtain solutions of ordinary differential equation using Euler method and Range-Kutta method.
3. To analyse numerical integration using Simpson 1/3-rd rule and trapezoidal algorithm.
4. To apply Newton's forward and backward interpolation methods.

Course Outcomes:

On completion of this course, the students will be able to

CO1: **Determine** roots of an equation using Bisection, Newton Raphson, Regular False method.
CO2: **Solve** ordinary differential equation using Euler and Runge Kutta method.
CO3: **Utilize** Simpson 1/3 and trapezoidal algorithm to numerically estimate the value of an Integration.
CO4: **Illustrate** Newton's forward and backward interpolation.
CO5: **Demonstrate** plotting of basic functions and plotting of data from a data file.

Catalog Description:

This course introduces basic concepts of Python/Mathematica/Matlab/Scilab programming language to solve numerical problems. All the lectures will be devoted on discussions of basic theories, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as audio visual virtual lab session. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

---

1. Scientific Applications

-Interpolation:
- Lagrange Interpolation
- Newton Forward Interpolation

-Numerical Integration:
- Trapezoidal rule
- Simpson’s one-third rule
- Numerical Integration by n-point Gaussian Quadrature method.

-Solution of ODE

- Solutions of 1st order and 2nd order ordinary differential equation using Euler algorithm
- Solution of 1st order and 2nd order ordinary differential equation using 4th order Runge Kutta (RK4) algorithm
- Examples: Capacitor charging/discharging
- Examples: Simulating a half-wave rectifier with a capacitor filter
- Examples: Particle dynamics in 1D Problem
- Examples: Harmonic Oscillator

-Curve fitting

- Curve fitting of a non-linear equations
- Goodness of Fit

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
2. A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
3. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , 2007 , Wiley India Edition.
4. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
5. Numerical Methods, Arun Kr Jalan, Utpal Sarkar, Univeristy Press
6. Scientific Computing in Python. Abhijit Kar Gupta, Techno World
7. Physics in Laboratory including python Programming (Semester III), Mandal, Chowdhuri, Das, Das, Santra Publication
8. mathplotlib Plotting Cookbook, Alexandre Devert, PACKT Publishing
9. Programming for Computation-Python, Svein Linge, Hans PetterLantangen, Springer
10. Numerical Python, Robert Johansson, Apress Publication

Paper Name: **WAVE AND OPTICS LAB II**
Paper Code: **PHY12008**
Credit: **2**
LTP: **0-0-4**

Course Objectives: To provide the knowledge about the dark room and basic waves and optics related instruments. Hands on experience and experimental evidence of the phenomenon related to the theory paper.

Course Outcome: On completion of this course, the students will be able to

CO1: Develop the concepts of wave superposition and study experimentally Lissajous figures.

CO2: Acquire knowledge of optical instruments like spectrometer and use it for determining various physical parameters like angle of the prism, dispersive power of the prism etc.

CO3: Acquire knowledge of interference of light and study different experiments related to it.

CO4: Examine diffraction of light and study different experiments related to it.

CO5: Analyze elliptically polarized Light by using a Babinet's compensator.

Course Description:

This course introduces basic concepts about the experiments related to the physical optics and waves. It emphasize on the theoretical topic related to the "Wave and Optics" paper.

Course Content:

List of Experiments:

1. Determination of wavelength of a light by LASER diffraction method
2. Familiarization with: Schuster's focusing; determination of angle of prism.
3. Adjustment of the Spectrometer for parallel rays by Schuster's method and to determine the refractive index and dispersive power of the material of a prism by spectrometer from (i-δ) curve.
4. To determine the wavelength of a monochromatic light by Newton's ring method.
5. Measurement of the slit width and the separation between the slits of a single and /or double slit by observing the diffraction and interference fringes.
6. To find the number of lines per centimetre of the transmission grating and hence to measure the wavelength of an unknown spectral line and to measure the wavelength difference between D1 and D2 lines of sodium using a slit of adjustable width.
7. To determine dispersive power and resolving power of a plane diffraction grating.

8. To study Lissajous Figures along with Phase and Frequency determination.

9. To find the fringe width of the interference pattern produced by Fresnel Biprism and to determine the wavelength of monochromatic source of light.

10. To analyze elliptically polarized Light by using a Babinet's compensator.

SEM III

BSC PHYSICS (HONS)

Paper Name: **ELECTRICITY AND MAGNETISM I**
Paper Code: **PHY11009**
Credit: 4
LTP: **4-0-0**

Course Objectives

1. To understand the concepts of electric field, electric potential and electric potential energy and to calculate field and potential by using different techniques, like from Gauss's Law, by solving Laplace's equation, by method of electrical images etc.
2. To understand the idea of capacitance and calculation for different structures.
3. To analyze and apply network theorems for different circuits, transient response of current and alternating currents.
4. To analyse different problems and explore every day phenomena with scientific aptitudes and design the solution accordingly.

Course Outcomes: On completion of this course, the students will be able to

CO1: **Estimate** the electric field and potential for different charge distributions by applying Gauss's law, solving Laplace's equation or analyzing through method of electrical.
CO2: **Define** and **estimate** the capacitance and electrostatic potential energy for different systems and explain the dielectric properties of matter and apply the concepts for real matter.
CO3: **Explain** the concept of steady current and analyze different electrical circuits by applying the Network Theorems.
CO4: **Evaluate** magnetic field and magnetic vector potential for a given current distribution.
CO5: **Explain** magnetization and different associative properties of a magnetic material.

Catalog Description

Electrostatics is a fundamental area of Physics that deals with the understanding of electric potential, electric field and electric potential energy estimate those parameters for a given charge distribution by using different approaches like applying Gauss's Law, solving Boundary Value problems, or using Method of Electrical Images. Then in magneto-statics the magnetic field is evaluated for different current distribution. In the last section the origin of magnetism in magnetic materials is taught.

Course Content

Module 1 : *Electric field and Potential:*

(8L)

Electrostatic Field, Potential and Energy, Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Superposition theorem (statement only). field due to a dipole; work done in deflecting a dipole; dipole-dipole interaction (for both electric and magnetic dipoles); force on dipole in an inhomogeneous field.

***Module 2: Boundary Value Problems and Method of Electrical Images* :**

(6L)

Application of Laplace's equation in 1D, 2D and 3D for Cartesian, Spherical Polar and Cylindrical Polar coordinates. Method of Electrical Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Module 3: Dielectric Properties of Matter:

(6L)

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.

***Module 4: Electrostatic energy of system of charges*:**

(4L)

Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Dielectrics, introduction, capacitance in presence of a dielectric. Gauss' Law in presence of dielectrics, free charge and bound charge, Polarization Vector. Electrostatic energy density in presence of a dielectric.

Module 5: Steady current:

(8 L)

Ohm's law – Differential form, Kirchhoff's Law; Wheatstone bridge – its sensitivity (qualitative discussion only), Network Theorems: Ideal Constant-voltage and Constant-current Sources. Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.T and π networks.

Module 6: Magnetostatics

(12L)

Lorentz force and concept of magnetic field; magnetic force on linear current element; Biot-Savart's law, $\vec{\nabla}.\vec{B}=0$; magnetic vector potential; calculation of vector potential and magnetic induction in simple cases e.g., straight wire, magnetic field due to small current loop; magnetic dipole; field due to a dipole; magnetic shell; Ampere's theorem; Ampere's circuital law illustration (straight wire); force between long parallel current carrying conductors, $\vec{\nabla}\times\vec{B}=\mu_0\vec{J}$, comparison between static electric and magnetic fields. Magnetic Scalar and Vector Potentials.

Module 7: Theory of Magnetism and Magnetic materials

(10L)

Free current and bound current; surface and volume density of current distribution; magnetisation; non-uniform magnetisation of matter; $\vec{\nabla} \times \vec{M} = J_b$; Ampere's law in terms of free current density and introduction of H; line integral of H in terms of free current; boundary conditions for B and H; permanently magnetized body; magnetic scalar potential; application of Laplace's equation to the problem of a magnetic sphere in uniform magnetic field; hysteresis and energy loss in ferromagnetic material; magnetic circuit; energy stored in magnetic field.

Reference Books

1. Electricity and Magnetism, Rakshit and Chattopadhyay, New Age Publisher
2. Foundations of Electricity and Magnetism, B. Ghosh
3. Electricity and Magnetism, D. C. Tayal, S. Chand Publisher
4. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
5. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
6. Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

Paper Name: **THERMAL PHYSICS**
Paper Code: **PHY11010**
Credit: **4**
LTP: **4-0-0**

Course Objectives:

- To develop knowledge in Kinetic theory of gases
- To understand transport properties and Brownian motion

- To apply knowledge in thermodynamics and its practical application.
- To understand various thermodynamics potentials and Maxwell's relations.

Course Description:

This course aims to provide the essential concepts of kinetic theory, heat transport and thermodynamics along with its applications. This course helps to develop a strong foundation of mathematical formulations of kinetic theory of gases. Thermodynamics portions of these thermal physics course are systematically developed. Students will learn about the laws of thermodynamics and concept of entropy. Students will also learn about thermodynamics potentials and Maxwell's Thermodynamic relations. At the end of the course students will learn about Joule Thompson effect and low temperature physics.

Course Outcomes: On completion of this course, the students will be able to

CO1: **Illustrate** the concept of Kinetic Theory of gases and develop the concept of mean free path, applications in transport phenomenon.
CO2: **Apply** equation of state of real gases to describe various experimental observations.
CO3: **Apply** 1st and 2nd law of thermodynamics and study *efficiency of heat engine.*
CO4: **Illustrate** the concept of entropy to study various thermodynamic processes.
CO5: **Develop** knowledge of thermodynamic potential and phase transition and study Maxwell thermodynamic relations.

Course Content:

Module 1 :Kinetic Theory of Gases: **[8 lecture hours]**

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heat of Gases.

Module 2: Molecular Collisions: **[6 lecture hours]**

Mean Free Path. Collision Probability.Estimation of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Module 3: Real Gases **[6 lecture hours]**

Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation.Andrew's Experiments on CO_2 Gas.Critical Constants.Continuity of Liquid and Gaseous State. Vapour and

Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants.Law of Corresponding States.Comparison with Experimental Curves.P-V Diagrams.Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and van der Waal Gases. Temperature of Inversion.Joule-Thomson Cooling.

Module 4: Introduction to Thermodynamics [4 lecture hours]

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Module 5 : Second Law of Thermodynamics [4 lecture hours]

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2^{nd} Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Module 6 : Entropy [6 lecture hours]

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Module 7 :Thermodynamic Potentials [12 lecture hours]

Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications.Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius-Clapeyron Equation and Ehrenfest equations

Module 8 : Maxwell's Thermodynamic Relations [6 lecture hours]

Derivations and applications of Maxwell's Relations, Maxwell's Relations (1) ClausiusClapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Reference Books

1. Thermal Physics, Roy and Gupta.
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
3. A Treatise on Heat, MeghnadSaha, and B.N.Srivastava, 1958, Indian Press
4. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
6. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
7. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.

Paper Name: **ELECTRONICS I**
Paper Code: **PHY11011**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To understand the principles of current flow in two/three terminal devices.
2. To understand the effect of optical effects on the electron devices
3. To analyze different problems with scientific aptitudes and design the solution accordingly.
4. To explore every day phenomena of the macroscopic world from a scientific point of view.
5. To explore and understand the application of various electron devices.

Course Outcomes: On completion of this course, the students will be able to

CO1: **Relate** and illustrate the fundamental principles of electron devices and its application in two terminal devices.

CO2: **Define** and explain the basic concepts of transistor, field effect transistor, bipolar junction transistor and Metal-Oxide-Semiconductor Field Effect Transistors.

CO3: **Explain** and estimate efficiency of various amplifiers.
CO4: **Analyze** and Apply the concepts of Digital Electronics and Boolean Algebra.
CO5: **Explain** the applicability of data processing circuits.

Catalog Description

Electronics is a fundamental area of Physics that deals with the understanding of current flow mechanism in devices, optical effects, and various application in real world. After studying this course, one should be able to recognize a variety of exciting high-tech products and systems enabled by electronics, manipulate voltages, currents and resistances in electronic circuits, demonstrate familiarity with basic electronic components and use them to design simple electronic circuits, see how signals can be represented in the time and frequency domains for Fourier analysis, record, analyse and filter audio signals to improve their fidelity.

Course Content

Module 1:

Fundamentals of Semiconductor Devices: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea).Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

(12 Lecture)

Module 2:

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cut-off and Saturation Regions.

FET and MOSFET : Field effect transistor: Structure and physical operation. Types of MOSFETs (qualitative discussion only).

(16 Lecture)

Module 3:

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. H-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B, AB & C Amplifiers, Push-pull amplifier, Darlington pair, RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

(12 Lecture)

Module 4:

Introduction to Digital Electronics: Difference between Analogue and Digital electronics. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion.BCD, Octal and Hexa-decimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

Boolean Algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

(10 Lecture)

Module 5:

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

(6 Lecture)

Reference Books

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
7. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
8. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
9. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
10. Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6th Edn.,2009, PHI Learning

Paper Name: **ELECTRICITY AND MAGNETISM LAB I**
Paper Code: **PHY12012**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

1. To develop the capability of the students for practical understanding of fundamental aspects of current electricity.

2. To give students electric circuit-based experiment background which is the key prerequisite for performing research near future.
3. To build up real-time idea on Digital Multimeter, Carey Fosters bridge, Anderson's bridge, LCR circuit etc, transient response of LR circuit.
4. To enrich students with visualization of Thevenin and Norton theorems, Superposition, and Maximum power transfer theorems.
5. These ideas can upgrade student's understanding in proper channel, so that they can flourish their career path.

Course Description:

In current electricity Lab course electric circuit-based Physics lab is enlisted to explain phenomena exist in the global technology. This information is then can be used for practical endeavours through a controlled Laboratory environment. In this course the focus will be on improving the logical learning moved into a physical environment. Digital Multimeter, Carey Fosters bridge, Anderson's bridge, LCR circuit, visualization of Thevenin and Norton theorems, Superposition, and Maximum power transfer theorems laboratories will be covered. We will combine traditional lab classes with other active teaching methodologies like digital platform, group discussions, cooperative group solving problems, weekly viva.

Course Content:

Experiment 1:

Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances and (e) Checking electrical fuses.

Experiment 2:

To measure the resistance per unit length of the wire of a bridge and to determine an unknown resistance by Carey Fosters bridge.

Experiment 3: To verify the Thevenin and Norton theorems.

Experiment 4: To verify the Superposition, and Maximum power transfer theorems.

Experiment 5: To draw the B-H curve of *Fe* using Solenoid & determine energy loss from Hysteresis curve.

Experiment 6: To study the nature of dependence of dipolar field of a short bar magnet on distance with the help of a deflection and Oscillation magnetometer and determine the horizontal component of the Earth's magnetic field.

Paper Name: **THERMAL PHYSICS LAB**
Paper Code: **PHY12013**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

To provide the knowledge about the thermal properties of different material like bad conductor, resistance or thermocouple. Hands on experience and experimental evidence of the phenomenon related to the theory paper.

Course Outcome: On completion of this course, the students will be able to

CO1: Estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan's law.

CO2: Determine the thermal conductivity of a bad conductor of heat by Lee's and Charlton's method.

CO3: Determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

CO4: Determine the thermoelectric power at a certain temperature of the given thermocouple.

CO5: Determine calibrate a thermocouple to measure temperature in a specified Range using (a) Null Method.

Course Description:

This course introduces basic concepts about the experiments related to thermal physics. It emphasize on the theoretical topic related to the "Thermal Physics" paper.

Course Content:

List of Experiments:

1. To estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan's law.

2. Determination of thermal conductivity of a bad conductor of heat by Lee's and Charlton's method.

3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

4. Determination of thermoelectric power at a certain temperature of the given thermocouple.

5. To calibrate a thermocouple to measure temperature in a specified Range using(1) Null Method.

6. Determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

7. Determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.

8. Calibrate a thermocouple to measure temperature in a specified range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Paper Name: **ELECTRONICS LAB**
Paper Code: **PHY12014**
Credit: **2**
LTP: **0-0-4**

Course Objectives

1. To understand the V-I characteristics of PN junction diode, Light emitting diode, Zener diode and its use as voltage regulator.
2. To analyze and design of a Half Wave and Full Wave rectifier with and without filter.

3. To explore the characteristics of a Bipolar Junction Transistor in CE configuration, various biasing configurations of BJT for normal class A operation, frequency response of voltage gain of a RC-coupled transistor amplifier.
4. To analyse a switch (NOT gate) using a transistor, to verify and design AND, OR, NOT and XOR gates using NAND gates. NAND and NOR gates as Universal Gates.

Course Outcomes On completion of this course, the students will be able to

CO1: Explain and experiment with PN junction diode, Zener diode and to apply Zener diode as voltage regulator.

CO2: Demonstrate and examine diode as Half Wave and Full Wave rectifier and can experiment with that.

CO3: Relate and experiment with Bipolar Junction Transistor in CE configuration, for normal class A operation.

CO4: Demonstrate and examine frequency response of voltage gain of a RC-coupled transistor amplifier and can experiment with that.

CO5: Outline the design of AND, OR, NOT , NAND and NOR gates using a diodes and transistor and can experiment with that.

CO6: Outline the design of combinational logic system for a specified Truth Table, using logic gate ICs and can experiment with that.

Catalog Description

Electronics I is a fundamental area of Physics that deals with the understanding of Experimental portion deals with analog and digital electronics. It comprises of application of electronic principle broadly on diode, transistors as well as on different IC's in case of digital electronics. It consist of knowledge from both digital and analog domain along with inter-relation between them.

Course Content

Experiment 1: To study V-I characteristics of PN junction diode, and Light emitting diode.

Experiment 2: To study the V-I characteristics of a Zener diode and its use as voltage regulator.

Experiment 3: Designing of a Half Wave and Full Wave rectifier with and without filter.

Experiment 4: To study the characteristics of a Bipolar Junction Transistor in CE configuration.

Experiment 5: To study the various biasing configurations of BJT for normal class Aoperation.

Experiment 6: To study the frequency response of voltage gain of a RC-coupled transistor amplifier.

Experiment 7: To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.

Experiment 8: To design a switch (NOT gate) using a transistor.

Experiment 9: To verify and design AND, OR, NOT and XOR gates using NAND gates. NAND and NOR gates as Universal Gates.

Experiment 10: To design a combinational logic system for a specified Truth Table.

Experiment 11: To convert a Boolean expression into logic circuit and design it using logic gate ICs, to minimize a given logic circuit.

Experiment 12: Hybrid parameter of transistor.

Reference Books

1. Practical PhysicsVol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

2. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central Book Agency (P) Ltd

3. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill

SEM IV

BSC PHYSICS (HONS)

Paper Name: **ELECTRICITY AND MAGNETISM II**
Paper Code: **PHY11018**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To learn the motion of charge particles under electromagnetic field.

2. To evaluate magnetic effect of steady current and realize the importance of application of Biot-Savarts Law and Amperes law.
3. To find the origin of magnetic field, techniques to calculate the magnetic field under some symmetrical conditions.
4. To realize the relevance of different magnetization and the boundary condition of magnetic field.
5. To adapt the fundamental ideas of special theory of relativity.

Course Outcomes: On completion of this course, the students will be able to

CO1: Explain and estimate the motion of charged particles in electromagnetic field.
CO2: Define and develop the concepts of electromagnetic induction and apply those in real life scenario.
CO3: Explain the concepts and propagation of E M waves in unbounded and bounded media.
CO4: Analyze polarization phenomena from the viewpoint of E M theory.
CO5: Explain and apply wave guide theory.

Catalog Description

Electronics is a fundamental area of Physics that deals with the understanding of current flow mechanism in devices, optical effects, and various application in real world. After studying this course, one should be able to recognize a variety of exciting high-tech products and systems enabled by electronics, manipulate voltages, currents and resistances in electronic circuits, demonstrate familiarity with basic electronic components and use them to design simple electronic circuits, see how signals can be represented in the time and frequency domains for Fourier analysis, record, analyse and filter audio signals to improve their fidelity.

Course Content

Module 1:

Motion of Charged Particles in Electro-magnetic field:

Motion of a charged particle in external Electric and Magnetic field (when velocity is perpendicular to the Magnetic field/not perpendicular to the magnetic field), Crossed Electric and Magnetic field. Basic principles of J. J. Thompson's Experiment.

(6 L)

Module 2:

Electromagnetic induction:

Faraday’s and Lenz’s law; motional e.m.f-simple problems; calculation of self and mutual inductance in simple cases; inductances in series and parallel; reciprocity theorem.

(8 L)

Module 3:

Maxwell Equations and EM Wave Propagation in Unbounded and Bounded Media:

Review of Maxwell’s equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density, Plane EM waves through vacuum and isotropic dielectric medium, Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel’s Formulae for perpendicular & parallel polarization cases, Brewster’s law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

(18 L)

Module 4:

Polarization of Electromagnetic Waves:

Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel’s Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light, Optical Rotation. Biot’s Laws for Rotatory Polarization. Fresnel’s Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel’s theory. Specific rotation. Laurent’s half-shade polarimeter.

(8 L)

Module 5:

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.

(6 L)

Reference Books

1. Electricity and Magnetism, Rakshit and Chattopadhyay, New Age Publisher
2. Foundations of Electricity and Magnetism, B. Ghosh
3. Electricity and Magnetism, D. C. Tayal, S. Chand Publisher
4. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
5. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings
6. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
7. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
8. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
9. Electromagnetic Fields & Waves, P.Lorrain&D.Corson, 1970, W.H.Freeman& Co.
10. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.

Paper Name: **ELEMENTS OF MODERN PHYSICS**
Paper Code: **PHY11019**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To find the scope of applicability of previous learned materials.
2. To demonstrate the concept of different physical aspects by organizing, comparing and interpreting.

3. To build the capability of applying concepts of energy quantization.
4. To distinguish the concepts of Classical physics and Modern Physics.

Course Outcomes: On completion of this course, the students will be able to

CO1: explain particle aspect of radiation and wave aspects of matter in real life problems, and apply the concepts of matter waves.

CO2: Analyze the uncertainty principle for microscopic length phenomena.

CO3: Model and examine the modern theory of atomic structure in real physical problems.

CO4: Analyze the nuclear force in real physical problems and illustrate and analyze the radioactivity phenomena in real physical problems.

CO5: Understand the basic principles of LASING action and understand the applications of optical fibers in different devices.

Catalog Description

The course, Elements of Modern Physics, deals with the physical aspects as analysed based on modern concept other than classical concept of physics. Here the concept of energy quantisation, particle nature of light, wave associated with material particles are included. It talks about the concept of uncertainty in the determination of conjugate physical measures. Modern theory of atomic structure, nuclear phenomena, LASER and Fibre Optics applications which encourage to know about the applications in real life physical problems.

Course Content

Module 1:

Particle aspect of radiation, Blackbody Radiation, Failure of classical theories (Wien's law, Rayleigh- Jean's Law), Planck's quantum theory, Stefan-Boltzmann Law, Wien's displacement law; Photo- electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave aspect of particles, Wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons.

De Broglie's Hypothesis, Matter waves, Wave-particle duality, Indeterministic nature of microphysical world, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables), Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. Probabilistic interpretation.

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter wave. Rutherford's planetary model of an atom

(22 L)

Module 2:

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

(20 L)

Module 3:

Laser & Fibre Optics:

Principle of Laser action, Population Inversion, Einstein's A and B coefficients, feedback of energy in a resonator,3 level and 4 level systems, Helium-Neon and Semiconductor Lasers. Application of Laser. Principle of holography (basic principle), isotope separation. Precision measurements (frequency and distance), Optical fibre, core and cladding, total internal reflection, optical fibre as waveguide, step index and graded index fibre, communication through optical fibres, energy loss, band width and channel capacity for a typical system, attenuation and dispersion, splicingand couplers, Fibre optic sensors.

(14 L)

Reference Books

1. Concepts of Modern Physics, Arthur Beiser, 2002,McGraw-Hill.

2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGrawHill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, PearsonEducation.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Quantum Mechanics: Theory & Applications, A.K.Ghatak&S.Lokanathan, 2004,Macmillan
6. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2ed. 2006, Robert Eisberg, Robert Resnick

Paper Name: **ELECTRONICS II**
Paper Code: **PHY11020**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To develop the Concept of Operational Amplifiers.
2. To acquire the knowledge construction and application of CRO.
3. To acquire the knowledge of different oscillators like Wein-bridge oscillator, Hartley &Colpitts oscillators
4. To be acquainted with Flip Flops, Timers, Shift registers, Counters.
5. To build up the Concept of Integrated Circuits, Computer Organization.
6. To build up the Concept of Intel 8085 Microprocessor Architecture, Assembly Language.

Course Outcomes: On completion of this course, the students will be able to

CO1: Explain the functioning of Operational Amplifiers in different devices.
CO2: Develop understanding of CRO and different oscillators like Wein-bridge oscillator, Hartley & Colpitts oscillators and can analyse and solve the problems related to them.

CO3: Explain the functioning of Flip Flops, Timers, Shift registers, Counters and apply them in different devices.
CO4: Adapt and analyse concepts of Integrated Circuits, Computer Organization and can apply them in real life situation.

CO5: Outline the knowledge of Intel 8085 Microprocessor Architecture, Assembly Language and can apply them to solve real life problems.

Catalog Description

Electronics II is a fundamental Branch of Physics that deals with the emission, behaviour, and effects of electrons and with electronic devices. It focuses on concept of Operational Amplifiers, CRO, oscillators like Wein-bridge oscillator, Hartley & Colpitts oscillators etc.It also comprises of digital electronics part like Flip Flops, Timers, Shift registers, Counters, Integrated Circuits, Computer Organization, Microprocessor Architecture and Assembly Language. Its approach can be tailored to applications in various domain of physics.

Course Content

Module 1:

Operational Amplifiers (Black Box approach): (12 L)

Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Application of Op-Amp;
(1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector.

Module 2:

Introduction to CRO: (8 L)

Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Sinusoidal Oscillators

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Wein-bridge oscillator, Hartley &Colpitts oscillators.

Module 3:

Digital Electronics II: **(20 L)**

Flip Flop: Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered), Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.**Timers:** IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). **Counters (4 bits):** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Module 4:

Integrated Circuits (Qualitative treatment only): **(8 L)**

Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs

Module 5:

(8 L)

Computer Organization, 8085 Microprocessor and Assembly Language
Input/output Devices. Data storage (idea of RAM and ROM).Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. 1 byte, 2 byte & 3 byte instructions.

Reference Books

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw

2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.

3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning

5. Logic circuit design, Shimon P. Vingron, 2012, Springer.

6. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.

7. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

8. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.

9. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.

10. Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6th Edn.,2009, PHI Learning

11. Electronic Devices & circuits, S.Salivahanan&N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

12. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall

13. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer

Paper Name: **ELECTRICITY AND MAGNETISM LAB II**
Paper Code: **PHY12021**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

- To understand the effect of electromagnetic induction and measure mutual inductance and self-inductance of a coil.
- To measure charge and current sensitivity and critical damping resistance (CDR) of Ballistic Galvanometer.
- To study the nature of dependence of dipolar field and determine the horizontal component of the Earth's magnetic field.

Course Description:

This course aims to impart knowledge of electromagnetic induction in a given circuit and student will perform measurements of mutual inductance and self-inductance of a coil. In addition they will measure charge and current sensitivity and critical damping resistance (CDR) of Ballistic

Galvanometer and will learn how to draw Hysteresis curve (B-H loop) of *Ferromagnetic* samples. Students will perform study of dipolar field of a short bar magnet on distance with the help of a deflection and Oscillation magnetometer and determine the horizontal component of the Earth's magnetic field. We mainly focus on the development of fundamental concepts of physical properties of materials which could be helpful in future to solve various real life problems. Apart from regular class on experiments some special classes will be arranged for student presentations.

Course Content:

Experiment 1: To study the variation of mutual inductance of a given pair of coaxial coils by using a ballistic galvanometer.

Experiment 2: To Measure charge and current sensitivity and critical damping resistance (CDR) of Ballistic Galvanometer.

Experiment 3: To determine *self-inductance* of a coil by Rayleigh's method.

Experiment 4: To determine the resistance of the material of the coil of a moving coil galvanometer by half deflection method.

Experiment 5: To study the characteristics of a series RC Circuit.

Experiment 6: To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

Experiment 7:

To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.

Experiment 8:

To determine self-inductance of a coil by Anderson's bridge.

Experiment 9:

Transient response of a LR circuit.

Paper Name: **MODERN PHYSICS LAB**
Paper Code: **PHY12022**

Credit: **2**
LTP: **0-0-4**

Course Objectives:

1. To develop the capability of the students for practical understanding of fundamental aspects of physics.
2. To give students experimental/laboratory-based background, the key prerequisite for performing research near future.
3. To build up real-time idea onPhoto-electric effect, vacuum diode, H-alpha emission line of Hydrogen atom, Ionization Potential of mercury, e/m measurement by J. J. Thompson method, Millikan oil drop apparatus, tunnel diode etc. These ideas can upgrade student's understanding in proper channel, so that they can flourish their career path.

Course Description:

In Modern Physics Lab course different aspects of Physics lab is enlisted to explain phenomena in the natural world as well as modern physics. This information is then can be used for practical endeavors through a controlled Laboratory environment. In this course the focus will be on improving the logical learning moved into a physical environment. Photo-electric effect,vacuum diode, H-alpha emission line of Hydrogen atom, Ionization Potential of mercury, e/m measurement by J. J. Thompson method, value of e/m by Millikan oil drop apparatus, tunnelling effect in tunnel diode etc. laboratories will be covered. We will combine traditional lab classes with other active teaching methodologies like digital platform, group discussions, cooperative group solving problems, weekly viva.

Course Content:

Experiment 1

Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light

Experiment 2

To determine the wavelength of H-alpha emission line of Hydrogen atom.

Experiment 3

To determine the value of e/m by J. J. Thompson method.

Experiment 4

To setup the Millikan oil drop apparatus and determine the charge of an electron.

Experiment 5

To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.

Experiment 6

To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.

Experiment 7: Verification of Bohr's atomic theory by Franck Hertz Experiment.

Paper Name: **ELECTRONICS LAB II**
Paper Code: **PHY12023**
Credit: **2**
LTP: **0-0-4**

Course Objectives

1. To design a Regulated Power Supply and study the load and line regulation characteristics.
2. To analyze and design of a Half and Full Adder, Half and Full Subtractor.
3. To design a Wien bridge oscillator for given frequency using an op-amp.
4. To write the different programs using 8085 Microprocessor.
5. To design and test the different circuits using an OPAMP.
6. To design a digital to analog converter (DAC) and analog to digital convertor (ADC) of given specifications.
7. To build Flip-Flop (RS, Clocked RS, D-type, JK and JKMaster-slave) circuits using NAND gates.

Course Outcomes

On completion of this course, the students will be able to

CO1: Explain and experiment with Regulated Power Supply and to analyze load and line regulation characteristics.
CO2: Demonstrate, and examine Half and Full Adder, Half and Full Subtractor etc. circuits using an OPAMP and can experiment with that and Relate, demonstrate and experiment with Wien bridge oscillator.
CO3: Apply different programs using 8085 Microprocessor on solving different problems of physics and can experiment with that.
CO4: Outline the design of digital to analog converter (DAC) and analog to digital convertor (ADC) of given specifications and can experiment with that.
CO5: Outline the design of Flip-Flop (RS, Clocked RS, D-type, JK and JK Master-slave) circuits using NAND gates and can experiment with that.

Catalog Description

Electronics Lab II is a fundamental experimental area of Physics that deals with the understanding of analog and digital electronics. It comprises of application of electronic principle broadly on adder, subtractor, OPAMP as well as on different Flip-flops in case of digital electronics. It consist of knowledge from both digital and analog domain along with inter-relation between them. It also deals with the knowledge og writing programs in Microprocessor for solving different problems in physics.

Course Content

Experiment 1: Designing a Regulated Power Supply and study of load and line regulation characteristics.
Experiment 2: Half Adder, Full Adder and 4-bit binary Adder.
Experiment 3: Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
Experiment 4: To design a Wien bridge oscillator for given frequency using an op-amp.
Experiment 5: Write the following programs using 8085 Microprocessor

a. Addition and subtraction of numbers using direct addressing mode
b. Addition and subtraction of numbers using indirect addressing mode
c. Multiplication by repeated addition.
d. Division by repeated subtraction.
e. Handling of 16-bit Numbers.
f. Use of CALL and RETURN Instruction.
g. Block data handling.
h. Other programs (e.g. Parity Check, using interrupts, etc.).

Experiment 6: To design and test the following circuits using an OPAMP

i. Inverting and non-inverting amplifier

ii. Differential amplifier.
iii. Schmitt trigger
iv. Adder
v. Integrator
vi. Differentiator.

Experiment 7: To design a digital to analog converter (DAC) of given specifications.
Experiment 8: To study the analog to digital convertor (ADC) IC.
Experiment 9: To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
Experiment 10: To build JK Master-slave flip-flop using Flip-Flop ICs.

Reference Books

1. Practical PhysicsVol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher
2. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central Book Agency (P) Ltd
3. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill

Paper Name: **QUANTUM MECHANICS AND APPLICATIONS**
Paper Code: **PHY11027**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To develop clear perception on time dependent Schrodinger equation, operator algebra.
2. To understand time independent Schrödinger equation, stationary state, composite state, wave packets and uncertainty principle.
3. To understand and analyze bound state solution to various potentials like infinite and finite potential well, harmonic oscillator, potential barrier and tunneling.
4. To solve and analyze Schrödinger equations for hydrogen like atoms, development of the concept of orbital angular momentum, degeneracy.
5. To explore the concepts of atoms in electric and magnetic fields, spin magnetic moment, Stern-Gerlach experiment and Zeeman effect.
6. To explore various models of many electron atoms.

Course Outcomes: On completion of this course, the students will be able to

CO1: Develop clear perception on time dependent and independent Schrodinger equation, explain and analyze wave function corresponding to particle and can apply operator algebra.

CO2: Define, develop, analyse and solve the bound state solution to various potentials like infinite and finite potential well, harmonic oscillator, potential barrier and tunneling etc.

CO3: Solve Schrödinger equations for hydrogen like atoms and can develop of the concept of orbital angular momentum and hence can analyze degeneracy.

CO4: Adapt and analyse concepts of atoms in electric and magnetic fields, spin magnetic moment, and can analyze Stern-Gerlach experiment, Stark effect and Zeeman effect.

CO5: Develop clearconcepts of various models of many electron atoms and can apply them to solve real life problems based on physics.

Catalog Description

Quantum mechanics is a fundamental Branch of Physics dealing with the behavior of matter and light on the atomic and subatomic scale. It focuses on Schrodinger equation, stationary state, composite state, operator algebra, wave packets, uncertainty principle, bound state solution to various potentials like infinite and finite potential well, harmonic oscillator, potential barrier and tunneling etc. It also comprises of solving of Schrödinger equations for hydrogen like atoms, Stern-Gerlach experiment and Zeeman effect. Its approach can be tailored to applications in various domain of physics.

Course Content

Module 1: Time dependent and Time independent Schrodinger equation:

(10 L)

Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Position, momentum and Energy operators; commutation of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle, Hamiltonian, stationary states and energy Eigen values; expansion of an arbitrary wave function as a linear combination of energy Eigen functions; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.

Module 2: Bound states in an arbitrary 1 D potential: (14 L)

Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem, free particle, step potential, Potential barrier, Infinite square well potential, Quantum mechanics of simple harmonic oscillator-energy levels and energy Eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle.

Module 3: Quantum theory of hydrogen-like atoms: (12 L)

Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d, f,.. shells.

Module 4: Atoms in Electric & Magnetic Fields: (14 L)

Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyro magnetic Ratio and Bohr Magneton. Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Module 5: Many electron atoms: (6L)

Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms, L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

Reference Books

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2ed. 2006, Robert Eisberg,Robert Resnick
6. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
7. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
8. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

9. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
10. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Paper Name: **STATISTICAL MECHANICS**
Paper Code: **PHY11028**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To find the scope of applicability of previous learned materials.
2. To demonstrate the concept of Statistical behavior of particles.
3. To build the capability of applying concepts of Entropy.
4. To distinguish the concepts of Classical physics and Modern Physics.

Course Outcomes

On completion of this course, the students will be able to

CO1: Demonstrate the basics of Microstate, Macrostate, Ensemble.
CO2: Explain and apply Maxwell-Boltzmann Statistics.
CO3: Apply and appraise the Quantum Theory of Radiation.

CO4: Demonstrate and apply Bose-Einstein Statistics.
CO5: Demonstrate and apply Fermi-Dirac Statistics.

Catalog Description

The course, Statistical Mechanics, deals with the physical aspects as analysed based on statistical behaviour of particles classically as well as quantum mechanically. Here the concept of Microstate, Macrostate, Ensemble, Maxwell-Boltzmann Statistics, Bose-Einstein Statistics, Fermi-Dirac Statisticsare included. It explains the black body radiation based on energy quantisation.Concept of entropy emerges based on statistical behaviour of the system.

Course Content

Unit-1: Classical Statistics:

Macro-state & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.
Basic idea about phase space, Liouville's Theorem, Ensembles (elementary idea), Micro-canonical, Canonical, Grand-Canonical Ensembles.

(15Hrs)

Unit-2: Classical Theory of Radiation:

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

(10Hrs)

Unit-3: Quantum Theory of Radiation:

Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

(10Hrs)

Unit-4: Bose-Einstein Statistics:

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

(10Hrs)

Unit-5: Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

(10Hrs)

Reference Books

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press
7. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
8. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2ed. 2006, Robert Eisberg, Robert Resnick

Paper Name: **QUANTUM MECHANICS LAB**
Paper Code: **PHY12029**
Credit: **2**
LTP: **0-0-4**

Course Objectives

To apply different numerical techniques in solving Quantum mechanical problems and visualizing the solutions.

Course Outcomes: On completion of this course, the students will be able to

1. Develop an idea about basic operations in Mathematica/ Matlab/ Scilab and develop the basic rules of writing a code.

2. Plot 2D and 3D graphs and visualization of energy eigenvalues and eigenfunctions for some given potential in 1D Schrodinger equation.
3. Solve time independent Schrodinger equation (2nd order differential equation) for different given potential distributions numerically.
4. Compute and plot Energy Eigenvalues, Eigenstates and probability distributions for different time dependent Schrodinger equation quantum mechanical problems.

Catalog Description

This course aims to develop and visualize the solutions that can be achieved by numerically solving the Schrodinger Equation for different given potentials, particularly for the radial part of H-atom functions and to solve time dependent Schrodinger equation.

Course Content

---

1. **Visualization of Eigenenergy Spectrum**, Electron Probability Density, Transmission Probability for different One Dimensional problems, such as,

a. 1D Harmonic Oscillator
b. Finite Potential Well
c. Delta Function Potential Well
d. Finite Potential Barrier

2. **Finding eigenstates solving transcendental equation**

To find eigenvalues of the bound state particle of mass in a one dimensional potential well by solving the transcendental equation that appears as the eigenvalue condition (graphs are to be plotted for appropriate guess values, scipy root searching package may be used) and to plot the eigenfunctions.

3. **Solve the s-wave Schrodinger equation** for the ground state and the first excited state of the hydrogen atom,

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E], \text{ where } V(r) = -\frac{e}{r^2}$$

Here, m is the reduced mass of the electron. Obtain the energy Eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(\text{eVÅ})^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511×106 eV/c^2.

4. **Solve the s-wave radial Schrodinger equation** for an atom,

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E],$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential,

$$V(r) = -\frac{e^2}{r}e^{-r/a}.$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e = 3.795 (eVÅ)1/2, m = 0.511x106 eV/c2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973(eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

5. **Solve the s-wave radial Schrodinger equation** for a particle of mass m,

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E],$$

for the anharmonic oscillator potential $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$.

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}. In these units, cħ = 197.3 MeV fm. The ground state energy is expected to lie between 90 and 110 MeV for all three cases.

6. **Solve the s-wave radial Schrodinger equation** for the vibrations of hydrogen molecule.

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

Where μ is the reduced mass of the two-atom system for the Morse potential,

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), \text{ and } r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: m = 940×106eV/c^2, D = 0.755501 eV, α = 1.44, r_0 = 0.131349 Å

7. **Time Evaluation of Wave Packet**

• Time evolution of a wave packet moving in free space by the numerical solution of the time dependent Schrödinger equation.

• Solving the TDSE to study Barrier penetration and tunneling for an initially Gaussian wave packet.

Reference Books

1. An Introduction to computational Physics, T.Pang, 2nd Edn., 2006,Cambridge Univ. Press
2. Scientific Computing in Python, Abhijit Kar Gupta, Techno World
3. Computational Physics problem solving with Computers, Landau, Paez, Bordeianu etextbook in Python 3rd Edition
4. Computational Methods for physcs, Joel Franklin, Cembridge University Press
5. Computational Quantum Mechanics, Joshua Izaac, Jingbo Wang, Springer

Paper Name: **STATISTICAL MECHANICS LAB**
Paper Code: **PHY12030**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

To use statistical mechanical concepts while writing a code to visualize the solutions for different type of statistical and probability related problems.

Course Outcomes: On completion of this course, the students will be able to
CO1: Demonstrate and analyze Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.

CO2: Demonstrate and analyze the behaviour of Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.

CO3: Evaluate and illustrate the Maxwell-Boltzmann/Fermi-Dirac/Bose-Einstein distribution function versus temperature.

CO5: To analyze a given time series and apply the concepts of central limit theorem.

CO5: To analyze random no related problems and apply the concepts in solving problems like 1D and 2D random walk.

Catalog Description:

In this course Mathematica/ Python/ Scilab will be used to demonstrate the properties of different types of statistics like Maxwell-Boltzman, Fermi-Dirac, Bose-Einstein etc, to learn to generate random numbers and apply the concepts to visualize 1D and 2D random walk problems, and to study time series.

Course Content:

Use Python/ Scilab /Mathematica for solving the problems based on Statistical Mechanics like

1. Plots and Scaling:

(a) Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.

(b). Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.

(c) Plot Maxwell-Boltzmann distribution function versus temperature.

(d). Plot Fermi-Dirac distribution function versus temperature.

(e). Plot Bose-Einstein distribution function versus temperature.

2. Study of Random Numbers and Time series

• Histogram and autocorrelation function of a given time series.
• Generating exponential variates from uniform variate using transformation
• Gaussian variate from uniform variate using central limit theorem.
• Study of histogram and moments of random sequences of different probability density using numpy.random.

3. Applications of Random Numbers

• Coin tossing. Fit with binomial distribution.
• Nuclear Decay: Simulation assuming a constant decay probability per unit time.
• Random Walk: – In 1D and in 2D (Square grid) – Plot of r.m.s. value of end to end distance as a function of time step – fitting and finding of exponent
• Monte Carlo Integration

Reference Books:

1. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
2. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
3. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010
4. Scientific Computing in Python. Abhijit Kar Gupta, Techno World
5. Computatioal Physics problem solving with Computers, Landau, Paez, Bordeianu etextbook in Python 3rd Edition
6. Computational Methods for physcs, Joel Franklin, Cembridge University Press

Paper Name: **ANALYTICAL MECHANICS AND SPECIAL THEORY OF RELATIVITY**

Paper Code: **PHY11060**
Credit: **6**
LTP: **5-1-0**

Course Objectives:

1. To formulate Lagrangian and Hamiltonian equations and solve those for different physical systems in Classical regime.
2. To criticize the failures of Classical Mechanics.
3. To evaluate the modes of small oscillations for different systems.

Course Outcomes: On completion of this course, the students will be able to

CO1: Apply variational principal and Lagrangian formulation to solve real life mechanical problems.

CO2: Apply Hamiltonian formulation to solve real life mechanical problems.

CO3: Develop the concepts of small oscillation and transition to continuum.

CO4: Analyze the principles of mechanics in relativistic limit.

Catalog Description:

This course aims to describe the motion of macroscopic object and the framework needed to describe the motion. How a discrete system can be transformed into a continuous one and how to develop the subject of classical fields are also discussed.

Course Content:

Unit 1: Variational Principles and Lagrangian Formulation:

Introduction to calculus of variations, few applications, Hamilton's Variational Principle, D ' Alembert's principle, Lagrange's Equation of motion, Linear harmonic Oscillator, Few applications like simple pendulum, linear harmonic oscillator, isotropic oscillator, particle moving under a central force field, Atwood's machine, particle on a sphere, Compound pendulum. Invariance of Lagrange's equation under Galilean Transformation.

(15L)

Unit 2: Hamiltonian Formulation:

Hamilton's equation of motion, Advantage of Hamiltonian approach, Applications of Hamilton's equation like simple pendulum, compound pendulum, Isotropic harmonic oscillator, Particle moving near the surface of earth, particle in a central force field. Hamiltonian for a charged particle in an electromagnetic field, Principle of least action, canonical transformation, Poisson's bracket.

(15L)

Unit 3: Mechanics of small oscillations and continuous systems:

Stable and unstable Equilibrium, Formulation of the problem: Lagrange's equation of motion for small oscillations, Properties of T, V and ω, Normal co-ordinates and normal frequencies of vibration, Few applications- Parallel pendulum, Double pendulum, Triple pendulum, Free vibrations of linear tri-atomic molecule, String as a system of particles: weighted string, Transition from discrete to a continuous systems.

(15L)

Unit 4: Special Theory of Relativity

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

(20L)

Reference Books:

1. Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
4. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
5. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
6. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
7. Solved Problems in Classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

Paper Name: **SOLIS STATE PHYSICS**
Paper Code: **PHY11060**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To understand different properties (electrical, thermal, optical, dielectric, magnetic etc.) of solids and analyze the origin with the help of quantum and statistical theory.
2. To interpret different experimental observations with the help of the theoretical formalism.

Course Outcomes: On completion of this course, the students will be able to

CO1: Explain the nature of different bonding in solids.
CO2: Explain different lattice structure and mechanisms of lattice vibration and analyse lattice specific heats as per Einstein and Debye model.
CO3: Analyze different electrical properties of solids using the concepts of free electron theory and band theory.
CO4: Analyze different magnetic and superconducting properties of solids.
CO5: Analyze different dielectric and optical properties of solids.

Catalog Description

Solid State Physics is an applied branch of Physics where the material properties are analyzed with the help of classical, quantum mechanical and statistical theories. The structure of matter and hence different properties like electrical, electronic, thermal, optical, dielectric and magnetic etc. of solids are classified and discussed and the experimental observations are explained.

CONTENT:

Interatomic Forces and Bonding in Solids:

Cohesive forces, Bonding in Solids, Ionic bonding, Covalent bonding, Metallic bonds, Intermolecular Bonds, Dipole, Hydrogen bonds.

(12 L)

Crystal Structure and Lattice Dynamics

Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.T^3 law.

(6L)

Free Electron Theory and elementary band theory:

Free Electron Gas, Electrical and Thermal conductivity, Electronic Specific Heat, Sommerfeld's correction, Kronig Penny model. Formation of energy bands, Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (4 probe method) & Hall coefficient.

(12L)

Magnetism and Superconductivity:

Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)

(6L)

Dielectric Properties of Materials:

Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Ferroelectricity, Piezoelectricity, Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.

Reference Books

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India

3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill

4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning

5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer

6. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

Paper Name: **SOLIS STATE PHYSICS LAB**
Paper Code: **PHY12046**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

- To understand the properties and applications of different solid materials.
- To determine the I-V characteristics of a Solar Cell.
- To understand how band-gap depends on temperature of a given (Ge) semiconductor.
- To understand how classification of various solids, like:metals, ceramics and semiconductors based on their properties can be made.

Course Description:

This course aims to impart knowledge of solids by measuring properties of materials experimentally. The course is designed in a way that students could have got more or less complete idea of property and types of materials. In this course students will perform current voltage characteristic of solar cell experimentally and also observe refractive index of a dielectric material by Surface Plasmon Resonance technique. Students can able to classify materials like: metals, ceramics, and semiconductors by studding their physical properties. The course will consist of practical classes and demonstration of theories of relevant experiments. We mainly focus on the development of fundamental concepts of physical properties of materials which could be helpful in future to solve various real life problems. Apart from regular class on experiments some special classes will be arranged for student presentations.

Course Content:

1: Determine the Hall coefficient of a semiconductor sample (*p type and n type*).

2: Measure the Dielectric Constant of a dielectric Materials with frequency/temperature.

3: Determine the I-V characteristics of a Solar Cell.

4: Determine the temperature dependence of energy band-gap of a Ge semi-conductor.

5: Determine the refractive index of a dielectric layer using Surface Plasmon resonance (SPR).

6: Study the tunneling effect in tunnel diode using I-V characteristics.

DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES (THEORY & LAB)

Paper Name: **EXPERIMENTAL TECHNIQUES**
Paper Code: **PHY11031**
Credit: **4**
LTP: **4-0-0**

Course Objectives

To understand different experimental techniques and develop a strong background in understanding the functioning of signaling, shielding and grounding, and handling different instruments like transducers, impedance bridge, vacuum systems etc.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Apply** the concepts of different methods of error analysis, statistical analysis, and curve fitting to **analyze** a dataset obtained experimentally.

CO2. **Develop** the working concepts of signaling, shielding and grounding and **apply** those to explain the functioning of different electrical instruments.

CO3. **Apply** the working principles of transducers and other related things in industrial instrumentation and **interpret** the outcome.

CO4. **Apply** the working principles of digital multimeters, different impedance bridges, Q-meters etc. in different sectors and **interpret** the outcome.

CO5. **Develop** a knowledge on vacuum systems and **apply** those in real life scenarios.

Course Content

Measurements:

Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution.

(8L)

Signals and Systems:

Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise

(8L)

Shielding and Grounding:

Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference.

(6L)

Transducers & industrial instrumentation (working principle, efficiency, applications):

Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

(12L)

Digital Multimeter:

Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

(2L)

Impedance Bridges and Q-meter:

Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.

(2L)

Vacuum Systems:

Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system-Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

(8L)

List of Books:

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
2. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
3. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
4. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
5. Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata Mc Graw Hill
6. Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
7. Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

Paper Name: **EMBEDDED SYSTEMS-INTRODUCTION TO MICROCONTROLLER**
Paper Code: **PHY11032**
Credit: **4**
LTP: **4-0-0**

Course Objectives:

1. To develop the capability of the students for understanding 8051 microcontroller and its programming aspects for system design.
2. To build up the foundations for embedded system design.

Course Outcomes

On completion of this course, the students will be able to:

CO1: Illustrate the basics of embedded system design.

CO2: Demonstrate 8085 microprocessor and its applications.
CO3: Demonstrate 8051 microcontroller and its programming aspect for system design.
CO4: Understand programming of embedded system.
CO5: Build up the foundations for design and development of embedded system.

Catalog Description

The course aims to demonstrate the architecture of 8051 microcontroller and its different programming aspect like I/O port programming, Timer and counter programming, Serial port programming with and without interrupt and interfacing for system design. The course also reviews the8085 microprocessor. The course builds up the foundations of embedded system design.

Course Content

Unit 1: Embedded system introduction:

Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges & design issues in embedded systems, operational and non-operational quality attributes of embedded systems, elemental description of embedded processors and microcontrollers.

(6L)

Unit 2: Review of microprocessors:

Organization of Microprocessor based system, 8085µp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts.

(6L)

Unit 3: 8051 microcontroller:

Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.8051 addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, arithmetic and logic instructions.

(8L)

Unit 4: 8051 Programming

I/O port programming: Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions, I/O port programming 8051 (using assembly language), I/O programming: Bit manipulation.8051 programming in C: for time delay & I/O operations and manipulation, for arithmetic and logic operations, for ASCII and BCD conversions.Timer and counter programming: Programming 8051 timers, counter programming. Serial port programming with and without interrupt: Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051.

(16L)

Unit 5: Interfacing 8051 microcontroller to peripherals:

Parallel and serial ADC, DAC interfacing, LCD interfacing.

(4L)

Unit 6: Programming Embedded Systems:

Structure of embedded program, infinite loop, compiling, linking and locating, downloading and debugging.

(6L)

Unit 7: Embedded system design and development:

Embedded system development environment, file types generated after cross compilation, disassembler/ decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry.

(6L)

Reference Books:

1. Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M. A. Mazidi, J.G. Mazidi, and R.D. McKinley, 2nd Ed., 2007, Pearson Education India.
3. Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India
4. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar, 2002, Prentice Hall
5. Embedded microcomputer system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole
6. Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.
7. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

Paper Name: **PHYSICS OF DEVICES AND INSTRUMENTATION**
Paper Code: **PHY11033**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To develop a strong idea on the working principles and applications of different devices like UJT, FET, MOSFET, Power supplies, multivibrators etc and understand the methods of IC fabrication.
2. To understand the rudimentary principles of digital data communication operations and systems.

Course Outcomes

On completion of this course, the students will be able to

CO1: **Apply** the concepts of different devices like UJT, BJT, MOSFET, CMOS etc. in instrumentation.

CO2: **Develop** the working concepts of power supply, different filters (both passive and active), astable and monostable multivibrators etc and apply then in different instruments.

CO3: **Explain** the working principles of Phase Locked Loop based devices.

CO4: **Explain** the methods of IC fabrication.

CO5: **Apply** the working principles digital data communication system and apply them in real life scenarios.

Course Content

Devices:

Characteristic and small signal equivalent circuits of UJT and JFET. Metal semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

(8L)

Power supply and Filters:

Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.

(4L)

Multivibrators: Astable and Monostable Multivibrators using transistors.

(3L)

Phase Locked Loop (PLL):

Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

(4L)

Processing of Devices:

Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.

(8L)

Digital Data Communication Standards:

Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART).Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.

(10L)

Introduction to communication systems:

Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator.
Demodulation of AM wave using Diode Detector. Basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

(10L)

Reference Books:

1. Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons

2. Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.

3. Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd

4. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.

5. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.

6. Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI

Learning Pvt. Ltd.

7. PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

Paper Name: **MEDICAL ELECTRONICS**
Paper Code: **PHY11056**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To understand the concept of medical physics in diagnostics and therapeutics of healthcare.

2. To design and realize biomedical devices, component, or process to meet the rising demands of healthcare industry.

3. To analyze different diseases with scientific aptitudes and design the solution accordingly.

4. To explore system characteristics of radiation interaction with matter.

5. To compare the application of advanced technology in restoration of functions of the human body.

Course Outcomes

On completion of this course, the students will be able to

CO1: Students will be able to illustrate the design considerations of biomedical devices.
CO2: Students will be able to define and compare different bio-signals and their measuring instruments.
CO3: Students will be able to interpret the working principle of diagnostic instruments.
CO4: Students will be able to appraise the working principle, calibration and maintenance of therapeutic instruments.
CO5: Students will be able to compare various imaging modalities used for non-invasive diagnosis of diseases.

Catalog Description

Medical Electronics is an interdisciplinary course which is based on the understanding the physics behind working principle of different medical devices. In this course, different aspects of designing and development of diagnostic and therapeutic devices are explained in depth. Furthermore, diagnostic and therapeutic radiation devices and radiation protection is also introduced as a part of medical physics. Through this course, students will be guided to apply the knowledge of instrumentation towards the development and maintenance of medical devices used to provide healthcare support to the human beings. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit I: Introduction to Biomedical Electronics (3 L)

The age of biomedical engineering, Development of biomedical instrumentation, Biometrics, Introduction to the main-instrument system, Components of the main instrument system, Standard Anatomical Position, Planes, Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal. Physiological Systems of the body, Problems encountered in measuring a living system, Design for bio-medical problems, diagnosis of disease and therapeutic applications.

Unit II: Sources of Bioelectric potentials, Transducers and Electrodes (5 L)

Resting and Action Potentials, Propagation of Action Potentials, Biochemical Transducers, transducer and transduction principles, Active transducers, Passive transducers, Transducers for biomedical applications, The Bioelectric Potentials Electrode theory, Bio Potential Electrodes, Study of various types of electrodes used in ECG, EEG, ENG, EOG and EMG, Measurement of ECG, EEG, ENG, EOG and EMG signals along with their diagnostic applications. (10 L)

Unit III: Physics of Diagnostic Systems (15 L)

Emerging trends in medical diagnostics and therapy, The physiology of the respiratory system, Tests and instrumentation for the mechanics of breathing, Gas exchange and distribution, Respiratory diagnosing equipment (Spirometer). Principles of sound wave propagation for hearing, audiometry, Clinical laboratory instrumentation, Blood cell counter and associated hematology system, Endoscopic diagnosis and foreign body removal.

Unit IV: Physics of Therapeutic Systems (12L)

Cardiac pacemaker, cardiac defibrillators, LASER applications in biomedical field, haemodialysis machine, drug delivery system, radiotherapy and nuclear medicine, Design of haemodialysis Machine, Biotelemetry, Patient Safety and biomedical ethics

Unit V: Medical Imaging Modalities: (18 L)

Electron transitions and the generation of X-rays; Characteristics of X-ray beam and interaction with matter. Generation and detection of X-rays (radiography techniques). Principle and Theory of computer tomography (CT) scanning, spiral CT scanning & (positron emission tomography) PET scan.

Physics of Nuclear Magnetic Resonance (NMR) imaging and its application in the field of diagnostics. Gamma camera, single photon emission computer tomography (SPECT) and other latest Medical imaging systems.

Physics of ultrasound imaging, uses in diagnosis, Image quality description & patient risk, Theory and applications of optical, thermography imaging.

Reference Books

1. Hand Book of Biomedical Instrumentation, Khandpur

2. Fundamentals of Bio-medical engineering, G. S. Sawhney.

3. Medical Instrumentation: Application and Design, John G. Webster

Paper Name: **EXPERIMENTAL TECHNIQUES LAB**
Paper Code: **PHY12034**
Credit: **4**
LTP: **4-0-0**

Course Objective:

1. To learn about various techniques associated with experiments.
2. To develop the skill of performing experiments and analysis of data.

Course Outcomes:

CO1: Illustrate the basics of working principle of sensors.

CO2: Demonstrate the calibration of Semiconductor type temperature sensor: AD590, LM35, or LM75 and RTD.

CO3: Demonstrate the working principle of pump and vacuum level measurements gauges.

CO4: Design Clippers and Clampers circuits using junction diode.

CO5: Demonstrate the measurement of Q of a coil and influence of frequency, using a Q-meter.

Course Description:

Hands on training to work with transducers, Q meters, sensors, etc, designing clippers and clampers etc. which shall enhance employability as it has a direct bearning on application.

List of Experiments:

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. Design and analyze the Clippers and Clampers circuits using junction diode
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter.

Paper Name: **MICROCONTROLLER LAB**
Paper Code: **PHY12035**
Credit: **2**
LTP: **2-0-4**

Course Objectives

1. To expose the students with computing knowledge to write the program for 8051 microcontrollers in assembly and C language.
2. To design embedded system using 8051 microcontrollers.

Course Outcomes

On completion of this course, the students will be able to

CO1: Familiar with8051 Kits, assembly and C programming.
CO2: Examine the difference operations and applications of 8051 microprocessors.
CO3: Build up the embedded system using 8051 microcontrollers.

Catalog Description

The Microcontroller Lab isdeveloped to Familiarization of 8051 Kits, examine difference operations and applications of 8051 microcontroller using Assembly and C programing. Students are also able to design embedded system based on 8051 microcontrollers for few applications like temperature measurement.

Course Content

List of experiments:

1. Introduction or Familiarization of 8051 Kits
2. To find that the given number is prime or not.
3. To find the factorial of a number.
4. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
5. Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's.
6. Program to glow the first four LEDs then next four using TIMER application.
7. Program to rotate the contents of the accumulator first right and then left.
8. Program to run a countdown from 9-0 in the seven segment LED display.
9. To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
10. To toggle '1234' as '1324' in the seven segment LED display.
11. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.
12. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

Paper Name: **DEVICES AND INSTRUMENTATION LAB**
Paper Code: **PHY12036**
Credit: **2**
LTP: **0-0-4**

Course Objective:

To develop an idea about modern day communication system.

Course Outcomes:

1. Students can get a basic idea about different signal filtration process.
2. Students will gather knowledge about characteristics and frequency response of different amplifier.
3. Students will get a hands on training of different modulation and de-modulation techniques.
4.Understand programing of embedded system.

Course Description:

Hands on training to work with passive and active filters, FET, MOSFET, UJT, AM modulator and Demodulator and consequently enhancing the chances of employability

Course Content:

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astable multivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Paper Name: **MEDICAL ELECTRONICS LAB**
Paper Code: **PHY12057**
Credit: **2**
LTP: **0-0-4**

Course Objectives

1. To understand the application of Biomedical Instrumentation.
2. To calibrate various medical devices to record vital stats of human body.
3. To understand various electrical activities that can be recorded non-invasively through surface electrodes.
4. To analyse the physiological data through signal processing

Course Outcomes

On completion of this course, the students will be able to

CO1: Students will be able to **illustrate** the design considerations of biomedical devices.

CO2: Students will be able to **define** and **compare** different bio-signals and their measuring instruments.

CO3: Students will be able to **interpret**the working principle of diagnostic instruments.

CO4: Students will be able to **appraise**the working principle, calibration and maintenance of therapeutic instruments.

CO5: Students will be able to **compare** various imaging modalities used for non-invasive diagnosis of diseases.

Catalog Description

This course aims to impart knowledge of the working principles of different biomedical instruments experimentally. The course is designed to introduce various biomedical sensors to the students. In this course students will perform experiments to determine the physiological parameters of human body such as SpO_2, Heart rate, body temperature, etc. The students will also observe ECG and EEG recorded from human subjects. The course will consist of practical classes and demonstration of theories of relevant experiments. We mainlyfocus on the development of fundamental concepts of bioinstrumentation which could be helpful in future to solve various real life problems associated with healthcare. Apart from regular class on experiments some special classes will be arranged for student presentations.

Course Content

1. Experiment on Calibration of ECG Unit
2. Experiment on Calibration of EEG Unit
3. Experiment on Calibration of Pulse Oxymeter unit
4. Experiment on Calibration of Audiometer unit
5. Experiment on Calibration of Pulmonary volumes
6. Experiment on Sphygmomanometer calibration with automated BP monitoring machine
7. Experiment on Thermal Sensor calibration

Reference Books

The Manuals are provided in Lab for respective experiments. Students are also encouraged to do research from different open access materials available in internet.

Paper Name: ADVANCED MATHEMATICAL PHYSICS
Paper Code: **PHY11037**
Credit: **4**
LTP: **4-0-0**

Course Objective:

1. To develop understanding in the field of Linear Algebra, Linear Transformations, Linear vector spaces etc
2. To develop understanding in the field of Tensor analysis

Course Outcomes:

CO1: Explain Vector Spaces over Fields of Real and Complex numbers.
CO2: Develop idea of representation of linear transformations by matrices and to learn similaritytransformation and linear operators.
CO3: Develop idea of Tensors and its application in various branches in physics.

CO4: Apply Euler's Equation in application to Simple Problems

Course Description:

Problems solving skill in the areas of Linear Algebra, Linear Transformations, Linear vector spaces and Tensor analysis etc.

Linear Algebra:

Vector Spaces: Vector Spaces over Fields of Real and Complex numbers. Examples. Vector space of functions. Linear independence of vectors. Basis and dimension of a vector space. Change of basis. Subspace. Isomorphisms. Inner product and Norm. Inner product of functions: the weight function. Triangle and Cauchy Schwartz Inequalities. Orthonormal bases. Sine and cosine functions in a Fourier series as an orthonormal basis. Gram Schmidt orthogonalisation.

(15L)

Linear Transformations:

Introduction. Identity and inverse. Singular and non-singular transformations. Representation of linear transformations by matrices. Similarity transformation. Linear operators. Differential operators as linear operators on vector space of functions. Commutator of operators. Orthogonal and unitary operators and their matrix representations. Adjoint of a linear operator. Hermitian operators and their matrix representation. Hermitian differential operators and boundary conditions. Examples. Eigenvalues and eigenvectors of linear operators. Properties of Eigenvalues and Eigenvectors of Hermitian and unitary operators. Functions of Hermitian operators/ matrices.

(15L)

Tensors:

Tensors as multilinear transformations (functionals) on vectors. Examples: Moment of Inertia, dielectric susceptibility. Components of a tensor in basis. Symmetric and anti-symmetric tensors. The completely anti-symmetric tensor. Non-orthonormal and reciprocal bases. Summation convention. Inner product of vectors and the metric tensor. Coordinate systems and coordinate basis vectors. Reciprocal coordinate basis. Components of metric in a coordinate basis and association with infinitesimal distance. Change of basis: relation between coordinate basis vectors. Change of tensor components under change of coordinate system. Example: Inertial coordinates & bases in Minkowski space, Lorentz transformations as coordinate transformations, Electromagnetic tensor and change in its components under Lorentz transformations.

(15L)

Calculus of Variations

Variational Principle: Euler's Equation. Application to Simple Problems (shape of a soap film, Fermat's Principle, etc.).Several Dependent Variables and Euler's Equations. Example: Hamilton's Principle and the Euler-Lagrange equations of motion. Geodesics: geodesic equation as a set of Euler's equations. Constrained Variations: Variations with constraints. Applications: motion of a simple pendulum, particle constrained to move on a hoop.

(10L)

Reference Books:

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications

2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.

3. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.

4. Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning

5. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole

6. Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press

Paper Name: **MACHINE LEARNING AND DATA ANALYTICS**
Paper Code: **PHY11058**
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To understand the concepts of machine learning.
2. To examine different types basic and advanced machine learning techniques
3. To be able to devise data collection protocols and extract meaningful features.
4. To extract information to serve needs of users using advanced data analytics.

Course Outcomes:

On completion of this course, the students will be able to

CO1: **Understand** the basic concepts of machine learning.

CO2: **Apply** different types of machine learning techniques

CO3: **Analyse** advanced machine learning algorithms

CO4: **Formulate** plans for data acquisition, annotation and processing

CO5: **Estimate** different types of concepts by using advanced data analysis techniques

Catalog Description

This is a curated course consisting of the fundamental basis of machine learning and covers a wide array of basic and advanced machine learning techniques. This course is designed to aid students of all domains and would allow them to implement state of the art predictive classifiers and clustering solutions along with inquisitive data analytics techniques to formulate data acquisition protocols, perform analysis and create comprehensive reports.

Course Content

Unit I: Introduction to Machine Learning **[7L]**

Evolution of machine learning techniques. Components of machine learning framework: information vs data, preprocessing, feature selection and extraction, training, validation and

testing, performance analysis, comparison of learning algorithms, cross-validation, learning curves, and statistical hypothesis testing.

Unit II: Supervised and Unsupervised Learning Techniques **[15L]**

Rule based learning: propositional and first-order Logic,regression models: linear and non-linear, mean square error, overfitting and underfitting, decision trees, Bayesian learning, instance-based learning), clustering techniques, cluster validity indices, support vector machines

Unit III: Advanced Learning Techniques **[10L]**

Artificial Neural Networks, Convolutional neural networks, RNNs, LSTMs, autoencoders,evolutionary algorithms, hidden Markov models, ensemble learning.

Unit IV: Data collection and pre-processing **[7L]**

Structured, unstructured and semi-structured data, data collection overview, basics of measurement scales, data collection methods, handling missing data, handling categorical variables, data distribution.

Unit V: Data Analysis Techniques **[6L]**

Descriptive statistics, probability, confidence intervals, hypothesis testing, goodness of fit, types of data analytics, summarization of results, outlier detection, association rules.

Reference Books

1. Tom Mitchell,*"MachineLearning"*,McGraw-Hill,1997.
2. Predictive Analytics, Eric Seigel, Wiley

Paper Name: **APPLIED DYNAMICS**
Paper Code: **PHY11039**
Credit: **4**
LTP: **4-0-0**

Course Objective:

1. To understand Simple mechanical systems as first order dynamical systems.
2. To understand the theoretical approach of Chaos and Fractals.
3. To develop understanding of Elementary Fluid Dynamics.

Course Outcomes:

CO1: Illustrate the ideas of phase space and simple mechanical systems as first order dynamical systems
CO2: Develop the knowledge of Population models e.g. exponential growth and decay, logistic growth, species competition.
CO3: Understand the rate equations for chemical reactions e.g. auto catalysis, bi stability.
CO4: Develop the knowledge of Chaos and Fractals.

CO5 : Illustrate the importance of fluids: Fluids in the pure sciences, fluids in technology.

Course Description:

Skill development in the areas of first order and non-linear dynamical systems, chaos and fractals, elementary fluid dynamics, etc.

Introduction to Dynamical systems:

Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Simple mechanical systems as first order dynamical systems : the free particle, particle under uniform gravity, simple and damped harmonic oscillator. Sketching flows and trajectories in phase space; sketching variables as functions of time, relating the equations and pictures to the underlying physical intuition. Other examples of dynamical systems, In Biology: Population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits In Chemistry: Rate equations for chemical reactions e.g. auto catalysis, bi stability In Economics: Examples from game theory. Illustrative examples from other disciplines. Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples. Computing and visualizing trajectories on the computer using a software packages. Discrete dynamical systems. The logistic map as an example.

(18L)

Introduction to Chaos and Fractals:

Examples of 2-dimensional billiard, Projection of the trajectory on momentum space. Sinai Billiard and its variants. Computational visualization of trajectories in the Sinai Billiard. Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle. Electron motion in mesoscopic conductors as a chaotic billiard problem. Other examples of chaotic systems; visualization of their trajectories on the computer. Self similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need for fractal dimension to describe self-similar structure. Deterministic fractal vs. Self-similar fractal structure. Fractals in dynamics – Sierpinski gasket and DLA. Chaos in nonlinear finite-difference equations- Logistic map: Dynamics from time series. Parameter dependence- steady, periodic and chaos states. Cobweb iteration. Fixed points. Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions. Period-Doubling route to chaos. Nonlinear time series analysis and chaos characterization: Detecting chaos from return map. Power spectrum, autocorrelation, Lyapunov exponent, correlation dimension.

(18L)

Elementary Fluid Dynamics:

Importance of fluids: Fluids in the pure sciences, fluids in technology. Study of fluids: Theoretical approach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: The continuum hypothesis concept of fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform & non-uniform flows, viscous & inviscid flows, incompressible & compressible flows, laminar and turbulent flows, rotational and irrotational flows, separated & unseparated flows. Flow visualization – streamlines, pathlines, Streaklines.

(15L)

Reference Books:

1. Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007
2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G. K. Batchelor, Cambridge Univ. Press, 2002
4. Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1987.

Paper Name: **ADVANCED MATHEMATICAL PHYSICS LAB**
Paper Code: **PHY12040**
Credit: **2**
LTP: **0-0-4**

Course Outcomes:

CO1: Determine the Eigen value and Eigen vectors of the matrices.
CO2: Determine Orthogonal polynomials as Eigen functions of Hermitian differential operators.
CO3: Determine the principal axes of moment of inertia through Diagonalization.
CO4: Apply Lagrangian formulation in Classical Mechanics with constraints.
CO5: Analyze and Estimate the ground state energy and wave function of a quantum system.

Course Description:

Hands on training for Advanced Computer Simulation, thereby increasing the chances of employability in the relevant sector

Course Content:

Simulation experiments based on Python/ Mathematica/Matlab/Scilab:

1. Linear Algebra:

(a) Multiplication of two 3×3 matrices

(b) Eigen value and Eigen vectors of the matrices of following types:

$$\begin{pmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 3 & 1 & 4 \end{pmatrix}, \begin{pmatrix} 2 & -i & 2i \\ i & 4 & 3 \\ -2i & 3 & 5 \end{pmatrix}, \text{and} \begin{pmatrix} 1 & -i & 3+4i \\ i & 2 & 4 \\ 3-4i & 4 & 3 \end{pmatrix}$$

2. Orthogonal polynomials as Eigenfunctions of Hermitian differential operators.

3. Determination of the principal axes of moment of inertia through Diagonalization.

4. Vector space of wave functions in Quantum Mechanics: Position and momentum differential operators and their commutator, wave functions for stationary states as Eigenfunctions of Hermitian differential operator.

5. Lagrangian formulation in Classical Mechanics with constraints.

6. Study of geodesics in Euclidean and other spaces (surface of a sphere, etc).

7. Estimation of ground state energy and wave function of a quantum system.

Paper Name: MACHINE LEARNING AND DATA ANALYTICS LAB

Paper Code: **PHY12059**
Credit: **2**
LTP: **0-0-4**

Course Objectives:

1. To create systems for pre-processing and feature extraction
2. To build machine learning tools for predictive analysis
3. To cluster datasets into meaningful clusters without annotations
4. To measure and compare the performance of several machine learning systems.

Course Outcomes:

On completion of this course, the students will be able to

CO1: Build feature extraction techniques from various data.
CO2: Create simple predictive classifiers
CO3: Create clustering techniques for unlabeled data
CO4: Develop neural networks for automatic feature extraction

Catalog Description:

This course introduces basic concepts of Fortran programming language to solve numerical problems. All the lectures will be devoted on discussions of basic theories, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as audio visual virtual lab session. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Unit 1: [12]

1) Principal Component Analysis
2) Image Features: Shape, Textures, Gradients and Edges
3) Text Features: term-document incidence matrix, tf-idf, bag-of-words

Unit 2: [16]

4) Linear and Quadratic Regression
5) K-Nearest Neighbor classification
6) SVM classification using LibSVM
7) Ensemble classifiers

Unit 3: [16]

7) K-Means Clustering
8) Hierarchical Clustering
9) Fuzzy C-Means Clustering
10) Cluster Validity Indices

Unit 4: [8]

11) Neuron and Stochastic Gradient Descent.
12) Multi-layered perceptron and Backpropagation

Reference Books:

1. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.

2. Predictive Analytics, Eric Seigel, Wiley

Paper Name: **APPLIED DYNAMICS LAB**
Paper Code: **PHY12041**
Credit: **2**
LTP: **0-0-4**

Course Outcomes:

CO1: Determine coupling coefficient of coupled pendulums and coupled oscillators.
CO2: Devolve knowledge about population models e.g. exponential growth and decay and logistic growth.
CO3: Understand Computational visualization of trajectories in the Sinai Billiard and Electron motion in mesoscopic conductors.
CO4: Understand Computational visualization of self-similar fractal.

Course Description:

Hands on training for Advanced Computer Simulation through learning about coupled pendulums, studying population model, chemical reaction's rate analysis, game theory, fractal analysis, flow visualizations thereby increasing the chances of employability in the relevant sector.

Course Content:

Laboratory/Computing and visualizing trajectories using software such as Scilab, Mathematica, Matlab, Python, Maple, Octave, XPPAUT based on Applied Dynamics problems

At least (any 8)

1. To determine the coupling coefficient of coupled pendulums.
2. To determine the coupling coefficient of coupled oscillators.
3. To determine the coupling and damping coefficient of damped coupled oscillator.
4. To study population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits.
5. To study rate equations for chemical reactions e.g. auto catalysis, bi-stability.
6. To study examples from game theory.
7. Computational visualization of trajectories in the Sinai Billiard.
8. Computational visualization of trajectories Electron motion in mesoscopic conductors as a chaotic billiard problem.
9. Computational visualization of fractal formations of Deterministic fractal.
10. Computational visualization of fractal formations of self-similar fractal.
11. Computational visualization of fractal formations of Fractals in nature – trees, coastlines, earthquakes.
12. Computational Flow visualization – streamlines, pathlines, Streaklines.

Paper Name: NUCLEAR AND PARTICLE PHYSICS

Paper Code: **PHY11047**
Credit: **6**
LTP: **5-1-0**

Course Objectives

1. To understand the nuclear Structure and properties.
2. To understand characteristics of two body Nuclear force and related properties.
3. To develop detailed understanding of radioactivity and nuclear reactions and applications.
4. To analyse different problems with scientific aptitudes and design the solution accordingly.
5. To explore basics of elementary particle and their interaction which are fundamental constituents of matter.

Course Outcomes

On completion of this course, the students will be able to

CO1: Explain different properties of nuclei and analyze different nuclear models.

CO2: Explain radioactive decays and apply it in different real life cases.

CO3: Analyze different types of nuclear reactions.

CO4: Develop an idea about the working principles of different radiation detectors and particle accelerators and apply those in real life scenarios.

CO5: Define and explain properties of elementary particle symmetries and conservation laws of nature related to subatomic physics

Catalog Description

Nuclear physics is a fundamental area of physics which includes basic constituent of matter and their interactions. The subject deals with the nuclear interactions, properties and relevant decay processes and its application in present day research. Application of radioactive detectors, particle accelerators and nuclear reactors are studied in detail. The properties fundamental particles related to their interactions and decays are also included..

Course Content

Unit I: General Properties of Nuclei and Nuclear Models:

18 Lecture Hours

Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force

Unit II: Radioactivity decays.

8 Lecture Hours

(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c)Gamma decay: Gamma rays emission & kinematics, internal conversion

Unit III: Nuclear Reactions:

8 Lecture Hours

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Unit IV: Detector for Nuclear radiations and Particle Accelerators:

16 Lecture Hours

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Accelerator facility available in India: Van-de Graff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons

Unit V: Particle Physics:

10 Lecture Hours

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, colour quantum number and gluons.

Reference Books

1. E. Fermi: Nuclear Physics.
2. R.R. Roy and B.P. Nigam: Nuclear Physics
3. S.N. Ghoshal: Atomic and Nuclear Physics (Vol. 2)

4. D.H. Perkins: Introduction to High Energy Physics
5. D.J. Griffiths: Introduction to Elementary Particles
6. W.E. Burcham and M. Jobes: Nuclear and particle Physics.

Paper Name: **ASTROPHYSICS**
Paper Code: **PHY11048**
Credit: **6**
LTP: **5-1-0**

Course Objectives

1. The course is designed to give a simple overview of the Astrophysics stressing on the fundamental concepts involved in the study of Astrophysics.
2. To study and describe solar parameters, solar atmosphere, origin of solar system, solar and extra-solar planets, planetary rings.
3. To acquire basic knowledge of Milky Way and Galaxies, their properties and structure.
4. To impart skills for understanding the basics of large scale structures and expending universe.

Course Outcomes

On completion of this course, the students will be able to

CO1: Understand and apply thebasic physical principles involved in the study of Astrophysics
CO2: Understand the Physics of the sun and the various aspects of the solar system.

CO3: Develop basic knowledge of galaxies and Milky Way.
CO4: Survey the large scale structure and expanding universe

Catalog Description:

Astrophysics is a science that employs the methods and principles of physics and chemistry in the study of astronomical objects and phenomena.The course outlines the basic physical principles in Astrophysics and develop basic knowledges about Astrophysics.

Course Content:

Physical principles:

Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium, Theory of Radiative Transfer (Radiation Field, Radiative Transfer Equation), Optical Depth; Solution of Radiative Transfer Equation, Local Thermodynamic Equilibrium.

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology).

The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.

Stellar spectra and classification Structure (Atomic Spectra Revisited. Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)

Stellar structure:

Hydrostatic Equilibrium of a Star, Some Insight into a Star: Virial Theorem, Sources of Stellar Energy, Modes of Energy Transport, Simple Stellar Model, Polytropic Stellar Model.

Star formation: Basic composition of Interstellar medium, Interstellar Gas, Interstellar Dust, Formation of Protostar, Jeans criterion, Fragmentation of collapsing clouds, From protostar to Pre-Main Sequence, Hayashi Line.

Nucleosynthesis and stellar evolution:

Cosmic Abundances, Stellar Nucleo-synthesis, Evolution of Stars (Evolution on the Main Sequence, Evolution beyond the Main Sequence), Supernovae. Compact stars: Basic Familiarity with Compact Stars, Equation of State and Degenerate Gas of Fermions, Theory of White Dwarf, Chandrasekhar Limit, Neutron Star (Gravitational Red-shift of Neutron Star, Detection of Neutron Star: Pulsars), Black Hole. The milky way: Basic Structure and Properties of the Milky Way,

Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the
Galactic Nucleus

Galaxies:

Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms, Active Galaxies

Active galaxies:

'Activities' of Active Galaxies, How 'Active' are the Active Galaxies? Classification of the Active Galaxies, Some Emission Mechanisms Related to the Study of Active Galaxies, Behaviour of Active Galaxies (Quasars and Radio Galaxies, Seyferts, BL Lac Objects and Optically Violent Variables), The Nature of the Central Engine, Unified Model of the Various Active Galaxies

Large scale structure & expanding universe:

Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter), Friedmann Equation and its Solutions, Early Universe and Nucleo-synthesis (Cosmic Background Radiation, Evolving vs. Steady State Universe)

Reference Books

1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
3. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
4. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
5. K.S. Krishnasamy, 'Astro Physics a modern perspective, 'Reprint, New Age International (p) Ltd, New Delhi,2002.
6. Baidyanath Basu, 'An introduction to Astro physics', Second printing, Prentice - Hall of

India Private limited, New Delhi,2001.

7. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

Paper Name: **ATMOSPHERIC PHYSICS**
Paper Code: **PHY11049**
Credit: **4**
LTP: **4-0-0**

Course Objective:

1. To understand the general features of Earth's atmosphere.
2. To understand various Atmospheric dynamics.
3. To analyze various Atmospheric waves.
4. To understand and analyze the operation of Radar, Lidar along with various data analysis tools and techniques.
5. To understand and explore the basics of Atmospheric Aerosols.

Course Outcomes:

On completion of this course, the students will be able to

CO1: Understand and explain the general features of Earth's atmosphere.
CO2: Understand and explain various Atmospheric waves.
CO3: Understand, analyze and explain the operation of Radar, Lidar along with various data analysis tools and techniques
CO4: Explain and analyze various stellar structures.

CO5: Analyze and explain the basics of Atmospheric Aerosols.

Course Description:

Skill development through knowledge acquisition about earth's atmosphere, atmospheric waves, RADAR, Lider and Aerosols.

Course Content:

<u>General features of Earth's atmosphere:</u>

Thermal structure of the Earth's atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones andantic clones, thunderstorms.

<u>Atmospheric Dynamics:</u>

Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Mesoscale circulations, The general circulations, Tropical dynamics.

<u>Atmospheric Waves:</u>

Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a non-homogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration

<u>Atmospheric Radar and Lidar:</u>

Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques.

<u>Atmospheric Aerosols:</u>

Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars.

Paper Name: **NANO-MATERIALS AND APPLICATIONS**
Paper Code: **PHY11050**
Credit: **4**
LTP: **4-0-0**

Course Objective:

1.Skill development through knowledge acquisition in different aspects of nanotechnology.
2. Application oriented topic

Course Outcomes:

CO1: Demonstrates length scales in physics and nanostructures: in 1D, 2D and 3D (nano dots, thin films, nanowires, nano rods).

CO2: Distinguish between Top down and Bottom up approach for synthesizing the nanoparticles.

CO3: Understand various characterization techniques; X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy and Transmission Electron Microscopy.

CO4: Illustrate concept of dielectric constant for nanostructures and charging of nanostructure.

CO5: Understand carrier transport in nanostructures and learn about Coulomb blockade effect.

CO6: Understand applications of nanoparticles like; quantum dots, nanowires and thin films for photonic devices (LED, solar cells) and Single electron devices.

Course Description:

Skill development through knowledge acquisition in different aspects of nanotechnology like confinement in nanoscale regime, synthesis nad characterization of nanomaterials, optical properties, electron transport through nanomaterials and applications. It has a direct bearing on employability too being a very contemporary and application oriented topic

Course Content:

NANOSCALE SYSTEMS:

Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

SYNTHESIS OF NANOSTRUCTURE MATERIALS:

Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.

CHARACTERIZATION:

X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunnelling Microscopy.

OPTICAL PROPERTIES:

Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures.

ELECTRON TRANSPORT:

Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunnelling and hoping conductivity. Defects and impurities: Deep level and surface defects.

<u>APPLICATIONS:</u>

Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Reference Books:

1. C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)

3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).

4. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.

5. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

Paper Name: **ATMOSPHERIC PHYSICS LAB**
Paper Code: **PHY12051**
Credit: **2**
LTP: **0-0-4**

Course Objective:

1. Hands on training for Skill enhancement by doing numerical analysis.
2. Climate change analysis

Course Outcomes:

1. Students can understand different types of atmospheric waves.
2. Students will get practical knowledge of how a Radarworks.
3. Study of different atmospheric parameter.
4. Students will get clear knowledge about climate change and how it affects our nature.

Course Description:

Hands on training for Skill enhancement by doing numerical analysis of atmospheric gravity waves, Kelvin waves etc., analyzing LIDAR data, RADAR data, Satellite Data, climate change analysis by studying temperature change in spatial and temporal profile.

Course Content:

---

1. Numerical Simulation for the following atmospheric waves using dispersion relations
(a) Atmospheric gravity waves
(b) Kelvin waves
(c) Rossby waves, and mountain waves

2. Offline and online processing of radar data
(a) VHF radar,
(b) X-band radar, and
(c) UHF radar

3. Offline and online processing of LIDAR data
4. Radiosonde data and its interpretation in terms of atmospheric parameters using vertical profiles in different regions of the globe.
5. Handling of satellite data and plotting of atmospheric parameters using radio occultation technique.

6. Time series analysis of temperature using long term data over metropolitan cities in India – an approach to understand the climate change

Paper Name: NANO MATERIALS AND APPLICATIONS LAB
Paper Code: **PHY12052**
Credit: **2**
LTP: **0-0-4**

Course Objective:

Hands on training for learning different techniques of synthesis and characterization of nanomaterials.

Course Outcomes:

1. Utilize wet chemical synthesis techniques to prepare metal nanoparticles and semiconductor nanoparticles.
2. Determine optical properties of the nanoparticles by using UV-Visible spectrophotometer.
3. Determine crystal structure of the nanoparticles by studying XRD patterns.
4. Utilize thermal evaporation to synthesize quantum dots and thin films.
5. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

Course Description:

Hands on training for learning different techniques of synthesis and characterization of nanomaterials.

Course Content:

---

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nano-materials and estimation of particle size.
5. To study the effect of size on colour of nano-materials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.

8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.

9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.

11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

ADDITIONAL COMPULSORY CORE COURSES

Paper Name: **INDUSTRY INTERNSHIP**
Paper Code: **PHY14042**
Credit: **2**

Direct Hands-on training in Industry/ Research Institutes, exposure to real world scenario which is helpful for employability.

Paper Name: **DISSERTATION**
Paper Code: **PHY15053**
Credit: **8**

Course Objectives

1. To motivate and engage the students to get introduced to different research areas of Physics and Applied Physics.
2. To enable students to learn different aspects of research in the field of Physics.

Course Outcomes

On completion of this course, the students will be able to

CO1: Identify the proper problem for research.
CO2: Outline the previous works that has been done in the concerned field through literature review.
CO3: Adapt and develop the methodology needed in that study.
CO4: Critically evaluate and interpret the results.
CO5: Test the repeatability of the proposed results in a generalized way.

Catalog Description

In this course unit, students will get introduced to different fields of research, and how to do it in a very basic form. They will learn to select a particular valid problem, working on the methodology, Evaluate the result, and draw the right conclusions from it. This is something where there is no bounded syllabus and students can work in their area of choice.

GENERIC ELECTIVES (THEORY & LAB)

OPTIONS: MATHEMATICS/STATISCTICS/CHEMISTRY/COMPUTER SCIENCE/BOTANY/ZOOLOGY

Paper Name: **ELECTIVE MATHEMATICS I**
Paper Code: **MTH11508**
Credit: **6**
LTP: **5-1-0**

Course Objectives:

1. To acquire the knowledge of Numbers, Set and Complex numbers by modern approach.
2. To enable the problem-solving ability of a student.
3. To give the students a perspective to understand the background theory of Mathematics.
4. To grow the logical thinking of a student.

Course Outcomes:

After completing this course, a student will,

CO1	**Recall** the knowledge to classify numbers into different number sets.
CO2	**Develop** a modern approach to the treatment of the theory of Integers and Complex numbers.
CO3	**Relate** the fundamental knowledge of limit, continuity and derivatives of different types of function.
CO4	**Illustrate** origins and applications of differential equations. Describe what Solutions of Differential Equations mean.
CO5	**Utilize** the knowledge of group theory with binary operations, properties and learn some special groups.
CO6	**Construct** double and triple integrals and its different applications.
CO7	**Make use of** the matrix calculus in solving a system of linear algebraic equations using multiple methods including Gaussian elimination and Matrix inversion methods.

Course Description:

Now a days Mathematics has become an integral part of all technologies and science. Therefore, without it, we will be unable to proceed for any development. All student should have some idea and logical mind set and mathematics made the job easy. In this course, various different aspects of mathematical parts will be discussed which help the student to understand different branches of mathematics. Apart from classroom activities, various assignments will be provided to the students. Through these, they can understand the concepts of their respective subjects also and probably find a relation of their subject with mathematics.

***Course Content*:**

Unit I **[20 hours]**

Complex numbers: De-Moivre's theorem and its applications, direct and inverse circular and hyperbolic functions, logarithm of a complex number, expansion of trigonometrical functions

Classical algebra: Relation between the roots and coefficients, fundamental theorem of Classical algebra (no proof required), nature of roots, Descartes rule of signs and of Sturm's theorem, transformation of equations, multiple roots, reciprocal equations, special roots, symmetric function of roots, solutions of cubic equations (Cardan method) and biquadratic equation (Ferrari's method). Cauchy-Schwartz inequality, inequality involving A.M. (including weighted), G.M., H. M. and their applications, m^{th}power theorem.

Set, relation, mapping and algebraic structure: Basic properties of sets, set operations. De Morgan's laws, cartesian product, relation, equivalence relation, mapping, injection, surjection, bijection, identity and inverse mappings, composition of mappings.

Group Theory: Group, abelian group, examples of groups from number system, roots of unity, matrices, symmetries of squares, triangles etc., groups of congruence classes, Klein's 4 group, order of an element of a group, order of a group, subgroups.

Unit II **[15 hours]**

Differential calculus: Limit of a function, indeterminate forms and L'Hopital's rule, continuity, derivatives and rates of change, the derivative of a function, derivatives of polynomials and exponential functions, the product and quotient rules, derivatives of trigonometric functions, the chain rule, implicit differentiation, derivatives of logarithmic functions, Roll's theorem, MVTs and their applications, successive differentiation, Leibnitz's rule, maxima and minima, asymptotes, envelopes, arc length, curvature.

Sequence and series: Sequences, series, the integral test and estimates of sums, the comparison tests, alternating series, absolute convergence and the ratio and root tests, strategy for testing series, power series, representations of functions as power series, Taylor and Maclaurin series.

Unit III **[15 hours]**

Differential equations: First order differential equations: order and degree of a differential equation, separable differential equations, homogeneous differential equations, equations reducible to homogenous differential equations form, linear differential equations and equations reducible to linear differential equations form, integrating factor and exact differential equations, Modelling using variable separable equations: Growth and Decay, population growth, growth of bacteria, pharmacology, spread of disease,doubling time and half-life, radioactive decay, carbon dating, Newton's law of cooling and heating,modelling of electric circuits: Kirchhoff's voltage law, Kirchhoff's current law.

Unit IV **[15 hours]**

Functions of several variables: Partial derivatives, the chain rule, the gradient and its properties, directional derivatives, total derivatives and Jacobians, differentials and their invariance, Taylor's formula for functions of several variables, transformation of partial derivatives by change of variables, the inverse and implicit function theorems, local extremal points, global extreme value problems with and without constraints, the Lagrange multiplier method, the method of least squares**,** maxima and minima of functions of several variables, finding critical points, the second derivative test for local maxima/minima and saddle points, the method of Lagrange multipliers.

Unit V **[10 hours]**

Matrices and Determinants: Matrices of real and complex numbers, Algebra of matrices. Symmetric and skew symmetric matrices. Hermitian and skew-Hermitian matrices. Orthogonal matrices, determinants: definition, basic properties of determinants, minors and cofactors, symmetric and skew-symmetric determinants, adjoint, invertible matrix, inverse of an orthogonal matrix, echelon matrix, rank of a matrix, determination of rank of a matrix, normal forms.
Solution of system of linear equation.

Unit VI **[15 hours]**

Integral calculus: The fundamental theorem of calculus (review), indefinite integrals and the net change theorem, the substitution rule, applications of integration, areas between curves, volumes, techniques of integration, integration by parts, trigonometric integrals, trigonometric substitution integration of rational functions by partial fractions, approximate integration, improper integrals. Multiple integrals: Double integrals over rectangles, iterated integrals, double integrals over general regions, triple integral.

***Text Books*:**

T1) Shanti Narayan,P K, Mittal, *Integral Calculus* , S Chand
T2) S. K. Mapa, *Higher algebra*, Lavent book distributors.
T3) Shanti Narayan, *Differential Calculus*. S.Chand Publishers.
T4) B. N. Mukherjee, B. C. Das, *Key to differential calculus*, U N Dhur& Sons.
T5) Ghosh, R.K., Maity K.C., *An Introduction to Differential Equations*, New Central book agency private Ltd.
T6) M. D. Raisinghania, *Ordinary and Partial Differential Equations*, S.Chand.
T7) S.K. Mapa, *Classical Algebra*, Lavent book publishers.

***Reference Books*:**

R1) B. S. Vaatsa, *Theory of matrix*, New Age Publication.
R2) Hoffman and Kunze, *Linear algebra*, Pearson.
R3) M.D. Raisinghania, *Advanced Differential Equations*,S.Chand.
R4) S.K. Mapa, *Introduction to Real Analysis*, Lavent Book House

Paper Name: **ELECTIVE MATHEMATICS II**
Paper Code: **MTH11509**
Credit: **6**
LTP: **5-1-0**

Course Objectives

1. To help the students to acquire basic knowledge on Vector space
2. To give the students ideas about advanced differential equation and different methods for solving such equations
3. To enable students acquire knowledge on partial differential equations and various methods for their solutions

4. To give the students a bit knowledge about Laplace transforms of elementary functions and its application in solving ordinary differential equations
5. To enable the students to acquire elementary knowledge of Fourier series
6. To help the students to acquire knowledge on calculation and interpretation of errors in numerical methods and various numerical methods to find solutions of differential equations, algebraic equations etc.
7. To give the students a bit knowledge about functions of complex variables

Course Outcomes

On completion of this course, the students will be able to

CO1. Define a real vector spaces, subspaces and various concepts on it
CO2. Extend the knowledge on ordinary differential equation
CO3. Find Series solution of differential equations by Power series method, Legendre's polynomials, and Bessels function.
CO4. Solve vibrating string problem, heat conduction problem, Laplace and beam equation using Lagrange's method, Charpit's method and Method of separation of variables for second order partial differential equations
CO5. Define Laplace transform and Fourier transform and obtain solutions of ordinary differential equations
CO6. Illustrate various numerical methods with examples to obtain numerical integration and solutions of algebraic and transcendental equations, differential equations
CO7. Find the errors in computation by numerical methods
CO8. Define analytic functions and study various concepts on it.

Catalog Description

The course is designed for students of various department like Economics, Physics, Chemistry etc. The focus of this course is to enable the students to apply basic Mathematical tools to learn other subjects easily. By taking this course student will gain the concept of sets and different properties of Vector spaces. This course is intended to provide knowledge about ordinary and partial differential equations. It also provide some tools/methods for solving different kind of ordinary and partial differential equations. Furthermore, some basic ideas about Laplace transform and Fourier transform of a given function are introduced in this course. It also includes some application of different kind of numerical methods to find solutions of algebraic and transcendental equations, differential equations, and numerical integration. Concepts on analytic functions and a few related concepts will be discussed in this course.

Course Content

Unit I **18 Lecture Hours**

Vector / linear space: Definitions and examples, subspace, linear combination, independence and dependence, linear span, basis, dimension of a vector space, null space, rank-nullity theorem (statement), linear transformation, translation, rotation, matrix representation of linear transformation, Eigen values and eigenvectors of matrices and their properties, Cayley-Hamilton, AM, GM, diagonalizations, quadratic forms, definiteness.

Unit II **15 Lecture Hours**

Advanced differential equation:
linear differential equations of order 2, homogeneous linear equations of arbitrary order with constant coefficients, non homogeneous linear equations with constant coefficients, Euler and Cauchy's equations, method of variation of parameters, system of linear differential equations. Series solution of differential equations, Power series method, Legendre's equation and Legendre's polynomials, Bessel's equation, Bessels function and its application

Unit III **15 Lecture Hours**

Partial differential equation of first order, Lagrange's method, some special types of equation which can be solved easily by methods other than general method, Charpit's method, Method of separation of variables for second order PDE, vibrating string problem, existence and uniqueness of solution of vibrating string problem, heat conduction problem, existence and uniqueness of solution of heat conduction problem, Laplace and beam equation, non-homogeneous problem.

Unit IV **17 Lecture Hours**

Laplace Transforms: Motivation, Definition, Linearity property, Laplace transforms of elementary functions, shifting theorem Inverse Laplace transforms of derivatives and integrals, Convolution theorem, Application of Laplace transforms in solving ordinary differential equations

Fourier series: Periodic functions, Euler's formulae. Fourier expansion of periodic functions with period 2, Dirichlet's conditions, Fourier series of even and odd functions, Fourier series of periodic functions with arbitrary periods, Half-range Fourier series.

Unit V **22 Lecture Hours**

Approximation and error in computation: Accuracy of numbers, error, types of error, round- off error, truncation error, error propagation, error in the approximation of a function, order of approximation.

Solution of algebraic and transcendental equations: Bisection method, false position method, fixed-point iteration method, secant method, Newton's method and its convergence.
Numerical integration: Newton-Cotes formula, Trapezoidal rule, Simpson's one-third and three-eight rules, Weddle's rule.

Numerical solutions of differential equations: Euler's method, Picard's method and Runge-Kutta method.

Unit VI **13 Lecture Hours**

Functions Of Complex Variables: Reorientation, Analytic function, Cauchy – Riemann equation (Cartesian and Polar forms), Harmonic functions, Conformal mappings, Complex integration, Cauchy's theorem and integral formula, Singularities, Taylor's and Laurent's Series theorem, Evaluation of integrals using residues

Reference Books:

1. B. S. Vaatsa, Theory of matrix, New Age Publication.
2. Hoffman and Kunze, Linear algebra, Pearson.
3. M.D. Raisinghania, Advanced Differential Equations,S.Chand.
4. M. D. Raisinghania, Ordinary and Partial Differential Equations, S.Chand.
5. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House 2002
6. B.S. Grewal , Numerical Methods in Engineering & Science with Programs in C & C++, Khanna Publications

Paper Name: **ELECTIVE CHEMISTRY I**
Paper Code: CHM11151
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To introduce important concepts required in the field of the course elective chemistry. This course gives students a thorough understanding regarding the prerequisites of basic chemistry knowledge in their course curriculums.
2. To introduce clear understanding of energy conditions necessary to execute a feasible chemical reaction.
3. To impart the basic notions of different properties of liquid states of chemical compounds and their effects with atmosphere.
4. To impart the concepts required for kinetics of a reaction mechanism and deeper understanding of the molecular interactions which can influence chemical reactivity. Students can understand the various kinds of reaction mechanisms occurring in their daily life cycle.
5. To learn the basic understanding of atomic structure of molecules important in our daily life and how nuclear reactions are pertinent to their structure.
6. To conceptualize the essence of molecular bonding of necessary molecules.

Course Outcomes:

On completion of this course, the students will be able to

CO1: **Learn** to recognize the exclusive terminologies associated with thermodynamics and explain the basic concepts of thermodynamics i.e. heat transfer and its consequences with the thermodynamic system.

CO2: **Understand** to explain the difference between what the molecules are doing in a solid, liquid, and gas, including movement, spacing, and organization, and how this explains the physical characteristics of these states.

CO3: **Understand** the properties of solutions that depends on the number of dissolved particles in solution, but not on the identities of the solutes.

CO4: **Learn** the concept of reaction rates and be able to use to predict products, yields etc.

CO5: **Understand** the concept of using the symbols for protons, neutrons, electrons, positrons, alpha particles, beta particles, and gamma rays.

CO6: **Recognize** the periodic properties of elements, principles in molecular theory and bonding models to the study of inorganic compound.

Course Description:

This course gives a detailed understanding of the basics of physical and inorganic chemistry required in other disciplines. This course will include expert instructors who will introduce thermodynamics of chemical reaction, colligative properties of liquid states, the structures of nucleus and subatomic particles and their relations with the chemical properties and especially molecular bonding of important molecules of our daily life. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical implementation of knowledge. Instructors will conduct theory classes by taking lecture as well as power point presentations, audio visual virtual lab sessions as perrequirement of the course. The tutorials and required assignments will acquaint the students with practical problem-solving techniques ledby the course coordinator. After finishing this course, students from different disciplines will strongly grasp the basic concepts of the subject via exercise anddiscussions with the coordinator.

Course Content:

Physical Chemistry-I

Unit- 1-Thermodynamics (10L)

Thermodynamics: Definition of thermodynamic terms; Concept of heat and work; First law of thermodynamics; Concept of enthalpy (H); Expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes; Concept of standard state, Standard enthalpy changes of physical and chemical transformations: fusion, sublimation, vaporization, ..-- solution, dilution, neutralization, ionization.; Hess's law of constant heat summation, Second law of thermodynamics; Heat engine; Carnot cycle and its efficiency; Entropy (S) as a state function. Spontaneous processes; Concept of Free Energy (G and A).

Unit-2-Liquid state: (4L)

Liquid States and Viscosity of Fluids: Nature of the liquid state (short range order and long range disorder); Physical properties of liquids; Vapor pressure, Surface tension; Surface energy, General features of fluid flow (streamline flow and turbulent flow); Coefficient of viscosity and their determination.

Unit-3: Colligative properties (6L)

Colligative Properties: What are colligative properties? Dependence of colligative properties; Freezing point depression; boiling point elevation, Raoult's Law and Vapor Pressure Lowering ; osmotic pressure.

Unit-4: Chemical kinetics (10L)

Chemical kinetics and catalysis: Order and molecularity of reactions; Rate laws and rate equations for first order and second order reactions (differential and integrated forms); Zero order reactions; Determination of order of reactions; Temperature dependence of reaction rate, energy of activation; Catalytic reactions: homogeneous and heterogeneous catalytic reactions. Enzyme catalysis

Inorganic Chemistry-I

Unit-I: Atomic structure (10L)

Extra-nuclear Structure of atoms, Bohr's model. quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many¬, electron atoms, Aufbauprinciple.

Unit-II: Chemical Periodicity (5L)

Classification of elements on the basis of electronic configuration; Positions of hydrogen and noble gases; Atomic and ionic radii; ionization potential; electron affinity; and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

Unit-III: Radioactivity and Nuclear Structure of Atoms (5L)

Natural radioactivity, group displacement law, law of radioactive decay, half-life of radio elements. Atomic Nucleus: Stability of 'atomic nucleus, nuclear binding energy,Nuclear reactions: fission, fusion, transmutation of elements.

Unit-IV: Chemical Bonding (10L)

Ionic Bonding: General characteristics of ionic compounds; Lattice energy; Born Haber cycle. Covalent bonding: General characteristics of covalent compounds; valence-bond approach, directional character of covalent bond; hybridization involving s-, p-, d orbitals; multiple bonding; Valence Shell Electron Pair Repulsion (VSEPR) concept; Partial ionic character of covalent bonds; Fajan's rules.Hydrogen bonding and its effect on physical and chemical properties.

Reference Books:

1. D. A. McQuarrie and J. D. Simon: Physical Chemistry — A Molecular Approach
2.G. W. Castellan: Physical Chemistry
3. P. W. Atkins: Physical Chemistry
4. J. E Huheey, E. A. Keiter, R. L. Keiter: Inorganic Chemistry (Principle and structure and reactivity).
5. N. N. Greenwood, A. Earnshaw: Chemistry of the Elements
6. D. F. Shriver, P. W. Atkins, C. H. Langford: Inorganic Chemistry

Paper Name: **ELECTIVE CHEMISTRY LAB I**
Paper Code: CHM12152
Credit: **2**
LTP: **0-0-4**

Course Objectives

1. To introduce important concepts required in the field of the practical field of elective chemistry. This course gives students a detailed understanding of lab-based chemistry knowledge in their course curriculums.
2. To introduce hands on training of standard solutions essential in every practical courses.
3. To impart the elementary ideas of physical methods of determination of surface tension, viscosity of organic solvents and acid catalysed hydrolysis of ester.
4. To learn the basic quantitative methods of titration of alkaline mixtures using various indicators.
5. To learn the determination methods of ionization constant of a weak acid by conductometric method.
6. To introduce the pH metric determination procedure of neutralization of acid-base titration.
7. To impart the determination method for rate constant of decomposition of H2O2 by acidified KI solution using clock reactions.

Course Outcomes: On completion of this course, the students will be able to

CO-1	To develop skills in the proper handling of apparatus and chemicals.
CO-2	To develop experimental skill of quantitative volumetric analysis and determination of physical properties of substances.
CO-3	The objective of the titration is the determination of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution.

Course Description:

This course gives a detailed understanding of the basics of chemistry lab techniques required in other disciplines. This course will include expert instructors who will introduce a detailed description of lab-based chemistry knowledges in their course curriculums, methods of determination of surface tension and viscosity of common liquids, correlation of theories of kinetics in the light of acid catalysed hydrolysis of ester, different quantitative methods of acid-base titrations using direct and pH mediated methods, determination of ionization constants of weak acids by conductometric titration and clock reaction mediated rate constant determinations. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical implementation of knowledge. Instructors will conduct demonstration classes by taking lecture followed by practical hands on training per requirement of the course. The tutorials and required assignments will acquaint the students with practical problem-solving techniques led by the course coordinator. After finishing this course, students from different disciplines will strongly acquire the hands-on training via experiencing practical lab sessions with the coordinator.

Course Content:

General Chemistry Lab: **(15 L)**

Preparation of Solution: Normal Solution; Molar Solution
Determination of surface tension of a given solution by drop weight method using a stalagmometer, considering aqueous solutions of NaCl, acetic acid, ethanol etc, as systems.
Determination of viscosity of organic solvents with Ostwald Viscometer at room temperature.
To determine the rate constant for the acid catalysed hydrolysis of an ester.

Inorganic Chemistry Lab:

Titration of Na4CO3 + NaHCO3 mixture vs HCl using phenolphthalein and methyl orange indicators.
Determination of ionization constant of a weak acid by conductometric method
Determination of neutralization point of the reactionbetween HC1 and NaOH with the help of pH meter .
Determination of rate constant of decomposition of H202 by acidified KI solution using clock reactions.

References:

1. Palit, S.R., De, S. K. Practical Physical Chemistry Science Book Agency
2. Handbook of Inorganic Analysis (First Edition): U.N Dhur& Sons Private Ltd.
3. Das, S.C. Advanced Practical Chemistry:

Paper Name: **ELECTIVE CHEMISTRY II**
Paper Code: CHM 11153
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To introduce important concepts required in the field of the course advanced elective chemistry. This course gives students a thorough understanding regarding fundamental knowledge of various branches of chemistry.
2. To introduce clear understanding of regarding the stabilization of colloidal systems and how solution properties are affected with different dissolutions.
3. To impart the basic notions of chemical equilibrium.
4. To impart detailed descriptions of basic properties of organic molecules and their related reaction mechanism which play major roles in everyday life cycle.
5. To learn the elementary concepts of acid-base chemistry required for daily life chemistry.
6. To understand the major role of inorganic complexes in living organisms which are very essential concepts in the course curriculum of some disciplines.
7. To introduce important tools of different spectroscopic methods required in structure analysis of molecules.

Course Description:

This course gives a detailed understanding of the basics of physical, organic, bioinorganic and spectroscopic knowledge required in other disciplines. This course will include expert instructors who will introduce the importance of chemical equilibrium, property of colloidal states, preliminary concepts of organic chemistry, stereochemistry and some and their various mechanisms, basic bioinorganic chemistry and spectroscopic methods required in analysing chemical structures. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical implementation of knowledge. Instructors will conduct theory classes by taking lecture as well as power point presentations, audio visual virtual lab sessions as perrequirement of the course. After finishing this course, students from different disciplines will strongly grasp the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Physical Chemistry-II

Unit-I: Colloids **(5L)**

Colloids and crystalloids; classification of colloids; Preparation and purification of colloids; Properties of colloids: Brownian motion, peptization, dialysis, Tyndal effect and its applications. Protecting colloids, Gold number, Isoelectric points, Coagulation of colloids by electrolytes, Schulze-Hardy rule

Unit II: Chemical and Ionic equilibrium **(10 L)**

Concept of Gibbs Free Energy; Criteria for thermodynamic equilibrium and spontaneity of a process; Chemical equilibria of homogeneous and heterogeneous systems, Derivation of expression of equilibrium constants; Temperature, pressure and concentration dependence of equilibrium constants (Kp, K. Kx); Le Chatelier's principle of dynamic equilibrium.Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).Concept of salt hydrolysis; Buffer solution and buffer capacity.

Organic Chemistry I

Unit-I:

Fundamentals of Organic Chemistry and Stereochemistry: **(5L)**

Functional group-based classification and nomenclature; Sources I origin of different compounds; Concept of hybridization; resonance (including hyperconjugation); inductive effect; steric effect; steric inhibition of resonance. Orbital pictures of bonding (spa, sp^2, sp: C-C, C-N & C-O system).

Stereochemistry: Symmetry elements, Molecular chirality, Concept of Stereo Centre, Representation of molecules in Fischer projection, Concept of E/Z and Cis-Trans stereo-isomers.

Unit-II: **(3L)**

Mechanistic classification: ionic, radical and pericyclic; heterolytic and homolytic bond cleavage and bond formation; representation of mechanistic steps using formalism. Reactive intermediates: carbocations (cabenium and carbonium ions), Carbanions, Carbon radicals, Carbenes-structure using orbital picture, Electrophilic/nucleophilic behaviour, Stability, generation and fate (elementary idea); Nucleophilic and electrophilic substitution reaction (only spcentre); Introduction to Elimination reaction and its types.

Unit-III: **(7L)**

Basic Organic Reactions:(Addition, Substitution, Elimination, Rearrangement Reactions) Addition Reactions: Halogenations, Hydration, Hydrogenation, Epoxidation, Hydroxylation, Ozonolysis, electrophilic addition to diene; Hydroboration-oxidation reaction; Radical addition: HBr addition, Birch Reduction. Nucleophilic addition to carbonyl group.

Substitution Reactions: SN 1 , SN2, NGP, Elimination Reactions: El, E2, Elimination vs. Substitution, Rearrangement Reactions: Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol-pinacolon and related rearrangements, dienone-phenol.

Inorganic Chemistry-II:15L

Unit-I: **(7L)**

Acids-Bases and Redox: Bronsted- Lowry concept of acid-base reaction, solvated proton, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle. Theory of acid-base titration and significance of Acid-base indicators.Common ion effect ;Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions; Nernst equation (without derivation);redox indicators

Unit-II: **(8L)**

Bioinorganic Chemistry:

Elements of life: essential major, trace and ultra-trace elements; Basic chemical reactions in the biological systems and the role of metal ions (specially Na+, K+, Mg2+,Ca2+, Fe3+, 12+ , Cu2+, R- ,and Zn2+);Biological functions of haemoglobin and myoglobin.

Spectroscopy: 15 L

Unit-I:

UV-Vis Spectra: Electronic transition, relative positions of k-max, Woodward's empirical rule; Labert-Beers Law.

Unit-II:

IR Spectra: Modes of molecular vibrations, application of Hooke's law, characteristic stretchingfrequencies and factors effecting stretching frequencies.

Unit-III:

NMR Spectra: Preliminary idea of NMR, Nuclear spin, NMR active nuclei, Equivalent and non-equivalent carbons and protons; Chemical shift 6; Shielding deshielding, Upfield and Downfield shifts.

Unit-IV:

Photochemistry: Fluorescence and phosphorescence; Quantum Yield; Jablonsky diagram

Reference Books:

Physical Chemistry:
1. D. A. Mcquarrie and J. D. Simon: Physical Chemistry — A Molecular Approach
2. G. W. Castellan: Physical Chemistry
3. P. W. Atkins: Physical Chemistry
Organic Chemistry:
1.D. Nasipuri: Stereochemistry of organic compounds: Principles and Applications
2.P. Sykes: A Guide to Mechanism in Organic Chemistry
3. R. T. Morrison and R. N. Boyd: Organic Chemistry

Inorganic Chemistry
1. Bioinorganic Chemistry. Asim K. Das.
Spectroscopy.
1. Organic Spectroscopy. William Kemp.

Paper Name: **ELECTIVE CHEMISTRY LAB II**
Paper Code: CHM 12154
Credit: **2**
LTP: **0-0-4**

Course Objectives

1. To introduce important concepts required in the field of the practical field of elective chemistry. This course gives students a detailed understanding of lab-based chemistry knowledges in their course curriculums.
2. To introduce hands on training of small instruments required for quantitative elemental determination.
3. To impart hand on training on qualitative determination of various acid and base radicals in inorganic complexes.
4. To introduce practical training on qualitative determination of functional groups present in an organic molecule.

Course Outcome:

On completion of this course, the students will be able to

CO-1	To acquaint students with various quantitative determination methods using small instruments.
CO-2	To detect qualitative determination of various acid and basic radicals in an inorganic complex.
CO-3	To identify various functional groups in the given organic compounds.

Course Description:

This course gives a detailed understanding of the basics of chemistry lab techniques required in other disciplines. This course will include expert instructors who will introduce a detailed description of lab-based chemistry knowledges in their course curriculums, methods of using small instruments like potentiometer, conductometer for quantitative titration,determination of acid and basic radicals in inorganic complexes and functional groups present in organic molecules. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical implementation of knowledge. Instructors will conduct demonstration classes by taking lecture followed by practical hands on training per requirement of the course. The tutorials and required assignments will acquaint the students with practical problem-solving techniques led by the course coordinator. After finishing this course, students from different disciplines will strongly acquire the hands-on training via experiencing practical lab sessions with the coordinator.

Course Content:

Practical IIa: **(15 L)**

1. Determination of E^0 of Fe^{+3}/Fe^{+2} couple in the hydrogen scale by potentiometric titration of ferrous ammonium sulfate solution using $KMnO_4$, or, $K_2Cr_2O_7$ as standard.

2. Determination of concentration of (i) $AgNO_3$ solution and (ii) solubility product of AgC1 by potentiometric titration of standard KC1 solution against $AgNO_3$ solution.

3. Detection of some acid and basic radicals present in water, soil etc.

Practical IIb: **(15L)**

1. To study the kinetics of inversion of sucrose using polarimeter.

2. Experiment A: Detection of special elements (N, Cl, and S) in organic compounds. Experiment B: Solubility and Classification (solvents: H20, dil. HC1, dil. NaOH) Experiment C: Detection of functional groups -NO2, -NH2, -COOH, carbonyl (-CHO, >C=0), -OH (phenolic) in solid organic compounds.

References:

• 1. Das, S.C. Advanced Practical Chemistry, Sixth edition

Paper Name: **ELECTIVE COMPUTER SCIENCE I**
Paper Code: CSE11641

Credit: **4**
LTP: **4-0-0**

Course Objectives

4. To understand the usage of computers in daily life applications.
5. To apply the Office productivity software applications in performing different tasks.
6. To understand about operating system about how it works.
7. To study about the different types of networks and their applications.

Course Outcomes

On completion of this course, the students will be able to

CO1: Describe the usage of computers and why computers are essential components in business and society.

CO2: Work effectively with a range of current, standard, Office Productivity software applications.

CO3:Evaluate, select and use office productivity software appropriate to a given situation

CO4: Utilize the Internet Web resources and evaluate on-line e-business system.

CO5: Solve common business problems using appropriate Information Technology applications and systems.

Catalog Description

This course introduces the student to the world of computers and their basics. It helps them to grasp knowledge about the different Office productivity software applications and their practical application scenarios. They become familiar with the basics of Operating System and its different types and also get knowledge about computer networks and their principal network components.

Course Content

Unit I: Knowing computer:

8 Lecture Hours

What is Computer, Basic Applications of Computer; Components of Computer System, Central Processing Unit (CPU), VDU, Keyboard and Mouse, Other input/output Devices, Computer Memory, Concepts of Hardware and Software; Concept of Computing, Data and Information; Applications of IECT; Connecting keyboard, mouse, monitor and printer to CPU and checking power supply.

Unit II: Operating Computer using GUI Based Operating System:

8 Lecture Hours

What is an Operating System; Basics of Popular Operating Systems; The User Interface, Status Bar, Using Menu and Menu-selection, Running an Application, Viewing of File, Folders and Directories, Creating and Renaming of files and folders, Opening and closing of different Windows; Using help; Creating Short cuts, Basics of O.S Setup; Common utilities.

Unit III: Understanding Word Processing:

10 Lecture Hours

Word Processing Basics; Opening and Closing of documents; Text creation and Manipulation; Formatting of text; Table handling; Spell check, language setting and thesaurus; Mail merge, Printing of word document.

Unit IV: Using Spread Sheet:

9 Lecture Hours

Basics of Spreadsheet; Manipulation of cells; Formulas and Functions; Editing of Spread Sheet, printing of Spread Sheet, Macro.

Making Small Presentation: Basics of presentation software; Creating Presentation; Preparation and Presentation of Slides; Slide Show; Taking printouts of presentation / handouts.

Unit V: Communications and collaboration:

15 Lecture Hours

Basics of electronic mail; Getting an email account; Sending and receiving emails; Accessing sent emails; Using Emails; Document collaboration; Instant Messaging; Netiquettes.

Unit VI: Introduction to Internet, WWW and Web Browsers: 5 lecture hours

Basic of Computer networks; LAN, WAN; Concept of Internet; Applications of Internet; connecting to internet; What is ISP; Knowing the Internet; Basics of internet connectivity related troubleshooting, World Wide Web; Web Browsing software, Search Engines; Understanding URL; Domain name; IP Address; Using e-governance website

Reference Books

1. Introduction to Computers with MS-Office, Leon, TMH
2. Personal Computer Software, EXCEL BOOKS
3. A First Course in Computers 2003, Saxena, VIKAS
4. Windows & MS-Office 2000, Krishnan, SCITECH

Paper Name: **ELECTIVE COMPUTER SCIENCE LAB I**
Paper Code: CSE12642
Credit: **2**
LTP: **0-0-4**

List of topics:

1. Introduction and familiarization with word with different type of stylings.
2. Table creation in and basic formatting.
3. Inclusion of image and editing image using Word and some basic designing features.
4. Example of Mail-merge.
5. Create spreadsheet with some basic calculation.
6. Creating Spreadsheet with some advance level formula and conditions.
7. Creating Macro in spreadsheet.
8. Creating colour conditioning in spreadsheet.
9. Creating different kinds of charts in spreadsheet.
10. Creating basic presentation.
11. Inclusion of different levels of animations in the presentation.
12. Project on Word.
13. Project on Excel.
14. Project on power-point.

Paper Name: **ELECTIVE COMPUTER SCIENCE II**
Paper Code: CSE11643

Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To understand the basic procedural programming skills.
2. To apply the conditional constructs to solution of different problems.
3. To understand the iterative way of programming.
4. To design solution to different problem scenarios using the programming constructs.

Course Outcomes

On completion of this course, the students will be able to

CO1: Understanding a functional hierarchical code organization.
CO2: Ability to define and manage data structures based on problem subject domain.
CO3: Ability to work with textual information, characters and strings.
CO4: Design algorithms to solve simple problems.
CO5: Demonstrate the ability to correct, test and debug Processing programs.

Catalog Description

This course introduces the students to the basics of programming skills. It familiarizes them with the procedural programming approach and design solutions to problems using conditional constructs, iterative programming and functions. They learn to create user-defined functions to solve different problem scenarios and grasp knowledge about string handling functions.

Course Content

Unit I:

8 Lecture Hours

Basics of C Programming: Characters used in C, Identifiers, Keywords, Data type & sizes, Constants &Variables, Different types of Operators, Standard Input/output functions.

Unit II:

8 Lecture Hours

Control Flow: Control Flow, if-else, switch-case, Loop Control Statements, for loop, while loop, do-while loop, nested loop, break, continue, goto label and exit( ) function.

Unit III:

15 Lecture Hours

Arrays: Definition, Single and Multidimensional Arrays, Representation of Arrays - Row Major Order, and Column Major Order, Application of arrays – searching and sorting, Sparse Matrices and their representations.

Unit IV:

9 Lecture Hours

String: Definition of a String, Declaration of a String, Initialization of a String, Various String Handling Functions with example.

Unit V:

10 Lecture Hours

Pointers: Definition of Pointer, Declaration of Pointer, Operators used in Pointer, Pointer Arithmetic, Functions with Pointer.

Unit VI:

5 lecture hours

Functions: Basic Concept of Function, Declaration or Prototype of Function, Types of Functions, Call by Value, Call by Reference, Recursion, Tail Recursion.

Reference Books

1. "The C Programming Language", 2nd Edition, Brian W. Kernighan, Dennis M. Ritchie, PHI
2. "Schaum's Outline of Programming with C", 2nd Edition, Byron S. Gottfried, Mcgraw Hill Education
3. "The Complete Reference", 4th Edition by Herbert Schildt, Tata Mcgraw Hill Education

Paper Name: **ELECTIVE COMPUTER SCIENCE LAB II**
Paper Code: CSE12644

Credit: **2**
LTP: **0-0-4**

Course Objectives

1. To understand the basic procedural programming skills.
2. To apply the conditional constructs to solution of different problems.
3. To understand the iterative way of programming.
4. To design solution to different problem scenarios using the programming constructs.

Course Outcomes

On completion of this course, the students will be able to

CO1: Identify situations where computational methods and computers would be useful.
CO2: Given a computational problem, identify and abstractthe programming task involved.
CO3: Approach the programming tasks using techniques learned and write pseudo-code.
CO4: Choose the right data representation formats based on the requirements of the problem.
CO5: Write the program on a computer, edit, compile, debug, correct, recompile and run it.
CO6: Identify tasks in which the numerical techniques learned are applicable and apply them to write programs, and hence use computers effectively to solve the task.

Catalog Description

This course introduces the students to the basics of programming skills. It familiarizes them with the procedural programming approach and design solutions to problems using conditional constructs, iterative programming and functions. They learn to create user-defined functions to solve different problem scenarios and grasp knowledge about string handling functions.

Course Content

List of experiments:

1. Introduction to C Programming
2. C program to implement different aspects of Control Flow
3. C program to implement different aspects of Arrays
4. C program to implement different aspects of String
5. C program to implement different aspects of Pointers
6. C program to implement different aspects of Functions

Reference Books

1. "The C Programming Language", 2nd Edition, Brian W. Kernighan, Dennis M. Ritchie, PHI
2. "Schaum's Outline of Programming with C", 2nd Edition, Byron S. Gottfried, Mcgraw Hill Education
3. "The Complete Reference", 4th Edition by Herbert Schildt, Tata Mcgraw Hill Education

Paper Name: **ELECTIVE STATISTICS I**
Paper Code: SDS 11506

Credit: **6**
LTP:**5-0-0**

Course Objectives:

The objective of this course for the graduate student of Physics is:

1. To provide a basic understanding of statistical data with preparation and presentation of data.

2. To develop the statistical concepts of the discrete and continuous variable or data and its various central and dispersion measures, regression, and correlation analysis with application in simple real life examples.

Course Outcomes:

On completion of this course, the students will be able to:

CO1: **Define** different types of statistical data, attributes, and variables (discrete and continuous) with frequency distribution. (r)

CO2: **Find** various measures of central tendency and dispersion for grouped and ungrouped data, regression lines and correlation coefficients. (r)

CO3: **Summarize**, collect**,** and present the different types of data graphically and numerically. (U)

CO4: **Compare** the results obtain from various central and dispersion measures, regression, and correlation Analysis. (U)

CO5: **Utilize** the concept of correlation and regression and its properties to obtain the solution of simple statistical/business/economics problems. (Ap)

Course Description:

Knowledge of basic statistics and methods is necessary to work on statistical data for the beginners of graduate students. This course gives an idea and understanding about the several statistical methods and measures are used to extract the information from various types of data comes from statistical problems. This course deals with data collection, preparation and presentation with frequency distribution, various measures of central tendency and dispersion, correlation, regression analysis, and its application in statistical problems. Classes will be conducted by lecture as well as power point presentation, audio visual session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques guided by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit-I **(10L)**

Collection and Scrutiny of Data

Statistical data: Primary Data and Secondary Data, Collection of Data, Presentation of data, tabular representation of data, Scrutiny of Data.

Unit-II **(14L)**

Frequency Distribution

Attribute and variable, Discrete variable and continuous variable, Frequency Distribution of an Attribute, Frequency Distribution of a variable, Case of a discrete variable, Case of a continuous variable, Graphical Representation of a frequency Distribution, Frequency curve.

Unit-III **(8L)**

Presentation of Data

Frequency data and non-frequency data, Textual presentation of Data, Tabulation of Data, Diagrammatic presentation of Data (Bar chart, pie diagram, Histogram, Ogives).

Unit-IV **(17L)**

Measures of Central Tendency:

Meaning of Central Tendency, Common measure of Central Tendency, Requirements of an ideal Average, Comparison of Mean, Median and Mode, Geometric Mean and Harmonic Mean, weighted Means.

Unit-V **(15L)**

Measures Of Dispersion:

Range, Mean Deviation, Standard Deviation, Quantiles and Percentiles, Quantile Deviation, Comparison of the Measures of Dispersion, Some important relations, Measures of relative Dispersion.

Unit-VI **(13L)**

Moments and Measures Of Skewness and Kurtosis:

Moments, Relationship between central and ordinary moments, Skewness, Kurtosis, Some important relations.

Unit-VII **(13L)**

Correlation and Regression:

Correlation: Scatter diagram, Karl-Pearson's correlation, concurrent deviation method, rank correlation, uses of correlation in business regression, regression lines, regression coefficients, properties of regression coefficients, Use of regression in business problems.

Books Recommended

T1. A.M. Goon, M.K. Gupta and B. Dasgupta (2005): *Fundamentals of Statistics*, Vol. I, 8th Ed., World Press, Kolkata

T2. S.C. Gupta and V.K. Kapoor (2007): *Fundamentals of Mathematical Statistics*, 11th Ed., Sultan Chand and Sons.

Reference book:

R1. N. G. Das (2009): Statistical Methods, combined edition (vol I & II), McGraw Hill Education (India).

Paper Name: **ELECTIVE STATISTICS II**
Paper Code: SDS 11507
Credit: **6**
LTP:**5-0-0**

Course Objectives:

This course aims to build up the advanced knowledge on the basic statistics. Here students will learn more tools and techniques which are useful for analyzing economic issues in real life. The difference between population and sample, why sampling is required for any study, has to be understood clearly before one delves into statistical analysis. In this paper students will get an idea of sampling theory and techniques, sampling distribution and its different forms, test of hypothesis and also learn business index numbers.

Course Outcomes

On completion of this course, the students will be able to

CO1: Recall basic terminologies of sampling, hypothesis testing.
CO2: Illustrate sampling distribution of statistics and test of significance for large sample and small sample.
CO3: Explain several methods of estimation to estimate population parameters.
CO4: Classify several types of index numbers to measure relative changes.

Course Description:

This course introduces basic concepts and techniques statistical theory. It emphasizes the intuitive logic that underlie the theory and techniques, and valid interpretation of the results obtained using the techniques. This course contains sampling techniques , estimation, test of hypothesis and index numbers.
All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Unit-I (8L)

Definitions of random sample, parameter and statistic, null and alternative hypotheses, simple and composite hypotheses, level of significance and probabilities of Type I and Type II errors, power of a test and critical region. Sampling distribution of a statistic, sampling distribution of sample mean, standard error of sample mean.

Unit-II (10L)

Large sample tests for single mean, difference of means, standard deviation and difference of standard deviations. Sampling distributions of chi-sq, t and F: definitions, properties and relationships between them. Tests of Significance based on Chi-square (goodness of fit and independence of attributes), t distribution and F- distribution using classical and p-value approach.

Unit-III (7L)

Methods of estimation: maximum likelihood, least squares and minimum variance, statement of Rao-Blackwell theorem and Lehmann-Schaffer theorem. Properties of maximum likelihood estimators (illustration). Interval Estimation: confidence intervals for the parameters of normal distribution, confidence intervals for difference of mean and for ratio of variances.

Unit-IV (5L)

Basic concept of index numbers – simple and weighted index numbers – concept of weights -types of index numbers – Business index number – CPT, WPI, Sensex, Niffy, Production Index.

Text book

T1. A.M. Goon, M.K. Gupta and B. Dasgupta (2003): *An outline of Statistical Theory* (Vol. I), 4th Ed., World Press, Kolkata.
T2. S.C. Gupta and V.K. Kapoor (2007): *Fundamentals of Mathematical Statistics*, 11th Ed., Sultan Chand and Sons.

Reference book

R1. V.K. Rohtagi and A.K. Md. E. Saleh (2009): *An Introduction to Probability and Statistics*, 2nd Edition, John Wiley and Sons.

Paper Name: **ELECTIVE BOTANY I**
Paper Code: BOT 11011
Credit: **4**
LTP: **4-0-0**

Course Objectives:

1. Students will be able to develop basic knowledge in plant science and also be able to explain various aspects of plant growth and development of lower group of plants;
2. Students will be able to explain intrinsic mechanism of plant growth and developments and their correlation with surrounding ecosphere as well biosphere;
3. Students will be able to develop fundamental knowledge and can be implemented agro techniques practices of economic important plant.

Course Outcomes: On completion of this course, the students will be able to

CO1. **Illustrate** in detail phycology in various aspects and also implementation of algal biotechnology for commercial purposes;
CO2. **Explain** and Categorize in detail various divisions of Fungi and their commercial importance as well harmful effects;
CO3. I**nterpret** basic knowledge and economic importance of Lichen;
CO4. **Compile** and summarize the basic concept of plant pathology and also can be able implement this knowledge in applied fields;
CO5. D**evelop** fundamental knowledge and can be implemented this skill for cultivation practices and commercial uses of economic important plant.

Catalogue Description

Elective Botany I lecture course covers a vast range of basic plant science including various branches of Botanical subjects. The course takes a broader approach and covers many aspects of lower group of plants as well physiological phenomena of all the plants community. Moreover, this curriculum covers cultivation practices of economic importance plants. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own perceive the knowledgeing strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content: (60 hours)

UNIT I (10 hours)

Algae: Introduction; habitat and range of thallus structure in algae; Principles of classification and outline classification of Lee (2009) up to divisions, Diagnostic characters of important algal family's examples, Algal genetics, Economic importance of algae, Bioreactor. Cultivation of algae and its prospects.

UNIT II **(10 hours)**
Fungi: Introduction; habitat, Basic classifications, Diagnostic characters of important families with examples, fungal genetics, Economic importance of fungi, Pathogenic and poisonous fungi.

UNIT III **(10hours)**
Lichen: Habitat and thallus structures; economic importance.

UNIT IV **(10 hours)**
*Plant Pathology:*Plant Diseases: Introduction and Definition; concepts of parasitism and saprophytism,Koch's postulates, Classification of plant diseases based on symptoms; Factors influencing infection, colonization and development of symptoms, Genetic basis of disease resistance and pathogenicity: gene for gene hypothesis; breeding for disease resistance, Brief idea about symptoms; disease cycles and control measures of: Loose smut of wheat, Citrus canker, Late blight of potato, Rust of wheat , Brown spot of Rice& Alternaria blight of Brassica.

UNIT V **(10 hours)**
Plant physiology: Transport in plants water and mineral uptake, Transpiration- Mechanism of stomatal movement, significance; Photosynthesis-types of photosystem, significance, cycles; Plant Growth regulators**.**

UNIT VI **(10 hours)**
Economic Botany: Introduction, Method of cultivation, processing and utilities of the products of the following: Rice, Tea, Jute and Brassica.

Text Books
1. Phycology by Robert Edward Lee
2. Introduction to Fungi by John Webster
3. Plant Pathology by G.N. Agrios
4. Plant Physiology by Lincoln Taiz, Eduardo Zeiger

Reference Books
5. College Botany Vol. II By Gangulee and Kar
6. Studies in Botany Vol I & II by J.N. Mitra, D. Mitra, S.K. Chaudhuri

Paper Name: **ELECTIVE BOTANY LAB I**
Paper Code: BOT12002
Credit: **2**
LTP: **0-0-4**

Course Objectives:
Upon completion of this course, students should be able to:

1. Explain a basic explaining of developmental terms and mechanisms of different plants.
2. Utilize laboratory techniques to design and carry-out experimental studies related to botany.
3. Convey and discuss experimental results via written assignments.

Course Content:

1.	Acquaintance with laboratory instruments –Microscope, Autoclave, Incubator, centrifuge, Analytical balance, pH Meter, Colorimeter, Water bath, Distillation plant, Laminar Air Flow operation etc.	**5 hours**
2.	S Study of the following genera and their identification: *Oscillatoria, Scytonema, Oedogonium, Chara,Ectocarpus, Polysiphonia.* (vegetative and reproductive structures).	**3 hours**
3.	Study of the following genera and their identification: *Rhizopus, Penicillium, Ascobolus, Agaricus, Polyporus.*	**3 hours**
4.	Identification of specimens with diseases prescribed in the theoretical syllabus: Loose smut of wheat, Citrus canker, Late blight of potato, Rust of wheat & Brown spot of Rice.	**4 hour**
5.	Chemical separation of photosynthetic pigments by paper chromatography.	**3 hours**
6.	Preparation of percent, normal, molal and molar solutions of any compound.	**4 hours**
7.	Comparison of imbibitions of starchy, proteinaceous and fatty seeds.	**6 hours**
8.	Determination of amount of water absorption, retention and transpiration.	**3 hours**

9.	Demonstration of Guttation.	**2 hours**
10.	Study of Monocot root.	**4 hours**
11.	Study of Dicot root.	**4 hours**
12.	Study of leaves anatomy of different plants.	**4 hours**

Paper Name: **ELECTIVE BOTANY II**
Paper Code: BOT12003
Credit: **4**
LTP: **4-0-0**

Course Objectives:

1. Students will be able to develop basic knowledge in higher groups of plants and also be able to explain various branches of Botany for explaining in details;
2. Students will perceive the knowledge practical implementations of various branches of plant science and their and commercial exploitations;
3. Students will be able to develop fundamental knowledge about surrounding ecosphere and biosphere and their corelations.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Students will be able to **illustrate** in detail about *Moses and Ferns*in various aspects and also their implementation for commercial purposes;

CO2. Students will be able to **explain** and Categorize in detail various divisions of *Gymnosperms* and their commercial importance as well harmful effects;

CO3. Students will be able to **infer** basic knowledge in Angiospermic plants and also be able to explain various divisions for explaining in details;

CO4. Students will be able to **construct** fundamental knowledge about surrounding ecosphere and biosphere and their corelations;

CO5. Students will be able to explain and **summarize** the basic concept of pharmacognosy and also can be able implement this knowledge in applied fields;

CO6. Students will be able to **develop** fundamental knowledge in plant biotechnology and can be implemented this skill for cultivation practices and commercial uses.

Catalogue Description

Elective Botany II lecture course covers a vast range of basic plant science. The course takes a broader approach and covers many aspects of higher group of plants as well fundamental knowledge of surrounding environments and their correlations. Moreover, this curriculum covers a practical approach for explaining implementation of gaining knowledge in industrial field. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own perceive the knowledgeing strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content: (60 hours)

UNIT-I (10 hours)

Moses and Ferns:

Bryophytes: Introduction, Basic classifications, Diagnostic characters of important families with examples, Economic importance.

*Pteridophytes:*Introduction, Basic classifications, Diagnostic characters of important families with examples, Economic importance.

UNIT-II (10 hours)

*Gymnosperms:*Introduction, Basic classifications, Diagnostic characters of important families with examples, Economic importance.

UNIT-III (10 hours)

*Angiosperm:*Brief ultra-structure of plant cell and tissues, Brief description of Plant Architecture (vegetative and reproductive parts); Taxonomic Definitions, principles, Outline of the system of classification with examples, Herbarium, ICBN(ICN), Diagnostic features of important angiospermic families.

UNIT-IV (10 hours)

Plant Ecology: Population and community ecology, Ecological Succession, Major Ecosystems and ecological adaptations, Environmental Pollution and its effects on plants, Biodiversity and conservation, Bio/Phytoremediation and their environmental significance.

UNIT V (10 hours)

Pharmacognosy: A brief idea about pharmacognosy, discuss about- active principles; Pharmacopeia and adulteration; Study of the following drug plants (Diagnostic features, active principles and uses): *Rauwolfia serpentina* (root), *Adhatoda vasica* (leaf), *Strychnos nuxvomica* (seed), *Cinchona succirubra* (bark), Business review of herbal industry.

UNIT VI (10 hours)

Plant Biotechnology: Plant Tissue Culture: Introduction, Composition of media; Nutrient and hormone requirements, Types, Applications, In vitro germplasm conservation;
Methods of gene transfer: Agrobacterium-mediated, Direct gene transfer methods;
Applications of Biotechnology: Problems and prospects of transgenic crops and their commercial utilizations

Text Books

1 Bhojwani S S & Dantu P K Plant Tissue Culture: An introductory text
2.Odum, E. P. 1971. Fundamentals of Ecology. W.B Sounders Co., Philadelphia
3. TrigianoR N & Gray D J Plant Tissue Culture, Development and Biotechnology

4. Trease & Evans: Pharmacognosy

Reference Books

1. College Botany Vol. II By Gangulee and Kar
2. Studies in Botany Vol I & II by J.N. Mitra, D. Mitra, S.K. Chaudhuri

Paper Name: **ELECTIVE BOTANY LAB II**
Paper Code: BOT 12003
Credit: **2**

LTP: **0-0-4**

Course Objectives:

1. Students will be able to explain and design with hands-on activities for applied plant science experiments in laboratory;
2. Students will be able to implement acquired knowledge in commercial field in crop improvement.

Course Outcomes

On completion of this course, the students will be able to

CO1. Students **develop** their skill by hands on training in laboratory Experiments on Imbibition in Plants

CO2. Students will be able to **design** and explain Root Pressure in Plants;

CO3. Students will be able to **explain** by performing Demonstration of opening & closing of stomata;

CO4. Students will be able to **compose** fundamental knowledge and can be implemented this skill for demonstrating Transpiration in Plants;

CO5. Students will be able to **illustrate** and explain Demonstration of respiration;

CO6. Students will be able to **elaborate** experiments for Osmosis in Plants;

CO7. Students **organize** their skill by hands on training in laboratory Experiments on performing Plasmolysis in Plants

CO8. Students **develop** their skill by hands on training in laboratory for Photosynthesis in Plants;

CO9. **Explain** the importance of plant growth and development by demonstration and hands on training;

CO10. Students develop their skill by **demonstration** and hands on training in laboratory basic techniques use for plant tissue culture;

CO11. **Perceive** the knowledge and develop the knowledge of using different modern tools and techniques in the field of biology which will help in their further academics.

Catalogue Description

Elective Botany practical is a skill enhancement course covers a vast range of basic as well applied implementation of knowledge in inherent metabolism of plants as well technical application for betterment for mankind. The course takes a broader approach and covers many spectra of plant physiological phenomena as well fundamental techniques in plant tissue culture using various technical parameters in laboratory scale which broadly covered by demonstration and hands on trainings.Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own perceive the knowledgeing strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content: **(45 hours)**

UNITI **(5 hours)**
Experiments on Imbibition in Plants

UNITII **(5 hours)**
Experiment on Root Pressure in Plants

UNITIII **(3 hours)**
Demonstration of opening & closing of stomata

UNIT IV
Experiments on Respiration in Plants **(2 hours)**

UNIT V **(5 hours)**
Experiments on Osmosis in Plants

UNIT V I **(5 hours)**
Experiments on Ascent of Sap in Plants

UNIT VII **(2 hours)**
Experiments on Plasmolysis in Plants

UNIT VIII **(3hours)**
Experiments on Photosynthesis in Plants

UNIT IX **(5 hours)**
Experiments on Plant growth

UNIT X **(5 hours)**
Basic plant tissue culture techniques: Media composition and Preparation of media Sterilization and contamination, Initiation of aseptic cultures from seed, isolated embryos and other explants

UNIT XI **(5 hours)**
Local Excursions and Field records

Text Books

1. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
2. Plant cell culture – A practical approach by Dixion RA. 1995

Reference Books

1. Practical Botany, Volume II, S C Samanta

Paper Name: **ELECTIVE ZOOLOGY I**
Paper Code: ZOL 11001
Credit: **4**
LTP: **4-0-0**

Course Objectives

1. To provide those students with some biology background with an introduction to zoology and the study of animals. This course is designed for students of any major, but will especially benefit biology majors, as well as secondary science education majors.
2. It will also provide an informative elective for 5-8 math/science education majors.
3. Gathering information about other organisms' structure and function, and how that compares to human beings, enables us to live a more knowledgeable, involved, and environmentally aware life in a science-conscious age.

Course Outcomes

On completion of this course, the students will be able to

1. Students will **explain** about the fundamentals of animal sciences, which helps them to explain the complex relations among various living organisms.
2. Students will be able to **illustrate** the course of evolution: i.e. how complex multicellular organisms develop from unicellular cells and correlate with other fields of biology.
3. Students will **compare** the basis of life processes in the non-chordates and chordates which helps them to identify the economically important organisms.
4. Students will able to know and **contrast** between acoelomate, pseudo-coelomate and coelomate.
5. Students will **develop** as lifelong perceive the knowledgeer about vertebrate and invertebrate organisms and animal ethical issues which contribute in greater benefit of humanity worldwide.

Course Description

Elective zoology I course will help to explain the behavior structure and evolution of animals. This course includes diverse approaches by studying animals and develop a better explaining of howwe, ourselves, function and interact with the world around us.All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniquesled by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

GE1: DIVERSITY OF LIFE FORMS (THEORY)(SEMESTER I)

Unit 1: Protista **3 Lecture Hours**

General characters of Protozoa; Life cycle of *Plasmodium*; Conjugation in *Paramoecium*.

Unit 2: Porifera **3 Lecture Hours**
General characters and canal system in Porifera.

Unit 3: Radiata **3Lecture Hours**
General characters of Cnidarians and polymorphism.

Unit 4: Acoelomates **3 Lecture Hours**
General characters of Helminthes; Life cycle of *Taenia solium*.

Unit 5: Pseudocoelomates **3 Lecture Hours**
General characters of Nemathehelminthes; Parasitic adaptations.

Unit 6: Coelomate Protostomes **4 Lecture Hours**
General characters of Annelida; Metamerism.

Unit 7: Arthopoda **4 Lecture Hours**
General characters; Social life in insects; Communication in Honey Bees.

Unit 8: Mollusca **4 Lecture Hours**
General characters of mollusca; Torsion in gastropoda.

Unit 9: Coelomate Deuterostome **4 Lecture Hours**
General characters of Echinodermata; Water Vascular system in Starfish.

Unit 10. Protochordata **4 Lecture Hours**
Salient features

Unit 11. Pisces **5 Lecture Hours**
Outline of classification; Parental care in Fish.

Unit 12. Amphibia **5 Lecture Hours**
General characters; Outline of classification; Paedogenesis.

Unit 13. Reptilia **5 Lecture Hours**
Amniotes; Origin of reptiles; Outline of classificationin reptiles.

Unit 14. Aves **5 Lecture Hours**
General characters; Flight adaptations

Unit 15. Mammalia **5 Lecture Hours**

Outline of classification; Dentition in mammals.

Reference Books

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
4. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi

Paper Name: **ELECTIVE ZOOLOGY LAB I**

Paper Code: ZOL 12002

Credit: **2**

LTP: **0-0-4**

DIVERSITY OF LIFE FORMS (PRACTICAL)

1. Identification and Classification of Any these of the following:

10 Lecture Hours

a. **Non-chordate specimens**: Scypha, *Obelia*, Sea-anaemone, *Ascaris*, *Hirudinaria*, Scorpion, *Bombyxmori*, *Achatina*, *Loligo*, Starfish, *Balanoglossus*.

10 Lecture Hours

b. **Chordate specimens**: *Branchiostoma*, *Petromyzon*, *Scolidon*, *Lates*, Axolotl larva, *Tylototriton*, *Gekko; Hemidactylus*, Turtle, *Naja*, Chiroptera.

10 Lecture Hours

2. Ecological Note – On any of the specimens in Exercise No 1.

15 Lecture Hours

3. Models of dissection of Cockroach - Cockroach: Digestive, Reproductive, Nervous System.

Reference Books

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
4. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi

Paper Name: **ELECTIVE ZOOLOGY II**

Paper Code: ZOL 11003

Credit: **4**

LTP: **4-0-0**

Course Objectives

1. To provide those students with some biology background with an introduction to ecology and the study of evolution. This course is designed for students of any major, but will especially benefit biology majors, as well as secondary science education majors.
2. It will also provide an informative elective for 5-8 math/science education majors.
3. Gathering information about ecological community, biodiversity and its structure and function, and how evolutionary concepts and animal behavior enables us to live a more knowledgeable, involved, and environmentally aware life in a science-conscious age.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Know** about habitat and niche, ecotone, edge effect, ecological succession.

CO2. **Explain** the significance of energy flow inecosystem and ecological succession, variation and ecological process which implement changes in perceive the knowledgeing towards a sustainable development.

CO3. **Compare** and illustrate between population growth curves, life strategies.

CO4. Explain and **correlate** between different animal behaviour, bee dancing which follows future practice of ethical philosophies.

CO5. **Solve** the analytical problems on density, mortality, natality from fecundity tables and life tables and population genetics.

Course Description

This course covers ecological and evolutionary principles on population, community, ecosystem and biodiversity. The very nature of ecology and evolution requires students to view role of evolutionary process, animal behavior on modern human life. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniquesled by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1: Introduction to Ecology **4 Lecture Hours**

History of ecology, Autecology and synecology, Levels of organization.

Unit 2: Population **9 Lecture Hours**

Unitary and Modular populations.Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion.Exponential and logistic growth, equation and patterns, r and K strategies.Population regulation - density-dependent and independent factors.

Unit 3: Community **9 Lecture Hours**

Community characteristics: species richness, dominance, diversity, Ecotone and edge effect. Ecological succession with one example.

Unit 4: Ecosystem **8 Lecture Hours**

Types of ecosystems with one example in detail, definition, components, energy flow, food chain, food web, and ecological pyramids.

Unit 5: Historical review of evolutionary concept **5 Lecture Hours**

Lamarckism, Darwinism, Neo-Darwinism, Geological time scale.

Unit 6: Sources of variations and Population genetics **10 Lecture Hours**

Heritable variations and their role in evolution, Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies), Speciation.

Unit 7: Animal Behaviour **7 Lecture Hours**

Instinctive and perceive the knowledgeing behaviour, Fixed action pattern, Communication in honeybees (dance Language), Elements of Sociobiology: Altruism and selfishness.

Unit 8: Biodiversity **8 Lecture Hours**

Basic concept of Biodiversity, Biodiversity hotspots, Conservation of wild life- purpose & methods, concept of Biosphere Reserve, importance & strategies of wildlife conservation; conservation act and application. National park & Wildlife Sanctuary, Animal cruelty and prevention act.

Reference Books

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert Leo Smith Ecology and field biology Harper and Row publishers
5. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press
6. Ridley,M (2004) Evolution III Edition Blackwell publishing
7. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.

Paper Name: **ELECTIVE ZOOLOGY II LAB**
Paper Code: ZOL 12003
Credit: **2**
LTP: **0-0-4**

Course Objectives

1. To provide students with hands-on activities designed to encourage interest in the field of ecology and evolution, as well as promote greater explaining of the concepts presented in lecture.
2. Students will need to become proficient with calculations, analysis and applications of different types from the hypothetical / data provided.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Identify** and compare between fossil specimens and also perceive the knowledge how to construct phylogenetic tree and draw them.

CO2. **Explain** the importance of field trip and they will get more interest on the subject as they perceive the knowledge how to work in the field tripeffectively as an individual, and as a member or leader in diverse teams controlling ethical issues, in multidisciplinary settings which help him to work in international field.

CO3. **Perceive** the knowledge, calculate and analyse Shanon-Weiner diversity index for the same community.

CO4. **Solve** the analytical problems on Hardy-Weinberg Law by chi square analysis.

CO5. **Compare** and illustrate between survivorship curves of different types from the hypothetical/real data provided.

Course Description

This course covers laboratory and on field hands on techniques and study of ecology and evolution. The very nature of ecology and evolution lab requires students to perceive the knowledge, calculate and illustrate of real different types from the hypothetical / data provided for the community and also perceive the knowledge to construct phylogenetic tree and draw them. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session, on field excursion as per requirement. The tutorials will familiarize the students with practical problem-solving techniquesled by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinaton.

Course Content

ELECTIVE ZOOLOGY II LAB

ECOLOGICAL PRINCIPLES, EVOLUTION AND BIODIVERSITY

10 Lecture Hours

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.

10 Lecture Hours

2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.

5 Lecture Hours

3. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

5 Lecture Hours

4. Study of fossils from models/ pictures.

10 Lecture Hours

5. Study and verification of Hardy-Weinberg Law by chi square analysis.

5 Lecture Hours

6. Construction of phylogenetic trees and its interpretation.

Reference Books

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
4. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi

SKILL ENHANCEMENT COURSE (SEC)

OPTIONS: COMPUTATIONAL SKILLS / BASIC INSTRUMENTATION SKILLS / WEATHER FORECASTING / RADIATION SAFETY TECHNIQUES

Paper Name: **COMPUTATIONAL SKILLS**
Paper Code: PHY11061
Credit: **2**
LTP: 2-**0-0**

Course Objectives:

1. Learn various computational methods to solve physical problems and gain insights from these exercises.
2. Use the computer language as a tool in solving physics / science problems.
3. Develop an idea about the scientific word processing and different editors
4. Learn plotting graph using suitable tools

Course Outcomes:

On completion of this course, the students will be able to

CO1: **To Recall** the basic concept of algorithm, flowchart and different components of a computer program.
CO2: **To Demonstrate**about the Linux operating system
CO3: **To Develop** the idea of advanced coding concepts based on Python programming.
CO4: **To Discover** the Python programming for data science.
CO5:**To Build** the idea about the scientific word processing such as Latex.
CO6: **To Improve** the plotting concept using suitable tools such as GNUPlot / Python

Module 1: Introduction and Recapitulation

Importance of computers in Physics, paradigm for solving physics problems for solution. Examples of Flowcharts: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. Discussion about the Floating-Point Numbers

Lecture 2 Hours

Module 2: Concepts of Linux Editor

Concepts of Operating Systems, Usage of Linux as an Editor, Some fundamental Linux Commands (Internal and External commands).

Lecture 5 Hours

Module 3: Advanced coding concepts based on Python

Scopes, namespaces, lists, tuples, dictionaries, sets, vectorization, recursion, Object Oriented Python: Classes, objects, encapsulation, polymorphism, inheritance, operator and function overloading.

Lecture 8 Hours

Programming:

1. Exercises on syntax on usage of PYTHON
2. Usage of Linux Commands, and working in an editor to write sources codes in Python.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1

Module 4: Python for Data Science

Uploading, streaming and sampling data streams, structured and unstructured data access, Use of NumPy and Pandas for data selection, filtering, visualization and other manipulations

Lecture 8 Hours

Module 5: Scientific word processing:

Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floating bodies, lining in columns- Tabbing and tabular environment, generating table of contents, bibliography and citation, making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

Lecture 4 Hours

Module 6: Visualization

Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.

Lecture 3 Hours

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.

8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

List of Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
4. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
5. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
6. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
7. Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn., 2007, Wiley India Edition.
8. Python for Data Science for Dummies, John Paul Mueller, 2nd Edition, Wiley Publisher

Paper Name: **BASIC INSTRUMENTATION SKILLS**
Paper Code: PHY11026
Credit: **2**
LTP: **2-0-0**

Course Objectives

1. To develop the capability of the students for understanding fundamental aspects of instruments used in laboratory.
2. To give students theoretical background, the key prerequisite for performing laboratory experiments.
3. To build up basic idea on analog and digital multimeter, voltmeter, CRO, AC bridge, signal generator etc. These ideas can upgrade student's understanding in proper channel, so that they can flourish their career path.
4. To explore every day phenomena of the macroscopic world from a scientific point of view.

Course Outcomes

On completion of this course, the students will be able to

CO1: Develop knowledge of Basic of Measurement and apply it in further study of experimental physics. Construct basic knowledge on working principal of multimeter.
CO2: Relate and illustrate the fundamental principles of electronic voltmeter/AC voltmeter and apply it in experimental physics.
CO3: Define and develop the concepts of cathode ray oscilloscope and apply it in experimental measurement
CO4: Define and analyse the fundamentals of signal generator
CO5: Define and explain the basic concepts of Impedance Bridges & Q-Meters and apply it in different relevant areas.
CO6: Develop the basic concepts of different digital instruments and apply it in practical situation.
CO7: Define, explain and estimate different feature of digital multimeter.

Catalog Description

In Basic Instrumentation Skills course, is a skill enhancement course, different aspects of experimental instruments and experimental measurements are enlisted to explain which are essential to perform any experiment. This information can be used for practical endeavours through a controlled Laboratory environment. In this course the focus will be on improving the logical learning moved into a physical environment. The analog and digital multimeter, voltmeter, CRO, AC bridge, signal generator etc. these basic field will be covered. We will combine traditional lectures with other active teaching methodologies like digital platform, group discussions, cooperative group solving problems. Course will be concluded with basic understanding of electronics which will make a background to perform electronics/electrical experiments.

Course Content

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

(4 Lectures)

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

(4 Lectures)

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

(6 Lectures)

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

(3 Lectures)

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

(4 Lectures)

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic(balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

(3 Lectures)

Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

(3 Lectures)

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

(3 Lectures)

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.

3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Paper Name: **WEATHER FORECASTING**
Paper Code: GEO11019
Credit: **2**
LTP: **2-0-0**

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.

(9 Periods)

Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

(4 Periods)

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

(3 Periods)

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

(6 Periods)

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

(8 Periods)

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
    (a) To calculate the sunniest time of the year.
    (b) To study the variation of rainfall amount and intensity by wind direction.
    (c) To observe the sunniest/driest day of the week.
    (d) To examine the maximum and minimum temperature throughout the year.
    (e) To evaluate the relative humidity of the day.
    (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis. 4. Formats and elements in different types of weather forecasts/ warning (both aviation and non aviation)

Reference books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
2. The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
4. Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
5. Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
6. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

Paper Name: **RADIATION SAFETY TECHNIQUES**
Paper Code: PHY11055
Credit: **2**
LTP: **2-0-0**

Course Objectives

1. To understand high energy radiation and its application in diagnostic and therapeutic purpose

2. To develop knowledge in design considerations for installation of high energy radiating devices.
3. To understand potential threats related to high energy radiation and their corresponding protective gears.
4. To understand the rules and regulations related to radiation techniques.

Course Outcomes

On completion of this course, the students will be able to

CO1: Students will be able to **define** and **illustrate** the guidelines of high energy radiation.

CO2: Students will be able to **comprehend** the effect of radiation on human cells and tissues.

CO3: Students will be able to **interpret**the working principle of devices used for radiation detection.

CO4: Students will be able to **explain**the routes of exposure, the risks associated with radiation exposure and why these must be kept "as low as reasonably practicable" (ALARP).

CO5: Students will be able to **compare** various techniques for applying radiation in diagnostic and therapeutic imaging.

Catalog Description

Radiation Safety Technique is an interdisciplinary course which is based on understanding radiation physics and its application in medical science. In Radiation Safety Technique, different aspects of safety protocols, guidelines for handling radiological and nuclear medicine instruments are covered in details. Through this course, students will be guided to understand dosimetry and learn about various types of dosimeters used by medical physicists.The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit I: Basics of Atomic and Nuclear Physics (6 L)

Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission.

Unit II: Interaction of Radiation with matter (7 L)

Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photoelectric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation. (7 Lectures)

Unit III: Radiation detection and monitoring devices(7 L)

Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Geiger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

Unit IV: Radiation safety management (5 L)

Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. (5 Lectures)

Unit V: Application of nuclear techniques (5 L)

Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterilization, Food preservation.

Reference Books:

1. Nuclear and Particle Physics by W. E. Burcham and M. Jobes, Harlow Longman Group, 1995.
2. G. F. Knoll, Radiation detection and measurement, 4th Edition, Wiley Publications, 2010.
3. Thermoluminescence dosimetry by A. F. Mcknlay, Bristol, Adam Hilger (Medical Physics Hand book 5)
4. Fundamental Physics of Radiology by W .J. Meredith and J.B. Massey, John Wright and Sons,UK, 1989.
5. An Introduction to Radiation Protection by A. Martin and S. A. Harbisor, John Willey &Sons,Inc. New York, 1981.

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

Paper Name: **ENGLISH LANGUAGE AND LITERATURE**
Paper Code: ENG 11057
Credit: **2**
LTP: **2-0-0**

Course Objectives:

1. To introduce the students to applied knowledge of English as a language

2. To give basic idea regarding the day-to-day usage of the language
3. To facilitate the students in various required writing techniques and skills
4. To give them the confidence to express themselves using basic communication skills of English as a language

Course Outcomes

On completion of this course, the students will be able to

1. **Explain** the ethical use of language at the work space
2. Recognizing the importance of language as lifelong process of learning
3. **Developing** the capability to work as a team.
4. **Identifying** their individual language related skills
5. **Describe** and develop the communication skills through speaking, reading and writing
6. Building perceptions for accommodating all sorts of opinions

Course Description:

English Language and Literature, is a foundational course for the students to sharpen their reading, writing, and speaking skills, using the language English. It would give them the confidence to speak their mind at a public form using English as the common language of communication and also would help them to perform extravagantly during any job interview on both national and international level. It would also train them in the basic applications of English as a language in their day-to-day lives at both formal and informal front.

Course Content:

Module 1: Communication a) Types of Communication b) Verbal and Non-verbal Communication c) Barriers and Strategies of Communication	

Module 2:

Grammar and Syntax

a) Subject-verb agreement
b) Conjunction
c) Articles
d) Prepositions
e) Editing
f) Idioms
g) One- Word Substitutions

Module 3:

Listening Skills

a) Active Listening
b) Types of Listening
c) Listening Exercises

Module 4:

Speaking Skills

a) Introduction
b) Extempore
c) Group Discussion
d) Mock Interview

Module 5:

Writing Skills

a) Composition
b) Paragraph
c) Letter writing- CV and application letter
d) Report Writing
e) Notice writing
f) Business Communication

Module 6:

Reading and Textual analysis

Reading Comprehension

Interpreting Graphics

Text Books

T1. Spoken English and Functional Grammar. P. C. Das.

T2. Essential Grammar in Use. Raymond Murphy

Reference Books

R1. Kaul Asha. *Effective Business Communication.* PHI Learning Pvt Ltd. 2014.
R2. Wren and Martin. *High School Grammar And Composition.* S. Chand, 1995.
R3. Lewis, Norman. *Word Power Made Easy*. Anchor: 2014.
R4. Riordan, Daniel G & Pauley Steven A. :*Technical Report Writing Today.* 2004.
R5. Hamp-Lyons and Heasely, B . *Study Writing; A Course in Written English. For Academic and Professional Purposes,* Cambridge Univ. Press, 2006.
R6. Quirk R., Greenbaum S., Leech G., and Svartik, J. *A Comprehensive Grammar of the English language*, Longman:London, 1985.

Paper Name: **ENVIRONMENTAL SCIENCE**
Paper Code: EVS11112
Credit: **2**
LTP: **2-0-0**

Course Objectives

1. To understand the intrinsic relation between humans and the environment, our position in the ecosystem around us
2. To comprehend the significance of the biodiversity surrounding us.
3. To figure out the importance and need for energy resources, various sources of energy, renewable and non-renewable sources, conventional and unconventional sources.
4. To have basic concepts about sustainability, our dependence on nature, and the consequences of overexploitation.
5. To enable students to appreciate the importance and how much we owe to the earth systems for our survival.
6. To have a basic concept about the types of pollution and mitigation procedures.
7. To have an overall idea about the environmental legal framework in our country and about the EIA and environmental audit procedures.

Course Outcomes: On completion of this course, the students will be able to

CO1: Compare between various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature.

CO2: Perceive the intrinsic relation between humans and the environment, our position in the ecosystem around us, and the importance of biodiversity.

CO3: Identify the presence of various pollutants, their significance, and impacts, and develop the underlying concepts involved in various air pollution prevention and mitigation measures.

CO4: Estimate the importance of natural resources including energy resources.

CO5: Relate to the legal framework in our country for safeguarding the environment including pollution prevention, control, management, and wildlife management.

Course Description:

To distinguish between various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature and feel connected, develop the concept of the innate relationship of humans and biodiversity, need for conservation, and different conservation strategies. The students will be developed in a way so that they can spontaneously comprehend the importance of studying the various air pollutants, their significance, and impacts, and develop the underlying concepts involved in various air pollution prevention and mitigation measures, understand fundamental water chemistry, deduce the relationship between various water pollutants, and understand the principles of various water and wastewater treatment procedures. They will understand the routes of generation, classification, management, and environmental significance of solid waste, apply the basic concepts of waste management in their daily lives, understand the need of the 5Rs of waste management, the importance of waste minimization.

Detailed syllabus

Unit I: Resources

Multidisciplinary nature of environmental sciences; scope and importance; need for public awareness; concept of sustainability and sustainable development

Forest resources: Function of forests, cause and effects of deforestation, case studies.

Water resources: distribution of water, hydrological cycle, use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies

Food Resources: World food problems and environmental concern, Food security, case studies

Energy resources: Concept of energy, SI Units of Work, Heat and Power, World energy use, Energy consumption pattern in India and U.S., Environmental aspects of energy utilization Renewable and non-renewable sources; Fossil fuel: types, use and environmental impacts, Solar energy: Solar Radiation – Passive and active solar systems – Flat Plate and Concentrating Collectors – Solar direct Thermal Application– Fundamentals of Solar Photo Voltaic Conversion-advantages and disadvantages of Solar Power generation, Solar energy status in India; Wind Energy: site selection, Wind turbine: basic working principle and types, Wind energy status in India, advantages and disadvantages of Wind Power generation; Hydroelectric power : How is it generated, advantages and disadvantages; Biomass energy: various types, generations of biofuel, Biogas plants, Bio diesel; Geothermal Energy: source, advantages and disadvantages, Nuclear Power: nuclear fission, moderation of reaction, nuclear reactor: pressurized water reactor, advantages and disadvantages

Unit II: Ecosystems and Biodiversity and its conservation

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Food chains, food webs and ecological pyramids, energy flow, ecological succession, Levels of Biodiversity: genetic, species and ecosystem diversity. Biogeographical classification of India, Values of biodiversity, Biodiversity at global, National and local levels, India as a mega-diversity nation, Biodiversity hotspots, Threats to Biodiversity, In-situ and Ex-situ conservation of Biodiversity

Unit III: Environmental Pollution and Waste Management

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, marine pollution; case studies. Nuclear hazards and human health risks.
Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes, Recycling of waste material. Waste minimization technologies.

Unit IV: Global Issues and Environmental Acts if India
Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, habitat loss, Holocene Extinction.
International agreements on Environmental conservation and pollution prevention.
Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. Waste Management Rules, 2016 and other important acts.

Text Books:

1. Principles of Environmental Science, 4th edition by Cunningham, W.P. and Cunningham, M.A. (2002), Tata McGraw-Hill Publishing Company, New Delhi

2. Basic Environmental Engineering & Elementary Biology by Monidranath Patra and Rahul Kumar Singha, Aryan Publishing house

3. Introduction to Environmental Engineering and Science, by Masters, G.M., Prentice Hall of India, Second Indian Reprint.

Reference Books:

1 Wastewater Engineering: Treatment and Reuse, 4th Edition, Metcalf and Eddy, Inc. McGraw-Hill, Inc., New York, 2002

2 Environmental Engineering", Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, McGraw-Hill Education (India) Private Limited, New Delhi

3 Introduction to Environmental Engineering, 2nd Ed. by Davis, M. L. and Cornwell D. A. McGraw Hill, Singapore.

4 Environmental Sciences: The Environment and Human Impact by Jackson, A.R.W. and Jackson, J.M., Longman Publishers

VALUE ADDED FOUNDATION COURSE

Paper Name: **DESIGN THINKING**
Paper Code: DGS11001
Credit: **2**
LTP: **2-0-0**

Course Objectives

1. To enable students to acquire knowledge, imagination and be more assertive on opinions on problems in society.
2. To enable students to learn basics of research, data collection, analysis, brainstorming to find solutions to issues.
3. To make them understand Design Thinking methodologies to problems in field of study and other areas as well.
4. To help students to understand future Engineering positions with scope of understanding dynamics of working between inter departments of a typical OEM.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Examine design thinking concepts and principles
CO2. Practice the methods, processes, and tools of design thinking
CO3. Apply the Design Thinking approach and model to real world scenarios
CO4. Analyze the role of primary and secondary research in the discovery stage of design thinking

Catalog Description

Design thinking course is a completely online course offered to the first year UG programs across all streams. This course is designed to help understand the steps followed in the process of designing a solution to a problem.

Course Content

UNIT I:WHAT IS DESIGN THINKING **2 hours**

Designers seek to transform problems into opportunities. Through collaboration, teamwork, and creativity, they investigate user needs and desires on the way to developing human-centered products and/or services. This approach is at the very heart of design thinking.

UNIT II: THE DESIGN THINKING MODEL 2 hours

A tool that helps guide you along a design thinking path. The model does this by providing a series of activities that that will help you effectively design a product, service or solution to a user's need. The model presents the approach as a process, allowing us to look at each step – or phase – along the journey to the development of a final design.

UNIT III: PHASE 1: DISCOVER 4 hours

Begin the design thinking process with the Discover phase, where you will identify the specific problem your design is intended to solve, as well as important usability aspects from those who will use your design. Discovery can be performed through a variety of different research methods which you will learn in this module.

UNIT IV: PHASE 2: DEFINE 4 hours

In the Define phase, you come to understand the problem. We often refer to this as framing the problem. You can do this by using a variety of tools, including storytelling, storyboarding, customer journey maps, personas, scenarios, and more.

UNIT V: PHASE 3: DEVELOP 4 hours

Turn your attention to solving the problem. In this phase you brainstorm custom creative solutions to the problems previously identified and framed. To do this, you conceptualize in any way that helps, putting ideas on paper, on a computer, or anywhere whereby they can be considered and discussed.

UNIT VI: PHASE 4: DELIVER 4 hours

This phase is all about testing and building concepts. Here you take all of the ideas that have been discussed to this point and bring them a little closer to reality by building a concept; something that makes it easier for a user to experience a design. This concept is referred to as a prototype.

UNIT VII: PHASE 5: ITERATE 4 hours

You will test the prototype of your design solution, collecting and acting on feedback received. These actions may mean minor or major revisions to your design, and are repeated as often as necessary until a solution is reached. Tools such as focus groups and questionnaires are used to help you collect feedback that can help with your final design.

UNIT VIII: BEYOND DESIGN THINKING 2 hours

The Design Thinking Model is a tool that helps guide you along a design thinking path. The model does this by providing a series of activities that that will help you effectively design a product, service or solution to a user's need. The model presents the approach as a process, allowing us to look at each step – or phase – along the journey to the development of a final design.

Text Books

1. All the references are available to download in the online course.

Reference Books

1. Brown, Tim. "What We Can Learn from Barn Raisers." Design Thinking: Thoughts by Tim Brown. Design Thinking, 16 January 2015. Web. 9 July 2015.

2. Knapp, Jake. “The 8 Steps to Creating a Great Storyboard.” Co.Design. Fast Company & Inc., 21 Dec. 2013. Web. 9 July 2015.
3. van der Lelie, Corrie. “The Value of Storyboards in the Product Design Process.” Journal of Personal and Ubiquitous Computing 10.203 (2006): 159–162. Web. 9 July 2015. [PDF].
4. Millenson, Alisson. “Design Research 101: Prototyping Your Service with a Storyboard.” Peer Insight. Peer Insight, 31 May 2013. Web. 9 July 2015.

Paper Name: **INTER DISCIPLINARY PROJECT**
Paper Code: IDP14001
Credit: **2**
LTP: **2-0-0**

Course Objectives	This course will develop a student's knowledge of and appreciation for the • interdisciplinary nature of knowledge and learning • importance and value of integrating knowledge and perspectives from multiple disciplines as a means to evaluating and understanding complex topics, problems, issues, phenomena, and events • competencies learned during the educational process and to apply these competencies in a real-world application
Course Outcomes	Upon successful completion of the course, students will be able to CO1. recognize the unique advantages of integrative research and learning CO2. understand the fundamentals of research methods and practices of various academic disciplines CO3. demonstrate an understanding of current issues and concerns CO4. realize the importance of ethics in research process CO5. understand the inter-disciplinary systems of research documentation
Typical Progress Roadmap	• After discussion with the Project Advisor(s), each student shallprepare an initial outline of their assigned project indicating the major sections of discussion, list the principal research sources for each section, and explain the overall objective of the project, including a justification of the interdisciplinary nature of the work. • Each student shall meet with the Project Advisor(s)regularly as per the weekly Time-Table. Other meetings may be scheduled at the discretion of the Project Advisor(s) at mutually agreed upon timings.

- Typically, the progress will include a combination of industrial and academic mentoring , self study sessions, case studies, trend studies, presentation by students, interactive sessions, industrial visits etc.
- Regular submission of progress reports shall be required of each student-group as notified through the Project Advisor(s) from time to time.

Mode of Evaluation	Students will be evaluated by team participation and a team presentation at the end of the project. Interactive & continuous, task/assignment- based evaluation methodology will be applied for the course.

Paper Name: **COMMUNITY SERVICE**
Paper Code: SOC 14100
Credit: **1**
LTP: **1-0-0**

Course Objectives

5. To familiarize the students on the concept 'giving back to the society'.
6. To familiarize the students on the issues faced by marginalized communities.
7. To provide an experiential platform to the students on any one or two issues as an internship.

Course Outcomes

On completion of this course, the students will be able to

CO1: Understand the concept of social responsibility through an internship.
CO2: Acquire hands on experience in 'giving back to the society' through the concept of social responsibility through an internship.

Catalog Description

Along with Intelligent Quotient, it is important for students to enhance their Emotional Quotient as well. The Social Internship offers opportunity to the student to be empathetic towards social issues facing our society. To help and support the affected community / cause through a field internship is the essence of the course in 'giving back to the society'.

Course Content

Unit I:
Introduction to the course. A brief on social issues facing the society with both global and Indian examples.

Unit II:
Minimum 24 hours of field work on a social issue and helping the marginalized / affected community / cause with photographs and testimonies.

Unit III:
Submission of individual reflection on the social service rendered.

The benefits that accrue to the students are

A.) Subjective

1. Psychosomatic benefits: Volunteering increases overall life satisfaction and also helps to relive stress and acts as an anti-depressant.
2. Intellectual benefits: Enhances knowledge through new experiences, and develops communication skills.
3. Career benefits : Enhances career prospects by acquisition of work-related skills, builds good references for employers and provides a forum to network with future potential employers. It also The experience allows gained helps students to take up leadership positions. Letters of recommendation can also be easily sought. Research shows that students who indulge in volunteer word perform better in studies as it invigorates their passion for learning
4. Personal benefits : Real world skills like leadership, problem-solving, collaboration with others, time management and communication skills, learn patience and empathy.
5. Connect learning to real world and enables deeper and lifelong learning.

B.) **Community**

1. Collective benefits: Strong interpersonal bonds are created, and leads to increased civic and social awareness and responsibility.

Further Reading :

1. Tadevosyan, Gohar&Schoenhuth, Michael. Participatory Research Approach : Principles, Challenges and Perspectives. http://ysu.am/files/01G_Tadevosyan_M_Schoenhuth.pdf
2. Bergold, Jarg& Thomas Stefan. Participatory Research Methods: A Methodological Approach in Motion http://www.qualitative-research.net/index.php/fqs/article/view/1801/3334

Plan of Work

1. Reading on social issues facing the society with both global and Indian examples.
2. Selecting an issue where the student wishes to contribute and wants to make a difference.
3. Areas - The internship may be broadly completed by getting in touch with NGO in your city / town / Police / Municipal Corporation / Local Gram Panchayat / Hospital / State Health Department / Women & Child Development Centre / CSR departments of Corporates /school / Old Age Home / Orphanage / Literacy Drive / Aanganwadi Centres / etc.
4. **Online Discussion –** Throughdiscussion, students elaborate their preferred area of work with reference to the Global Scenario and India. Reason for choosing that area also needs and resources of the people in their area of Social Internship and also submit the testimonials, which include signature of the authority where students initiated theirwork, or the signature of the authority in whose area students are currently working or photographs of work (photographs must include students working).

5. **Final Report Submission** - Submission of theTestimonials include signatures of the authorities you have worked with, or the signature of the authority in whose area you have worked or photographs of your work (photographs must include you working). Students' accomplishment in their area of operation along with the major successes student experienced and major challenges faced.
6. Students will submit the complete elaborated report along with testimonials and completion certificate in the form of signed Template

- The registration for all students will open twice, during winter and summer breaks. They may enroll for the internship in either of the two breaks.
- The student will have to submit a continuous record of their 10 to 15 days internship in the form of photographs and testimonies (wherever required).

Paper Name: **VENTURE IDEATION**
Paper Code: EIC11001
Credit: **2**
LTP: **2-0-0**

Course Objectives

1. To help the students understand the way to be an Entrepreneur
2. To identify the right business opportunity
3. To empower students to perform a technical feasibility study and thereby developing a prototype
4. To help students in identifying their customers using primary and secondary research methods.
5. Expose students to various factors of market and competition with the help of market feasibility study, forecasting techniques, business model canvass and insights about financial statements.
6. To prepare students with finalizing their entrepreneurial Portfolio

Course Outcomes

On completion of this course, the students will be able to:

CO1. Assess personal capacity in the context of the entrepreneurial process

CO2. Assess characteristics of successful entrepreneurs and entrepreneurial forms and processes

CO3. Apply resources, research and tools for Entrepreneurial ventures

CO4. Analyze and apply opportunity identification techniques, feasibility terminology, processes and models

CO5. Develop Ideation and planning documents for entrepreneurial venture

Catalog Description

Over the last decade, the core of our economy has been transitioning from one of industrial might, large monolithic corporations and mass production towards one of networks, flexible enterprises comprising many smaller units and unique value. This new economy is based on innovation originating in creativity and design; it is also disrupting long-standing and established employment patterns and bringing to the fore the importance of entrepreneurship. This core unit will bring together creativity, design and entrepreneurship at the conceptual and more practical level. It aims to explore the nature, determinants and consequences of creativity, design and entrepreneurship as well as the interaction between them.

Course Content

Unit 1. Introduction **6 hours**

Preview of the Course, Introduction to the Course, Guest Lecture with U.S. Secretary of Commerce Penny Pritzker – Meaning of Innovation, Entrepreneurial opportunities, Factors influencing the feasibility of an innovation, Innovation strategy: technology-push or market-pull, Product-market fit, How to develop a business model, Walkthrough of the business model canvas, Welcome to Innovation for Entrepreneurs: From Idea to Marketplace.

Unit 2. Customer Discovery and Validation **6 hours**

Customer types, Customer archetypes, Customer segments and business models, Customer segments, value propositions, product features, value mapping, interviewing customer, insights of your customers.

Unit 3: Product Understanding and Marketing. **6 hours**

Customer value, The DNA of customer-centricity, Crossing the chasm, Qualitative and quantitative marketing research, importance and methods of market segmentation, Focusing on the target market, Beyond the chasm, Strategic implications of beyond the chasm, E-commerce: The internet as a selling platform.

Unit 4. Prototyping and Testing. **6 hours**

Planning for prototyping, Rapid prototyping and development, Lean startup MVPs, Choosing a wire framing/UX prototyping tool, Anatomy of an experience map, What you'll learn from user testing, Analytics and insight, Troubleshooting your customer discovery, Levels of a product/service.

Paper Name: HUMAN VALUES AND PROFESSIONAL ETHICS

Paper Code: PSG11021

Credit: **2**

LTP: **2-0-0**

CourseObjecti ves

- To inculcatehumanvaluesandprofessionalethics instudents.
- Toenhance theunderstandingofstudents towardspersonal, professional&societalrelationshipsandachieveharmonyinlife.
- Todevelopmoralresponsibilitiesandethicalvision.

CourseOutco mes

At thecompletionof thecourse, thestudent shouldbeable to:

CO1.Understandtheimportanceofvalues,ethics,harmonyandlifelonglearninginpersonalandprof essionallife

CO2.Applytheknowledgetoperformself-explorationandtransformationaugmentingharmony,peaceandpositivityin thesurroundings

CO3.Appreciate thecorevalues that shapetheethical behaviorofaprofessional

Catalog Description

Thiscourseaims todevelopanunderstandingforamovementfrom rulebasedsocietytoarelationshipbasedsociety.Apartfromteachingvalues,thiscourseencouragesstudentstodiscoverwhatvaluesareforthemandforsociety.Self-explorationalsoenablesthemtocriticallyevaluatetheirpre-conditioningsandpresentbeliefs.It is designed in a way where students get familiar with the Ethical Code of Conduct, Ethical Dilemma, Conflict of Interest and all this will help them eventually in their professional life.

Course Content

UnitI:Introductionto Human Values: Character,Integrity,Credibility,MutualRespect,Dedication,Perseverance,HumilityandPerception.Self-Assessment&Analysis,SettingLifeGoals,ConsciousnessandSelf-Transformation.TeamWork,ConflictResolution,InfluencingandWinningPeople,AngerManagement,ForgivenessandPeace,Morality, Conscience.YogaandSpirituality

UnitII:Harmony and LifeLongLearning: Harmonyinhumanbeing,NatureandExistence.Harmonyinfamilyandsociety–Responsibilitiestowardssociety, Respectingteachers.TransitionfromSchooltoCollege-Freedom&Responsibilities, RespectingCultural Diversity, LearningbeyondtheClassrooms,Independentstudyandresearch

UnitIII: Introduction toProfessionalEthics: Work Ethics, Engineering Ethics, Moral Dilemma, Moral Development Theories, Ethical Theories-Kantinism,Utilitarianism, etc, Case Studies for Choice of the theory, Code of Ethics

UnitIV:Individual to Global Issues: Industrial Standards, A Balanced Outlook on Law, Safety, Responsibility, Rights, Confidentiality, Conflict of Interest, Occupational Crime, Whistle Blowing, Environmental Ethics, Business Conduct in MNC, E-Professionalism (IPR, Internet Ethics & Privacy issues)

Text Books

1. Shetty, FoundationCourse in Human Values and Professional Ethics[R.R. Gaur, R. Sangal, G.P. Bagaria]