P. E. Society's

Modern College of Arts, Science and Commerce Ganeshkhind, Pune-16 (Autonomous)

T.Y.B.Sc. (Physics)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2024-2025

Structure of the Course:

Semester	Course Type	Course Code	Course Name	Credit
V	Discipline Specific Course	24-PHY-351	Mathematical Methods in Physics-II	2
		24-PHY-352	Electrodynamics	2
		24-PHY-353	Classical Mechanics	2
		24-PHY-354	Atomic and Molecular Physics	2
		24-PHY-355	Computational Physics	2
		24-PHY-356 **Elective-I**	Biophysics	2
		24-PHY-357	Physics Laboratory-3A	2
		24-PHY-358	Physics Laboratory-3B	2
		24-PHY-359	Project-I	2
	Skill Enhancement Course	**24-PHY-3510: Skill Enhancement Course-I**		2
		24-PHY-3510	Python Programming	
		24-PHY- 3511: Skill Enhancement Course-II		2
		24-PHY-3511	Basics of Electrical Wiring	
VI	Discipline Specific Course	24-PHY-361	Solid State Physics	2
		24-PHY-362	Quantum Mechanics	2
		24-PHY-363	Thermodynamics and Statistical Physics	2
		24-PHY-364	Nuclear Physics	2
		24-PHY-365	Electronics- II	2
		24-PHY-366 **Elective-II**	Acoustics-II	2
		24-PHY-367	Physics Laboratory-4A	2
		24-PHY-368	Physics Laboratory-4B	2
		24-PHY-369	Project-II	2
	Skill Enhancement Course	**24-PHY-3610: Skill Enhancement Course-III**		2
		24-PHY-3610	Scientific Data Analysis using Python	
		24-PHY- 3611: Skill Enhancement Course-IV		2
		24-PHY- 3611	Radiation Physics	

Semester-V

T.Y.B.Sc. (Physics) (Sem-V)
PHY-351: Mathematical Methods in Physics-II

Lectures: 36 **(Credits-02)**

1: Curvilinear Co-ordinates (10L)

Review of Cartesian, spherical and cylindrical co-ordinate, transformation equation, General Curvilinear co-ordinate system: Co-ordinate surface, co-ordinate lines, length, surfaces and volume elements in curvilinear co-ordinate system.

Orthogonal curvilinear co-ordinate system, expressions for gradient, divergence, Laplacian, and curl, special case for gradient, divergence and curl in Cartesian, spherical polar and cylindrical co-ordinate system, Problems.

2: The Special Theory of Relativity (10L)

Introduction and applications, Newtonian relativity, Galilean transformation equation, Michelson-Morley experiment, Postulates of special theory of relativity, Lorentz transformations, Kinematic effects of Lorentz transformation, Length contraction, Proper time, Problems.

3: Partial Differential Equations (8L)

Introduction and applications of Partial differential equations (PDE), General methods for solving second order PDE, Method of separation of variables in Cartesian, Spherical polar and cylindrical co-ordinate system (two dimensional Laplace's equation, one dimensional Wave equation), Singular points ($x = x_0$), Solution of differential equation-Statement of Fuch's theorem, Frobenius method of series solution.

4: Special Functions (8L)

Introduction, generating function for Legendre Polynomials: $P_n(x)$, Properties of Legendre Polynomials, Generating function for Hermite Polynomials: $H_n(x)$, Properties of Hermite Polynomials, Bessel function of first kind: $J_n(x)$, Properties of Bessel function of first kind, Applications of Special Functions in Physics, Problems.

Reference books:

1. Mathematical methods for physicists, Arfken and Weber, Acadmic press Newyork, 7th Edition.
2. Mathematical physics, Rajput, Pragati prakashan-1997.
3. Mathematical methods in the physical sciences – Marry L. Boas, John Willy & Sons publication, 3rd Edition-2005.
4. Introduction to special relativity, Robert Resnick, John Wiley & Sons, Inc.-1968.
5. Mathematical physics, B. D. Gupta, Vikas publishing house Pvt. Ltd., 4th edition-2010.
6. Mathematical physics, H. K. Dass, Dr. Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition-2014
7. The Special Theory of Relativity: A Mathematical Approach-Farook Rahaman, Springer Publication -2014.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-352: Electrodynamics

Lectures: 36 **(Credits-02)**

1: Electrostatics **(12 L)**

- **a.** Revision of Coulomb's law, Gauss law, Electric field, Electrostatic Potential.
- **b.** Potential energy of system of charges.
- **c.** Statement of Poisson's and Laplace's equation, Boundary Value problems in electrostatics- **S**olution of Laplace equation in Cartesian system, Boundary conditions.
- **d.** Polarization **P**, Electric displacement **D**, Electric susceptibility and dielectric constant, bound volume and surface charge densities.
- **e.** Electric field at an exterior and interior point of dielectric.

2: Magnetostatics **(12 L)**

- a. Concepts of magnetic induction, magnetic flux and magnetic field.
- **b.** Magnetic induction due to straight current carrying conductor, magnetization of matter, relationship between **B, H** and **M.**
- c. Boundary conditions at the interface of two magnetic media (Normal and tangential components).
- d. Biot-Savart's law, Ampere's force law, Magnetic force between two current carrying loops, Ampere's circuital law.
- e. Equation of continuity, Magnetic vector potential **A,** Magnetic susceptibility and permeability.

3: Electrodynamics **(12 L)**

- **a.** Day to day applications of Electrodynamics.
- **b.** Concept of electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law.
- **c.** Maxwell's equations (Differential and Integral form) and their physical significance.
- **d.** Polarization, reflection and refraction of electromagnetic waves through media.
- **e.** Wave equation and plane waves in free space.
- **f.** Poynting theorem and Poynting vector.

Reference Books:

1. Introduction to Electrodynamics; D. J. Griffith; Cambridge India; Fourth edition (2020)
2. Classical Electrodynamics; J. D. Jackson; Wiley; Third edition (2007)
3. Introduction to Electrodynamics; A. Z. Capri, Panat P. V.; Alpha science international ltd; Illustrated edition(2002)
4. Foundations of electromagnetic theory; Reitz, Milford and Christy; Pearson education India; Fourth edition (2010)
5. Electrodynamics; Gupta, Kumar, Singh; Pragati Prakashan; Ninteenth edition (2011)
6. Electromagnetic field and waves; Paul-Lorrain, D. R. Corson; W.H. Freeman & co. Ltd; Second edition (1970)
7. Electricity and magnetism; Murugeshan; S. Chand; (2020)
8. Electromagnetic theory and electrodynamics; Satya Prakash; Kedar Nath Ram Nath; (2020)

T.Y.B.Sc. (Physics) (Sem-V)
PHY-353: Classical Mechanics

Lectures: 36 **(Credits-02)**

1: Motion of Particles **(8L)**

a. Charged Particles: Motion of a charged particle in constant electric, magnetic and electromagnetic field,
b. System of particles: Concept of Centre of mass, Conservation of linear momentum, angular momentum, energy of system of particles.(statements only)
c. Day to day applications of Classical mechanics,
d. Problems

2: Central force Field **(8L)**

a. Central force Field: Definition and Properties of central force field. Reduction of two body problem to an equivalent one body problem
b. Motion in central force field,
c. Kepler's laws of planetary motion and their proof
d. Artificial satellite and its orbit
e. Problems.

3: Scattering of particles **(10L)**

a. Elastic and inelastic scattering: Definition and properties,
b. Elastic scattering - Laboratory and center of mass system.
c. Scattering: Scattering angles in laboratory and center of mass system.
d. Differential cross-section, impact Parameter, total cross-section in brief.
e. Problems

4: Langrangian and Hamiltonian formulation **(10L)**

a. Limitations of Newton's Law of Motion,
b. Constraints and Their Classification, Example of Constrains, degrees of freedom, generalized coordinate, configuration space,
c. Principle of Virtual work done,
d. D'Almeberts Principle of virtual work,
e. Langrangian equation from D' Alembert's principle, cyclic coordinates,
f. Phase space, Hamiltonian's equations
g. Problems

Reference books:

1. **Classical Mechanics**, J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition of 2005.
2. **Introduction to Classical Mechanics,** R. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi.
3. **Classical Mechanics,** NC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, 1991.
4. **Classical Mechanics** by P.V.Panat.
5. **Classical Mechanics,** Herbert Goldstein, Narosa Publishing House.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-354: Atomic and Molecular Physics

Lectures: 36 **(Credits-02)**

1: Atomic structure **(6 L)**

1. Revision of various atomic models
2. Vector atom model (Concepts of space quantization and electron spin)
3. Pauli Exclusion Principle and electron configuration, Quantum states, Spectral notations of quantum states.
4. Problems

2: One and Two Valence electron systems **(12 L)**

1. Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na-atom, Selection rules, Spectra of sodium atom, Sodium doublet.
2. Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ-coupling schemes.
3. Singlet-Triplet separations for interaction energy of LS coupling, Lande's interval rule, Spectra of Helium atom.
4. Problems

3: Zeeman Effect **(4 L)**

1. Zeeman Effect
2. Experimental arrangement
3. Normal and anomalous Zeeman Effect
4. Stark effect (Qualitative discussion)
5. Applications of Zeeman effects
6. Problems

4: Molecular spectroscopy **(8 L)**

1. Introduction of molecular spectra and its types
2. Rotational energy levels, Rotational spectra of rigid diatomic molecule
3. Vibrational energy levels
4. Rotational and Vibrational spectra
5. Electronic spectra of molecules
6. Applications of UV-Vis spectroscopy
7. Problems

5: Raman spectroscopy **(6 L)**

1. History of Raman effect, Molecular polarizability
2. Classical theory and Quantum theory of Raman Effect
3. Characteristics Raman Lines and Applications of Raman spectroscopy
4. Problems

Reference books:

1) R. Murugeshan, Er. K. Sivaprasath, Modern Physics, S. Chand, 2014, Revised edition
2) Robert Eiseberg, Robert Resnik, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley, 2016, 2nd edition
3) G. Aruldhas, Molecular structure and Spectroscopy, PHI, 2015, 2nd edition
4) Colin Banwell, Elaine McCash, Fundamentals of Molecular Spectroscopy, TMH, 4th ed
5) Arthur Baiser, Concepts of Modern Physics , McGraw Hill International, 4th edition
6) White H. E, Introduction to Atomic spectra, McGraw Hill International

T.Y.B.Sc. (Physics) (Sem-V)
PHY-355: Computational Physics

Lectures: 36 **(Credits-02)**

1: Concepts of Programming and Introduction to C-programming: (14 L)

a) Definition and Properties of algorithms, Algorithm development, Flow charts- symbols and simple flowcharts.
b) Introduction and Structure of C-program, 'C' Character set, key words, Constants and variables, Variable names, Data types, qualifiers and their declarations, Symbolic Constants.
c) Input/output functions: scanf( ), printf( ), getchar(), putchar(), gets(), puts().
d) Operators and Expressions: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Conditional Operator.
e) Control statements: if, if else, while, do while, for loop, nested control structures (nested if, nested loops), break, continue, switch- case statement, goto statement.
f) Use of Library functions: e.g. mathematical, trigonometric, graphics.

2: Arrays, Pointers and user defined function in C-Language (8 L)

a) Arrays: 1-D, 2-D: Arranging numbers in descending and ascending order, Sum of matrices, multiplication of matrices.
b) Concept of pointers with suitable illustrative examples.
c) User defined functions: Definitions and declaration of function, function prototype, passing arguments (Call by value, Call by reference). Simple illustrative examples.

3: Graphics in C-Language: (3 L)

Concepts of graphics in C, Some simple graphic commands- Point, Line, Circle, Arc, Ellipse, Bar with suitable illustrative examples.

4: Computational Physics: (11 L)

Numerical Methods to solve the Physics Problems

a) **Iterative methods:** Bisection method and Newton-Raphson Method– Algorithm, Flowchart and writing C- program for finding the roots of the equation, problems
b) **Integration:** Trapezoidal rule, Simpson's $1/3^{rd}$ rule – Algorithm, Flowchart and C-program, problems

Reference Books:

1. Programming in C- (Schaum's series), Gottfreid, TMH
2. Programming in C- Balgurusami, Prentice Hall publications
3. Let us C- Yashwant Kanetkar, BPB publications
4. Programming with C- K.R. Venugopal, S. R. Prasad, TMH.
5. Introductory methods of numerical analysis-S. Sastry, Prentice Hall
6. Computer oriented numerical methods – V. Rajaraman.

PHY-356: Elective-I

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (C): Biophysics

Lectures: 36 **(Credits-02)**

1: Introduction of Biophysics **(13L)**

1.1 History of Biophysics, Concept of Biophysics and Physical properties applied to biology- Surface tension, Viscosity, adsorption, diffusion, osmosis, Definition for Biostatistics and Biometry

1.2 Cell: Animal and plant cell, types of cell, Functional aspects of cell membrane, cytoplasm, nucleus, mitochondria and chloroplast

1.3 Protein structure (Primary and Secondary), amino acid structure, Genetic code- symmetry, DNA structure

1.4 Photosynthesis process:- electron transport, Gibbs's free energy, Redox couple, Redox potential, Oxidation and reduction, Examples of redox potential in biological system.

2: Bio-potentials **(9L)**

2.1 Bioelectric signals: structure of neuron, resting potential, action Potential, Nernst equation

2.2 Bioelectrodes- Half-cell potential, polarizable and non-polarizable electrodes, Microelectrode- metal and glass electrodes

2.2 Study of Cardiovascular system, Compound action potential of human body-ECG (Electrocardiography), Electrodes for ECG

3: Bio-instruments **(6L)**

3.1 Basic principle, Construction and working of colorimeter, spectrophotometer, PH meter and Centrifuge measurement.

3.2 Electron Microscope: SEM, TEM.

4: Radiation Biophysics **(8L)**

4.1 Definition, Units of Radioactivity and radiation doses, Types of radiation (Ionizing and non- ionizing), radioimmunoassays.

4.2 Applications: PET (Positron Emission Tomography), NMR (Nuclear Magnetic Resonance), MRI (Magnetic Resonance Imaging Techniques), Ultrasonography, CT (Computed Tomography) Scan.

Reference books:

1. Introduction to Biophysics - by P. Narayanan.New Age P.
2. Medical Instrumentation - by Khandpur, TMH
3. Laboratory Manuals of Biophysics Instruments - by P.B. Vidyasagar
4. Biophysics -by Vatsala Piramal, Dominant Publisher and Distributors, New Delhi-110002
5. Textbook of Biophysics - by R.N. Roy
6. Photosynthesis - by Hall and Rao.
7. Introduction to Biomedical Equipment Technology (Fourth Edition) by-Joseph J.Carr
8. Text Book of Bio-medical Electronics-by S.S. Agrawal

List of Experiments : (Any 2)

1. Recording and analysis of ECG signals
2. Verification of Beer's and Lambert's Law
3. Absorption spectrum of Blood/Chlorophyll.
4. pH value of Amino acids.
5. Bimolecular model building using standard kits.
6. Separation of components of Milk/Chlorophyll using centrifuge machine.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-357: Physics Laboratory-3A

Lectures: 36 **(Credits-02)**

(General Laboratory, Electromagnetism, Atomic and Molecular Physics, and Optics)
(Any Eight)

GROUP-I: GENERAL PHYSICS (any FOUR)

1. Kater's pendulum
2. Moment of Inertia by Bifilar suspension
3. Young's modulus by Koeing method
4. Surface tension of mercury by ripple method
5. Surface tension liquid by Fergusson method
6. Surface tension of mercury by Quincke's method
7. 'Y' by vibration of wooden scale
8. Young's modulus by Newton's rings
9. Determination of wavelength of light by Michelson's interferometer
10. Study of damped oscillations of physical pendulum and finding log decrement

GROUP-II: ELECTROMAGNETISM (any TWO)

1. Study of forced oscillations by electromagnetically driven simple pendulum
2. Self-Inductance by Anderson's bridge
3. Core losses in transformers
4. Electromagnetic pendulum
5. Self-Inductance by Maxwell's bridge

GROUP-III: ATOMIC AND MOLECULAR PHYSICS AND OPTICS (any TWO)

1. Determination of Rydberg's constant
2. Zeeman Effect
3. Llyod's mirror
4. Determination of Resolving Power of grating
5. Determination of wavelength by Constant deviation spectrometer

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform **ten** experiments or **one** additional activities in addition to **eight** experiments mentioned above. Total laboratory work with additional activities should be equivalent to **ten** experiments.*

T.Y.B.Sc. (Physics) (Sem-V)
PHY-358: Physics Laboratory-3B

Lectures: 36 **(Credits-02)**

GROUP-I: EXPERIMENTS USING CRO/INSTRUMENTATION (any TWO)

1. Charging and discharging of capacitor and RC time constant
2. Measurement of g using simple pendulum
3. Velocity of sound
4. Radiation detection
5. IV Characteristics of diode
6. Measuring a value of a capacitor using CRO.
7. Temperature controller using AD590
8. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter.

GROUP-II: C-PROGRAMMING (any TWO)

1. Factorial of a number by simple and recursive method.
2. To find out the first 100 prime numbers
3. Matrix multiplication
4. Position time data using kinematic equations
5. Finding pressure using Van-der-Waals' equation of state

GROUP-III: COMPUTATIONAL PHYSICS (NUMERICAL BASED) (any TWO)

1. Roots of an algebraic equation (Bisection)
2. Roots of polynomial (Newton Raphson)
3. Numerical Integration by Trapezoidal rule
4. Numerical Integration by Simpson's 1/3 rule

GROUP-IV: PRACTICAL FROM OPTIONAL COURSE (Any TWO)

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-V)
PHY-359: Physics Project-I

Lectures: 36 **(Credits-02)**

Guidelines:

It is expected that,

1. The student does work equivalent to about ten (10) laboratory experiments throughout the semester in the third year.
2. One bears in mind that the project work is a practical course and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the final presentation at the time of viva voce.
6. It is also recommended that a teacher will look after Four (4) projects at one time.
7. Practical examination will be conducted semester wise.
8. The student can perform an Experimental/Theoretical/Computational Project in Physics or interdisciplinary areas under the supervision of one or more guides.
9. The student can learn the basics of the topic chosen for project, to learn how to do literature survey and set up the basic experimental/theoretical and computational techniques needed for the project.
10. The department encourage to students for projects both in experimental and theoretical areas of Physics in collaboration with other institutes and industry.

The Project work shall consist of the following Criterions.

1. Project work is mandatory for all the T. Y .B. Sc. students.
2. All the T. Y. B. Sc. students will be have to complete the Project work prescribed by the Board of Studies in Physics of Savitribai Phule Pune University during the V^{th} Semester.
3. The Project work shall consist of the following Criterions.
    - It is expected that students must finalize the Title of Project, Aim and objective, Significance, Literature survey, Materials required, Method and Application etc.
    - Introduction to foundations of Project Work.
    - Introduction of Project Research Methodology.
    - Study of Data Collection Methods.
    - Project Problem Writing and Presentation Skills.

Evaluation weightage:

- Project-I: Semester End University Examination : 35 Marks
- Internal Examination: 15 Marks

Skill Enhancement Courses

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (G): Python Programming

Lectures: 36 **(Credits-02)**

Pre-requisite : Basic mathematics (XII-Science)
Version of python : 3.4
Proposed IDE : Spider, Py Charm or Jupyter

Python Programming:

Python is one of the top ten popular programming languages. Python is a general purpose and high level programming language. You can use Python for developing desktop GUI applications, websites and web applications. Also, Python, as a high level programming language, allows you to focus on core functionality of the application by taking care of common programming tasks. The simple syntax rules of the programming language further makes it easier for you to keep the code base readable and application maintainable. There are also a number of reasons why you should prefer Python to other programming languages.

Advantages of Python Programming

i.) Readable and Maintainable Code
ii.) Multiple Programming Paradigms
iii.) Compatible with Major Platforms and Systems
iv.) Robust Standard Library
v.) Many Open Source Frameworks and Tools
vi.) Simplify Complex Software Development
vii.) Adopt Test Driven Development

Objectives:

i.) To build foundation for understanding Python environment to enhance computational skills.
ii.) Understand variables, input and output functions in python and To Apply computational skill in problem solving approach of Physics
iii.) Get exposure to arithmetic, assignment, relational, logical and Boolean operators.
iv.) Be familiar with Python modules and Libraries

Course outcomes:

After completion of this course student will be able

i.) To write code for complex scientific computational requirement.
ii.) Use Libraries like NumPy for numeric computation
iii.) Use Library SciPy for scientific and technological calculations
iv.) Use Library Matplotlib for plotting of graph and its visualization.
v.) Develop own functions for Physics or mathematics.

Syllabus

a) Python Programming:

Unit No.	Topic	Lectures
1	**Introduction to Python Programming Language**: Introduction to Python Language, • Strengths and Weaknesses, • IDLE, Dynamic Types, • Naming Conventions, • String Values, • String Operations, • String Slices, • String Operators, • Numeric Data Types, • Conversions, • Built In Functions	**03**
2	**Data Collections and Language Component:** • Introduction, • Control Flow and Syntax, • Indenting, • The if Statement, • Relational Operators, • Logical, • Operators, • True or False, • Bit Wise Operators, • The while Loop, break and continue, • The for Loop, Lists, • Tuples, • Sets, • Dictionaries, • Sorting Dictionaries, • Copying Collections.	**05**
3	**Functions and Modules :** • Introduction • Defining Your Own Functions Parameters • Function Keyword and Optional Parameters • Passing Collections to a Function • Variable Number of Arguments Scope • Functions Passing Functions to a Function • Mapping Functions in a Dictionary	**05**

	• Modules • Standard Modules – sys • Standard Modules – math • Standard Modules – time • The dir Function	
4	**Modules and packages in Python :** • NumPy, SciPy • MathPlot etc	**05**

Activity: **any- 6** **[18L]**

Sr. No.	**Practical/Demonstration to Communicate Concepts and Application in Physics, Electronics, Statistics and Mathematics**
1	Write python program to use basic math and string operations.
2	Write python program to find roots of quadratic equation, prime numbers etc
3	Write python program to store data in list and perform matrix operation
4	Write python program to do numerical methods
5	Write python program involving tuples, dictionaries in problems related to physics or mathematical concepts
6	Write python program to use random number generator as probability density to show expected value is 0.5 to explain quantum mechanical behaviour of particle in one dimensional well.
7	Write python program to use NumPy library for more complex arithmetic operations
8	Write python program to use complex numbers and complex algebra
9	Write python program to use bitwise operation
10	Write python program to plot graphs using mathplotlib or similar library

Reference books:

- Python Programming: Using Problem Solving Approach. By Reema Thareja.
- Think Python By Allen Downey
- Problem Solving and Python Programming By Balguruswami McGrow Hill
- Let Us Python By Aditya Kanetkar
- Learning with Python By Allen Downey
- Data Analytics By Bharti Motwani

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3511 SEC (K): Basics of Electrical wiring

Lectures: 36 **(Credits-02)**

Objectives:

This course is to get exposure with various aspects of Domestic Electric Circuits and their usage through hands-on mode.

Course outcomes:-

On completion of this course, the Students should be able to

1. Identify and understand the basic electrical components and circuits.
2. Understand and explain the materials used for switches and electrical circuits.
3. Know how the household wiring is done and what materials are required for household wiring.
4. Get basic knowledge of electrical circuits and accessories.

Syllabus:

Unit 1: Wring materials and types of wires **(5 L)**

1.1 Conducting materials
1.2 Insulating Materials
1.3 Semiconductor Material
1.4 Basic types of wires: Live, Neutral, Earth wire
1.5 Earthing: Purpose, method of earthing (plate and pipe) and selection of earth wire, Rules for earthing
1.6 Single and multi-strand wires
1.7 Types of cables: Ribbon electric, Shielded, Twisted pair, Fiber Optics and Polyvinyl Chloride cable, Data and Power Cables
1.8 Single phase and Three phase supply
1.9 Colour coding of cables

Unit 2: Tools for electrical wiring and wiring devices **(5 L)**

2.1 Wire strippers, Screw drivers, Pliers, Electrical Tape, Hacksaws, Wire Cutters, Spanners
2.2 Voltage tester- Multimeter
2.3 Types of switches and sockets
2.4 Fuse, Miniature Circuit Breaker (MCB)
2.5 Safety Measures

Unit 3: Basic Electrical Components and its circuit **(10 L)**

3.1 Resistor, Capacitor, Inductor
3.2 Open, Closed, Series and Parallel circuits
3.3 Ohm’s law, Conductivity and Resistivity
3.4 Kirchhoff’s Current Law and Kirchhoff’s Voltage Law
3.5 Circuit Theorems- Thevenin, Norton and Max. Power transfer

3.5 R-L and R-C Network, R-L-C Series & Parallel circuits Network
3.5 Voltage divider circuits
3.6 Work, energy, power- units
3.7 Semiconductor diodes- Rectifiers and Zener as voltage stabilizer
3.8 Energy Units and Energy Calculations

Unit 4: Electromagnetic Induction (10 L)

4.1 Introduction of electromagnetic induction
4.2 Electric and magnetic flux, Faraday's and Lenz's law
4.3 Self and Mutual induction
4.4 Transformer – Step up and Step down and its construction and working
4.6 AC and DC circuits
4.7 Single phase and Three phase motors (Fan and Water pump)

Reference Books:

1. A textbook of Electrical Technology volume I, basic electrical engineering by B.L Theraja and A.K. Theraja, S. Chand Publications
2. ITI electrician theory I and II: Priti Agarwal and Rahul Garg (Neelkanth publication)
3. Fundamentals of Electrical Engineering and Electronics by B.L. Theraja, S. Chand Publications
4. Circuits & Networks: Analysis & Synthesis, A Sudhakar, and Shyammohan S. Palli, Tata McGraw Hill publication
5. Concepts of Physics by H. C. Verma
6. Basic Electrical Engineering by Dr. K. Balachander , Notion Press

Semester-VI

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-361: Solid State Physics

Lectures: 36 **(Credits-02)**

1: The Crystalline Structures **(10 L)**

Lattice, Basis, Translational Vectors, Primitive Unit Cell, Symmetry Operations, Different types of lattices: 2D and 3D (Bravais lattices) Miller indices, Inter Planer Distances, SC, BCC and FCC structures, Packing Fraction, Crystal structures NaCl, diamond, CsCl, ZnS, HCP, Concept of Reciprocal Lattice and its properties, Problems

2: X ray Diffraction and Experimental Methods **(9 L)**

Bragg's Diffraction, Bragg's Law, Experimental X-ray diffraction Methods: The Laue Method, Bragg's Spectrometer, The Powder Crystal Method, Analysis of cubic structure by Powder Method, Ewald's Construction, Bragg's Diffraction condition in direct and reciprocal lattice, Problems

3: Free Electron and Band Theory of Metals **(9L)**

Assumptions of Classical and Somerfield Free Electron model, Energy levels and Density of States (One and Three Dimensions), Nearly free electron model, Fermi energy, Fermi level, Hall Effect, Mobility, Hall Angle

Band Theory of Solids: Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator, Problems

4: Magnetism **(8L)**

Diamagnetism, Langevin theory of Diamagnetism, Paramagnetism, Langevin theory of Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferromagnetic Domains, Hysteresis, Curie temperature, Neel temperature, **Superconductivity**, Day to day applications of Magnetism, Problems

Reference books:

1. Solid State Physics S.O.Pillai, 6th Edition, New Age International (P) Ltd, Publisher, (2010).
2. Solid State Physics – Kakani S.L. and Hemrajani C, 4th Edition, S. Chand Publication (2005).
3. Fundamentals of Solid State Physics – B.S.Saxena, R.C.Gupta and P.N.Saxena, Pragati Prakashan, Meerut , Uttar Pradesh
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics- A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Elementary Solid State Physics Principles and Applications, M Ali Omar, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.(2006)
8. Problems and Solution in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
9. Solid State Physics, P.K. Palanisamy, Scitech Publications(India) Pvt Ltd, Chennei, 1st Edition (2004)
10. Solid State Physics: Essential Concepts, David W. Snoke, 2nd Edition, Cambridge University Press

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-362: Quantum Mechanics

Lectures: 36 **(Credits-02)**

1: Origin of Quantum Mechanics (08 L)

1. Historical Background: Black body radiation, photoelectric effects.
2. Matter waves - De Broglie hypothesis. Davisson and Germer experiment.
3. Wave particle duality
4. Concept of wave function, wave packet, phase velocity, group velocity and relation between them
5. Heisenberg's uncertainty principle with Electron diffraction experiment, different forms of uncertainty.
6. Different fields of applications of quantum mechanics
7. Problems

2: The Schrodinger equation (10 L)

1. Physical interpretation of wave function
2. Schrodinger time dependent equation.
3. Schrodinger time independent equation.(Steady state equation).
4. Requirements of wave function.
5. Probability current density, equation of continuity, and its physical significance.
6. An operator in Quantum mechanics, Eigen function and Eigen values.
7. Expectation value, Ehrenfest's theorem (Only statements)
8. Problems

3: Applications of Schrodinger Steady state equation (14 L)

1. Free particle.
2. Step potential.
3. Potential barrier. (Qualitative discussion). Barrier penetration and tunnelling effect.
4. Particle in infinitely deep potential well (one - dimension).
5. Schrodinger's equation in spherical polar co-ordinate system.
6. Rigid rotator (free axis).
7. Problems

4: Operators in Quantum Mechanics (4 L)

1. Hermitian operator.
2. Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian).
3. Commutator brackets- Simultaneous Eigen functions.
4. Commutator Algebra
5. Commutator bracket using position, momentum and angular momentum operator
6. Concept of parity according to quantum mechanics, parity operator and its Eigen values.
7. Applications of Operators in Quantum Mechanics
8. Problems

Reference books:

1. Eisberg, Robert M., and Robert Resnick. *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*. Wiley, 1985. ISBN: 9780471873730.
2. Liboff, Richard L. *Introductory Quantum Mechanics*. Addison Wesley, 2002. ISBN: 9780805387148.
3. Griffiths, David J. *Introduction to Quantum Mechanics*. Upper Saddle River, Pearson Prentice Hall, 2005. ISBN: 9780131118928
4. Feynman, Richard P., Robert B. Leighton, and Matthew L. Sands. *The Feynman Lectures on Physics*. Addison Wesley, 1989. ISBN: 9780201500646.
5. P M Mathews and K Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw Hill publication, *ISBN*. : 9780070146174
6. N. Zettili, *Quantum Mechanics- Concepts and applications*, Wiley publication, *ISBN*: 978-0-470-02679-3
7. Ajoy Ghatak, S. Lokanathan, *Quantum Mechanics: Theory and Applications*, Springer Publication, *ISBN* 978-1-4020-2130-5
8. G Aruldhas, *Quantum Mechanics*, Phi Learning Private Ltd., *ISBN* : 97881203363
9. Shankar, Ramamurti. *Principles of Quantum Mechanics*. Springer, 2008. ISBN: 9780306447907.
10. Gupta, Kumar & Sharma, *Quantum Mechanics*, Jai Prakash Nath Publications.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-363: Thermodynamics and Statistical Physics

Lectures: 36 **(Credits-02)**

1: **Transport phenomenon and Maxwell's relations:** **(9L)**

Mean free path, Transport phenomenon, Viscosity, Thermal conductivity and diffusion.
Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function,
Derivation of Maxwell Relations, Specific heat and latent heat equations, Joule Thomson effect (Throttling Process), Problems

2: Elementary Concepts of Statistics: **(9L)**

Probability, distribution functions, Random Walk and Binomial distribution, Simple random walk problem, Calculation of mean values, Probability distribution for large-scale N, Gaussian probability distributions, Problems

3: Statistical Distribution of System of Particles and Ensembles: **(12L)**

Specification of state of system, Statistical ensembles, Basic Postulates, Probability calculations, Behaviors of density of states, Thermal, Mechanical and general interactions
Micro canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble, Molecules in Ideal gas, Calculation of mean values in canonical ensemble.
Problems.

4: **Introduction to Quantum Statistics**: **(6L)**

Quantum distribution function, Maxwell-Boltzmann's statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics, Comparison of the distributions. Applications of Quantum Statistics, Problems.

Reference books:

1) Lokanathan, R.S. Gambhir, Statistical and Thermal physics
2) F. Reif, Fundamentals of statistical and thermal physics
3) A. Beiser, Perspectives of modern physics
4) B.B. Laud, Fundamental of Statistical Mechanics
5) R.B. Singh, A primer of Statistical Mechanics
6) Gupta, Kumar, Statistical Mechanics

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-364: Nuclear Physics

Lectures: 36 **(Credits-02)**

1: Nuclear Structure, Properties and Radioactivity: (12 L)

a) Basic Concept of Nucleus:

- Composition, charge, size, density of nucleus(Revision)
- Nuclear Angular momentum,
- Nuclear magnetic dipole moment
- Electric quadrupole moment, Parity & symmetry,
- Mass defect and Binding energy, packing fraction,
- Classification of nuclei,
- Stability of nuclei (N Vs Z Curve)
- Day to day applications of Nuclear Physics
- Problems.

b) Radioactivity:

- Radioactivity disintegration (concept of natural and artificial radioactivity, Properties of α, β, γ-rays, Laws of radioactive decay, half-life, mean life, Specific activity and its units (Revision)
- Successive disintegration and equilibriums and radioisotopes.
- Radiocarbon dating
- Application of radioactivity (Agricultural, Medical, Industrial, Archaeological).
- Problems

Ref.(1) Ch.(2,3), Ref.(3) Ch.(3, 6)

2: Particle Accelerator and Radiation Detectors: (06 L)

a) Particle Accelerators:

- Introduction and Classification
- Linear Accelerator (electron/proton LINAC)
- Cyclic Accelerator (Cyclotron)
- Particle Accelerators In India (Discussion only)

Ref.(1) Ch.(12)

b) Nuclear Detector:

- Classification of Nuclear Detectors
- Gas filled Detectors (G. M. counter)
- Solid state detectors (scintillation counter)
- Problems:

Ref.(2) Ch.(4), Ref.(3) Ch.(7, 15)

3: Nuclear forces and Nuclear Models: (09 L)

a) Nuclear Forces:

- Classification of Nuclear Forces

- Meson theory of nuclear forces,
- Properties Of nuclear forces, properties of deuteron system,
- Elementary particles,

b) Nuclear Models:

- Quarks model for elementary particles
- Shell Model: Assumptions, Evidences, and Spin and Parity limitations.
- Liquid drop model: Assumptions
- Semi-empirical B.E. formula
- Problems:

Ref.(1) Ch.(9, 17, 18), Ref.(3) Ch.(18)

4: Nuclear Reactions and Reactor Theory: (09 L)

a) Introduction to Nuclear reactions:

- Nuclear Reaction, Conservation laws (Revision)
- The Q-value equation, Exothermic and Endothermic reaction
- Compound nucleus
- Threshold energy
- Nuclear cross-section
- Nuclear fission , nuclear fusion stellar energy, chain reaction and critical mass,

b) Reactor Theory:

- Nuclear reactor and its basic components, homogeneous and heterogeneous reactors, power reactor, fast breeders
- Nuclear Reactors In India (Discussion only)
- Problems.

Ref.(1) Ch.(14, 15), Ref.(3) Ch.(11, 13, 14)

Reference books:

1. Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014
2. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House.
3. K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988
4. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill
5. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989
6. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-365 (A): Electronics-II

Lectures: 36 **(Credits-02)**

1: Semiconductor Devices: **(9L)**

a. LED and Photodiode, Optocoupler. (Working Principles) Problems. Ref. 1.
b. BJT: Transistor amplifier classifications - Class A, B, C and AB (working only), Differential amplifier (transistorized), Problems. Ref. 1.
c. Field Effect Transistor: JFET (Introduction, classification, principle, working and IV characteristics) MOSFETs (DE-MOSFET and E only MOSFET). Problems. Ref. 1

2: Applications of Semiconductor Devices: **(9L)**

a. Three Pin Regulators: Block diagram of 3-pin IC regulator, study of IC-78XX, 79XX. Dual Power Supply using IC-78XX, 79XX. Ref. 1
b. Switching Regulators (SMPS): Introduction, Block diagram, Advantages and Disadvantages. Ref. 4
c. Modulation and Demodulation : Concept of Carrier Wave, Need of Modulation and Demodulation, Methods of Modulation like AM, FM, PM (Concepts Only),
d. Concept of Modulation Index, Upper and Lower Side Band Frequencies in AM. Problems, Ref.3

3: Integrated Circuits: **(9L)**

a. Integrated Circuits: Introduction, Scale of Integration, Advantages and drawbacks of IC Ref.4
b. OP-AMP Applications as Integrator, Differentiator, Comparator. Ref. 1
c. Timer IC-555: Block diagram, Astable, monostable multivibrator (working and design). Problems, Ref. 1

4: Combinational and Sequential Circuits: **(9L)**

a. Combinational Circuits: Introduction to SOP and POS equation. Concept of Standard SOP and POS equation. Concept of K-map and their use in reduction of Boolean expressions, design of half adder, full adder, half subtract, Study of binary to gray and gray to binary code conversion. Problems. Ref. 2
b. Sequential Circuits: RS flip flop using NAND/NOR, clocked RS, D, JK and T-flip flops. Application of flip flops in Sequential Circuits as Counters and Registers. Asynchronous and Synchronous Counters. (3-bit Counter), Shift Registers and their types of operation -SISO, SIPO, PISO, PIPO (Concepts only). Ref. 2

Reference books:

1. Malvino, Electronic Principles (6th Ed.), Tata McGraw Hill, New Delhi
2. R. P. Jain, Modern Digital Electronics (3rd Ed.), Tata McGraw Hill, New Delhi
3. B. L. Theraja, Basic Electronics - Solid State, S. Chand and Company, New Delhi
4. K. R. Botkar, Integrated Circuits, Khanna Publishers, Delhi

PHY-356: Elective-II

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (V): Acoustics-II

Lectures: 36 **(Credits-02)**

1: Microphones:
Carbon, Moving Coil and Condenser microphones: construction, equivalent circuit, expression for sensitivity (no derivation), constant pressure frequency response and sensitivity related problem-solving (6L)

2: Loudspeakers:
Direct radiator loudspeaker: construction, equivalent circuit, expression for efficiency (no derivation), acoustic power radiated; problem-solving relating to efficiency and acoustic power; Woofer, tweeter and squawker; Bass-reflex cabinet; Horn Loudspeakers: types, wave equation, cut-off frequency, folded horns, problem-solving relating to exponential horns and cut-off frequency (8L)

3: Sound systems, Recording and Reproduction:
Amplifier power specifications for auditoria: Power required for various applications, expression for power calculation; problem-solving related to power; Audio file formats: Lossy compressed (MP3, WMA), uncompressed (WAV, AIFF, AU); Dynamic range; Volume compressors, expanders, and limiters; Graphic equalizer; Monophonic and Stereophonic sound reproducing systems; Dolby Noise Reduction, Dolby Atmos (12L)

4: Environmental Acoustics:
Community noise criteria: Highway noise, aircraft flyover noise, sonic boom; Weighted sound levels: A-weighted sound level, C-weighting, Phon, Sone, Noise induced hearing loss: Trauma and chronic Hearing aids (6L)

5: Ultrasound: Ultrasound Transducers, Medical Ultrasound, Ultrasonography, Distance Measurement, NDT (4L)

Reference Books:

1. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
2. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
3. Acoustics, W.W. Seto, Schaum's Outline Series, McGraw Hill 1970
4. Handbook of Sound Engineers, G.M. Ballou, Academic Press
5. Basic Acoustics, D.E. Hall, Oxford University Press
6. Design for good Acoustics and Noise Control, J.E. Moore, Univ. Press
7. Consumer Electronics, S. P. Bali
8. Modern Electronics, A. B. Gupta, Books and Allied (P) Ltd

List of experiments (Any two):

1. Polar response of a microphone
2. Speaker response of a direct radiator loudspeaker
3. Graphic equalizer
4. Acoustic power of direct radiator loudspeaker using hemispherical array
5. Distance measurement using ultrasound transducer

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-367: Physics Laboratory-4A

Lectures: 36 **(Credits-02)**

(General Physics, Thermodynamics and Statistical Physics, Nuclear Physics and Quantum Mechanics)
(Any Eight)

GROUP-I: GENERAL PHYSICS (any FOUR)

1. Surface Tension of Mercury by method of Ripples.
2. Viscosity of Liquid by rotating cylinder method.
3. Coefficient of sound absorption
4. 'Y' by Cornu's Method
5. Hall Effect: To measure the Hall coefficient
6. Energy gap of a semiconductor
7. Study of XRD spectrum of any material.
8. Resistivity by Four probe method
9. Platinum resistance thermometer

GROUP-II: THERMODYNAMICS AND STATISTICAL PHYSICS (any TWO)

1. Determination of pressure coefficient of air by constant volume thermometer.
2. Verification of Stefan's fourth power law by bulb filament
3. Thermal conductivity by Forbes Method.
4. Thermal conductivity of rubber tube.
5. Thermal diffusivity of Brass.
6. Thermal and Electrical conductivity of Cu.

GROUP-III: NUCLEAR PHYSICS AND QUANTUM MECHANICS (any TWO)

1. Characteristics of G.M. tube
2. Inverse square law (γ-rays)
3. e/m by Thomson method
4. Determination of Planck's constant
5. Study of Gaussian distribution by G. M. tube.

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-368: Physics Laboratory-4B

Lectures: 36 **(Credits-02)**

(Electronics (Essential) or Advanced Electronics, acoustics and Lasers, Optional Courses)
(Any Eight)

GROUP-I: ELECTRONICS (ESSENTIAL) (any TWO)

(For the students not offering advance electronics in theory courses)

1. Characteristics of JFET
2. Design and built astable multivibrator using IC 555/IC 741
3. Half adder /Full adder
4. Integrator and differentiator using IC 741
5. IC 723 as regulated power supply

GROUP-I: ADVANCED ELECTRONICS (any TWO)

(For the students offering advance electronics in theory courses)

1. Instrumental amplifier using three op-amps
2. Temperature controller using PT 100 / thermocouple /thermistor temperature sensors
3. Object counter (two digit)
4. Schmitt trigger
5. Study of LVDT

GROUP-II: ACOUSTICS AND LASERS (any FOUR)

1. Frequency response of loudspeaker (twitter, woofer, mid-range)
2. Study of interference by Quinck's method
3. Use of Ultrasonic interferometer to measure velocity of sound in liquids
4. Transmission loss using expansion chamber muffler.
5. Study of diffraction using a transmission/reflection grating (metal ruler)
6. Study of the characteristics of a laser beam.
7. Determination of the diameter of a thin wire using a laser beam.
8. 'μ' By total internal reflection of light

GROUP-III: PRACTICAL FROM OPTIONAL COURSE (Any-2)

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-369: Physics Project-II

Lectures: 36 **(Credits-02)**

Guidelines:

It is expected that,

1. The student does work equivalent to about 10 laboratory experiments throughout the semesters in the third year.
2. One bears in mind that the project work is a practical course and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the presentation of the final report at the time of viva voce.
6. The viva voce should be conducted at the time of evaluation of project work at least for twenty minutes per student. Extra care must be taken in the evaluation of projects done in a pair or group. Delegation of the work done by individuals must be sought from the students in such cases.
7. Any ready-made material used in the report (such as downloaded pages from the web) must be clearly referred to and acknowledged.
8. It is also recommended that a teacher will look after 4 projects at one time.
9. Any non-adherence to this norm should attract a penalty by way of deduction in the marks awarded to a student. It is recommended that the College will provide consumables/contingencies for every project, to the tune of Rs. 750 /- each. (*If the students paid extra fee other than laboratory fee then college will provide financial assistance for the Project work.)

The Project work shall consist of the following Criterions.

1) Working model (Experimental or Concept based simulation/Demonstration Related to Physics).
2) Understanding of the project.
3) Experimental Details.
4) Data collection and Data Analysis.
5) Innovation.
6) Outcomes/Result.
7) Conclusion.

Note: At the time of project practical examination, the candidate must submit the certified project report by the project in-charge and HOD. A candidate will be allowed to appear for the Project practical examination only if the candidate submits a project completion report duly certified by the project in-charge and Head of the department.

The Project work shall include:

Models based / Demonstrated Applications / Review articles / Simulation on PC on any concept in Physics / Comparative & differentiative study / Improvement in the existing experiment (Design and fabrication concept) / Extension of any regular experiments / Attempt to make experiment open-ended / Thorough survey of existing active components / devices, ICs, methods, means, technologies, generations, applications etc. / any innovative projects using the concept of Physics / Interdisciplinary areas.

Evaluation weightage:

- Semester End University Examination : 35 Marks
- Internal Examination: 15 Marks

Skill Enhancement Courses

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-3610 SEC (U): Scientific Data Analysis using Python

Lectures: 36 **(Credits-02)**

Pre-requisite	: Basic knowledge of computer programming (Python/c)
Mode of internal Assessment	: A small project analysing scientific data for visualization
Data sets may include	: Pollution Data, Rain data, Astronomical data, any scientific data Related to Physics or science in general
Sources of Data sets	: MERI, Nashik, AIUCAA Pune, NASA or similar 1. Website for competition: https://www.kaggle.com/ 2. Google dataset: https://datasetsearch.research.google.com/ 3. Data for visualization and dataset resources: https://dev.to/aspittel/my-favorite-data-visualization-and-dataset-resources-35kp Other potentially useful searches: 1. https://bigdata-madesimple.com/70-amazing-and-free-data-sources-for-data-visualization/ 2. https://eduinpro.com/blog/data-sets-for-data-visualization-projects-datascience/

Learn how to analyses data using Python. This course will take you from the basics of Python to exploring many different types of data. You will learn how to prepare data for analysis, perform simple statistical analyses, create meaningful data visualizations, predict future trends from data, and more

Student will learn how to:

- Import data sets, access different elements of data frames.
- Understand the functions available in existing Python modules.
- Understand the utility of functions available in NumPy and Pandas library.
- Clean and prepare data for analysis
- Manipulate pandas Data Frame
- Understand awareness with different types of basic charts and functions in matplotlib library
- Get exposure to visualization techniques from seaborn library
- Build data pipelines

  Data Analysis with Python is delivered through lecture, hands-on labs, and assignments. It includes following parts:
- Data Analysis libraries: will learn to use Pandas Data Frames, Numpy multi-dimensional arrays, and SciPy libraries to work with a various datasets. We will introduce you to pandas, an open-source library, and we will use it to load, manipulate, analyze, and visualize cool datasets. Then we will introduce you to another open-source library, scikit-learn, and we will use some of its machine learning algorithms to build smart models and make cool predictions.

Outcome of the course

- Know basic notions and definitions in data analysis.
- Know standard methods of data analysis and information retrieval.
- Be able to formulate the problem of knowledge extraction as combinations of data filtration, analysis and exploration methods.
- Be able to translate a real-world problem into mathematical terms.

Syllabus:

Unit No.	Topics	Lectures
I	**Data Structures, modules and Importing Datasets** Lists: Creating list, accessing list elements, functions for lists, programming with lists Tuples: Creating Tuples, accessing list elements, functions for Tuples, programming with Tuples Dictionary: Creating Dictionary, accessing list elements, functions for Dictionary, programming with Dictionary. In Built modules : Math module, random Module, Array module, string Module etc	6
II	**Core libraries in Python** NumPy Library for Arrays Pandas Library for Data Processing Basics of data frames, create, adding/ deleting of rows, columns to data frames Import of data, functions of data frames Data Normalization Sets, data extraction using relational, logical operators. Group by functionality, missing values	6
III	**Summarizing the Data Frame and visualization** Matplotlib Library for visualization: Pie chart, violin plot, scatter plot, histogram, bar chart, area plot. Seaborn Library for Visualization: Box plot, point plot, line plot, count plot, bar plot, strip plot, scatter plot and Regression Plot	6

Activity: Hands on data Analysis and Visualization with Pandas [18L]

Note: For Internal assessment students will either do **any-6 activities** related to data analysis and visualization on particular dataset or will carry out small project on analysis or visualization using science (preferably physics) related dataset.

Reference Books:

- Python Programming: Using Problem Solving Approach - Reema Thareja.
- Let us Python - Aditya Kanetkar
- Learning with Pythob - Allen Downey
- Data Analytics - Bharti Motwani

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AA): Radiation Physics

Lectures: 36 **(Credits-02)**

Course Objectives:

1. Students should understand the mechanism of interaction of various types of radiations with matter.
2. Students should get acquainted with principles of Measurement radiation levels, design principles and and actual implementation of variety of radiation detectors.
3. Students should learn about standards regarding safety levels laid down by National and International agencies, methods adapted to maintain safety standards in various places and methods of shielding.
4. Students should study the applications of radiations in various fields.

Course outcomes:

1. Students can use the knowledge in the applications of Radiation Physics in the fields like radio carbon dating, medical diagnostic tools.
2. Students acquire skill in operating different types of radiation detectors to detect and measure radiation levels in different places.
3. Students can work as advisers in maintenance of radiation safety standards and following of strict protocols at various places like Hospitals, Industry, and Laboratories etc.
4. Students become able to employ their skills to develop applications of radio activity in the fields like agriculture, industry, hospitals etc.

Syllabus:

Unit No.	Title and Contents	Lectures
I	**Interaction of Radiation with Matter** Interaction of different types of radiation with matter-Ionizing & Nonionizing radiations, excitation, ionization, radioactive losses-Energy loss by collision, range energy relation, Bethe-Bloch formula collision stopping power, radiation stopping power, Straggling.	3
II	**Radiation Detectors** Characteristic curve of Gas-filled detectors. Ionization chamber, Proportional counter, Gas filled detectors (G. M. counter), Characteristics of organic and inorganic scintillation detectors, Scintillator detector, Semiconductor detector.	3
III	**Radiation units and Measurement of radiation exposure** Units for radiation exposure- Roentgen, Becquerel, Gray, Sievert, RAD, REM, KERMA. Radiation exposure, Absorbed Dose, Equivalent Dose, Effective Dose, Ambient and directional equivalent dose, Relative biological effective dose, Quality factor, Personal dosimeters, Film badge dosimeters, Thermo luminescent dosimeter.	3
IV	**Radiation Sources and Radiation Shielding** Natural & Artificial radioactive sources, Alpha, Beta, Gamma Sources, Basic concept of radiation shielding, linear and mass absorption coefficient, stopping power, materials for shielding of gamma and neutron, shielding interaction cross section.	3

V	**Radiation Protection:** Time, Distance, Shielding, Radiation Protection and Safety rules as per the regulatory guidelines of the Government of India, Safety codes for handling radioactive sources. Monitoring of radiation levels around an open radioactive source, ICRP, NCRP, AERB recommended limit.	3
VI	**Radiation Applications:** Radioactive pharmaceuticals and labelled compounds. Radioactive nuclei used in diagnostic applications. Applications of gamma-rays in sterilization of medical instruments, medication items and preservation of food.	3

Activity: any-6 [18L]

1. Study the different types of radio isotopes and their applications in medical field.
2. Study use of isotopes in radiocarbon dating.
3. Study of working of G. M. Counter.
4. Study of G. M. Counter characteristics – Dead Time and End point energy.
5. Study of commercially available portable, handy radiation detectors.
6. Survey of various places to measure radiation levels
7. Visit to hospitals and other such locations for measuring radiation exposure.
8. Visit to industrial areas to measure radiation exposure levels
9. Study of various shielding materials and their stopping power.
10. Study of dependence of radiation stopping power of materials on physical properties of materials
11. Study of protocols followed by various units to follow safety measures
12. Visit to food industry using preservation techniques using nuclear radiations.
13. Visit to pharmacy industry producing radioactive compounds.
14. Visit to diagnostic centres which employ radiation sources

Reference books:

1) Nuclear and Radiation Physics in Medicine. Tony Key. World Scientific. 2014
2) Introduction to Radiological Physics and Radiation dosimetry. Frank H. Attix. Wiley. 1986
3) Medical Physics by Glasser O, Vol 1, 2, 3 Year Book Publisher Inc Chicago.
4) Radiation Protection and Health Science. Marilyn E. Noz. World Scientific. 2007.
5) Introduction to Radiation Protection. Grupen C. Springer. 2008.
6) Radiation Physics for Medical Physicists. Podgorsak Ervin B. Springer. 2005.
7) Techniques for Nuclear and Particle Physics experiments. Leo. W. R. Springer. 2005.