Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

1990

'A' Grade
NAAC Re-Accredited
(4th Cycle)

Program Structure and Syllabus for

T.Y. B.Sc. As per NEP-2020 Pattern

With Effect from June - 2026

Submitted by Board of Studies (Physics)

Semester V Structure

Course	Course Type	Course Code	Course Title	Credits
DSC-10	DSC	PH-311	Mathematical Methods for Physics	2
DSC-11	DSC	PH-312	Classical Mechanics	2
DSC-12	DSC	PH-313	Solid State Physics	2
DSC-13	DSC	PH-314	Atomic and Molecular Physics	2
DSC-14	DSC	PH-315	Optics	2
DSC-15	DSC	PH-316	Laboratory-V	2
DSC-16	DSC	PH-317	Laboratory-VI	2
DSE-1	DSE	PH-318 (A)	Technical Electronics-I	2
		PH-318 (B)	Python for Physics-I	2
		PH-318 (C)	Sensors & Transducers-I	2
DSE-2	DSE	PH-319 (A)	Lab on PH-318 (A)	2
		PH-319 (B)	Lab on PH-318 (B)	2
		PH-319 (C)	Lab on PH-318 (C)	2
SEC-3	SEC	PH-320	Computational Physics	2
FP-1	FP	PH-321	Field Project corresponding to the Major Subject	2

Semester VI Structure

Course	Course Type	Course Code	Course Title	Credits
DSC-17	DSC	PH-322	Quantum Mechanics	2
DSC-18	DSC	PH-323	Nuclear Physics	2
DSC-19	DSC	PH-324	Statistical Thermodynamics	2
DSC-20	DSC	PH-325	Materials Science	2
DSC-21	DSC	PH-326	Laboratory-VII	2
DSC-22	DSC	PH-327	Laboratory-VIII (Simulation Based Practical)	2
DSE-3	DSE	PH-328 (A)	Technical Electronics-II	2
		PH-328 (B)	Python for Physics-II	2
		PH-328 (C)	Sensors & Transducers -II	2
DSE-4	DSE	PH-329 (A)	Lab on Technical Electronics-II	2
		PH-329 (B)	Lab on Python for Physics-II	2
		PH-329 (C)	Lab on Sensors & Transducers-II	2
VC-3	VSC	PH-330	Microcontrollers: Basics and application	2
VC-4	VSC	PH-331	Lab on VSC	2
FP-2	FP	PH-332	Field Project corresponding to the Major Subject	2

Special Notes:

1. The BOS has taken special efforts to assign a specific reference book to every unit in most of the courses. There are three main objectives behind this:

   (a) To present the topics in the unit in well-defined sequence,

   (b) To define the depth of every topic in the unit. The depth of the topic is expected to be the same as that in the given reference book,

   (c) To encourage the students, who wish to study the topics using reference books.

2. The reference books chosen are mostly available in soft-copy format on www.

3. The authors of the textbook are advised to refer to specific references defined for each unit, to know the expected depth/scope of the topic

4. A Study-tour of the students with major in Physics can be arranged as a part of the curricular activities.

5. **The contents for PH-321 and PH-323 given in this document are suggestive. The teachers are requested to strictly follow the guidelines given by the University in this regard.**

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Course Code: PH-311

Course Title: Mathematical Methods for Physics

Course Code: PH-311	**Course Category: Major Course (DSC)**
Course Title: Mathematical Methods for Physics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop understanding of complex numbers and their applications in physical sciences.
2. To introduce concepts of partial differentiation and their use in solving multivariable problems in physics.
3. To impart knowledge of multiple integrals and their applications in evaluating physical quantities.
4. To build a foundation in vector analysis for describing and analyzing physical systems in different coordinate systems.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Apply complex number techniques and elementary functions to solve problems in physics.
2. Use partial differentiation methods to analyze multivariable functions, including maxima and minima problems.
3. Evaluate double and triple integrals and apply them to compute physical quantities such as area, volume, and mass.
4. Utilize vector algebra and calculus to solve problems involving fields, gradients, divergence, and integrals in various coordinate systems.

Course Content:

Unit 1: Complex numbers and their application in Physics (7 Hours, 7 Marks)

Elementary Functions of Complex Numbers, Euler's Formula, Powers and Roots of Complex Numbers, Exponential, Trigonometric functions and Hyperbolic Functions, Logarithms, Complex Roots and Powers, Inverse Trigonometric and Hyperbolic Functions, Some Applications

Reference: Chapter 2: Mathematical Methods in Physical Sciences by Mary L. Boas

Unit 2: Partial Differentiation (8 Hours, 8 Marks)

Introduction and Notation, Power Series in Two Variables, Total Differentials, Approximations using Differentials, Chain Rule or Differentiating a Function of a Function, Implicit Differentiation, Application of Partial Differentiation to Maximum and Minimum

Reference: Chapter 4: Mathematical Methods in Physical Sciences by Mary L. Boas

Unit 3: Multiple Integrals (7 Hours, 7 Marks)

Introduction, Double and Triple Integrals, Applications of Integration; Single and Multiple Integrals,

Reference: Chapter 5: Mathematical Methods in Physical Sciences by Mary L. Boas

Unit 4: Vector Analysis (8 Hours, 8 Marks)

Vector Algebra, Differential Calculus, Integral Calculus, Curvilinear Coordinates

Reference: Chapter 1: Introduction to Electrodynamics David J. Griffiths

Reference Books:

1. Mathematical Methods in Physical Sciences by Mary L. Boas
2. Introduction to Electrodynamics David J. Griffiths
3. Advanced Engineering Mathematics by Erwin Kreyszig
4. Mathematical Physics by B. D. Gupta
5. Vector Analysis, Infinite Series and Special Functions by S. Lipschutz and M. R. Spiegel

Course Code: PH-312

Course Title: Classical Mechanics

Course Code: PH-312	**Course Category: Major Course (DSC)**
Course Title: Classical Mechanics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop a strong foundation in classical mechanics by reviewing fundamental laws of motion and various types of forces governing physical systems.
2. To understand the motion of particles under central force fields and analyze orbital motion including Kepler's laws.
3. To introduce advanced formulations of mechanics using Lagrangian and Hamiltonian approaches for solving complex dynamical problems.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Students will be able to explain and apply Newtonian mechanics, including different force laws and their limitations in physical systems.
2. Students will analyze motion in central force fields and derive equations of motion and orbital characteristics using appropriate mathematical tools.
3. Students will formulate and solve mechanical problems using Lagrangian and Hamiltonian methods, and interpret physical systems in terms of generalized coordinates and conservation principles.

Course Content:

Unit 1: Introduction to Classical Mechanics **(08L, 08M)**

What is classical mechanics?, The place of classical mechanics in Physics and some basic definitions, Newton's laws of motion: Law of Inertia, Law of causality, law of reciprocity, law of superposition, Force laws and corresponding motions: Hook's law, Newton's law of Gravitation, Lorentz's law of electromagnetic force, Law of constant force, Stoke’s law of viscous drag, Coulomb’s law of friction, Limitations of Newton's law

Reference: Classical Mechanics: N. C. Rana and P. S. Joag

Unit 2: Lagrangian formulations (12L, 8M)

Constraints, Holonomic and Non-holonomic constraints, Degree of freedom with examples, generalized coordinates, Concept of virtual displacement and vitual work, D'Alemberts principle, Lagrange's equation, simple application of Lagrange's equation (simple pendulum, harmonic oscillator), kinetic energy in generalized coordinates, generalized momentum, cyclic coordinates

References: Classical Mechanics by Panat P. V. Classical Mechanics by G. Aruldhas

Unit 3: Motion in Central force field (10L, 10M)

Central force, Reduction of two body problem into equivalent one body problem, Properties of central force, Motion in central force field, Motion in inverse square law force field, General features of the motion, Equation of the orbit (Nature of the orbit), Kepler's laws (Statements and proof)

References: Classical Mechanics: Gupta, Kumar and Sharma

Introduction to Classical Mechanics: R. G. Takwale and P. S. Puranic

Reference Books:

1. Introduction to Classical Mechanics by R. G. Takwale and P. S. Puranic
2. Classical Mechanics by Panat P. V.
3. Classical Mechanics by N. C. Rana and P. S. Joag
4. Classical Mechanics by G. Aruldhas
5. Classical Mechanics by Gupta, Kumar and Sharma

Course Code: PH-313

Course Title: Solid State Physics

Course Code: PH-313	**Course Category: Major Course (DSC)**
Course Title: Solid State Physics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop a comprehensive understanding of interatomic forces, bonding mechanisms, and cohesive energy governing the stability and properties of solid materials.
2. To introduce the fundamental concepts of crystal structures, symmetry, and defects, and their influence on the physical properties of crystalline solids.
3. To equip students with analytical tools such as Miller indices, reciprocal lattice, and X-ray diffraction techniques for structural determination of crystalline materials.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Analyze and compare different types of bonding in solids (ionic, covalent, metallic, and secondary bonds) and evaluate cohesive energy and related properties.
2. Describe and interpret crystal structures and defects, including calculation of packing fraction, coordination number, and understanding their impact on material behavior.
3. Apply crystallographic methods and diffraction principles (Miller indices, reciprocal lattice, Bragg's law, XRD techniques) to determine and analyze crystal structures.

Course Content:

Unit 1: Interatomic Forces and Bonding in Solid (10 L, 10 M)

Forces between atoms, Cohesion of atoms and cohesive energy, calculation of cohesive energy, types of bonding in solids, Ionic bonding: band energy, lattice energy and Madelung constant, properties and examples, Covalent bond: saturation, directional nature, hybridization, properties Metallic bonds, Dispersion bonds, Dipole bonds, Hydrogen bonds,

Reference: Chapter 3, Solid State Physics by S. O. Pillai

Unit 2: The Crystal Structures: Basic concepts **(10 L, 10 M)**

Lattice points, Basis and crystal structure, Unit cell and lattice parameters, Primitive Cell, crystal systems, symmetry elements, metallic crystal structure and their properties: co-ordination number, atomic radius and packing fraction, Other cubic structures: Diamond, Zinc blend and NaCl, Imperfections: thermal vibrations, point defects, line defects, surface defects, volume defects

Reference: Chapter 4, Solid State Physics by S. O. Pillai

Unit 3: Crystalline solids: Structural study **(10 L, 10 M)**

Concept of Directions, planes, Miller indices, application in cubic crystals: distribution of atoms in planes and separation of planes, reciprocal lattice: concept, geometrical construction, reciprocal lattice vector, reciprocal lattice parameters to direct lattice parameters, interplanar spacing; X-ray diffraction: Bragg's law, spectrometer, Powder method, Rotating crystal method

Reference: Chapter 4 and 5, Solid State Physics by S. O. Pillai

Reference Books:

1. Solid State Physics by S. O. Pillai
2. Introduction to Solid State Physics by Charles Kittle.
3. Elementary Solid State Physics by M. Ali Omer
4. Solid State Physics by A.J. Dekkar
5. Solid State Physics by R. L. Singhal

Course Code: PH-314

Course Title: Atomic and Molecular Physics

Course Code: PH-314	**Course Category: Major Course (DSC)**
Course Title Atomic and Molecular Physics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To develop a modern understanding of atomic structure using quantum mechanics, including solutions of the Schrödinger equation and vector atom model.
- To explain the origin and characteristics of atomic spectra, including selection rules, X-ray spectra, and the significance of Moseley's law.
- To introduce molecular spectroscopy concepts such as rotational, vibrational, and Raman Effect, along with their theoretical basis and applications.

Course Outcomes:

After successful completion of the course, students will be able to:

1. analyse atomic structure using quantum numbers, coupling schemes (L-S and j-j), and apply principles like Pauli exclusion principle to explain atomic behavior.
2. interpret atomic spectra, explain spectral line formation, apply selection rules, and evaluate X-ray spectra using Moseley's law.
3. describe molecular energy levels (rotational and vibrational), interpret molecular spectra, and explain the theory and applications of Raman spectroscopy.

Course Content:

Unit 1:Modern view of atom: Vector atom model (8L, 8M)

Introduction, Schrödinger's equation for Hydrogen atom, Quantum numbers: total, orbital, magnetic, angular momentum, Electron spin, spin-orbit coupling, total angular momentum, Pauli's exclusion principle, Definition of L-S coupling and j-j coupling schemes

Reference: Chapter 9, 10: Perspective of Modern Physics, A. Beiser

Unit 2: Atomic Spectra **(7 L, 7 M)**

Origin of spectral lines, selection rules, one-electron spectra, two-electron spectra, X-ray spectra, Characteristic X-ray spectra, Moseley's law and its importance, Energy level of Cadmium

Reference: Chapter 10, 11: Perspective of Modern Physics, A. Beiser

Unit 3: Molecular spectra **(8 L, 8 M)**

Introduction, Regions of electromagnetic spectrum, Types of molecular spectra, Rotational energy levels: diatomic molecules, rotational spectra, Vibrational energy levels: diatomic molecules, Vibrational spectra

Reference: Chapter 14: Perspective of Modern Physics, A. Beiser

Unit 4: Raman spectra **(7 L, 7 M)**

Introduction, Raman Effect, How Raman Measured the Effect of Light Scattering, Classical theory of Raman Effect, Limitations of the Classical Theory, Quantum theory of Raman Scattering, Why the Stokes lines are higher in intensity than the Anti- Stokes lines, Setup used for Raman Effect, applications

Reference: Atomic, Molecular and Laser Spectroscopy by e-pathshala, https://share.google/kNdcwWNpfPtdUf8Es

Reference Books:

1. Perspective of Modern Physics by A. Beiser
2. Introduction to atomic spectra by H. E. White
3. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Elaine MC. Cash
4. Modern Techniques of Spectroscopy by Dheeraj Kumar Singh, Manik Pradhan, Arnulf Materny
5. Atomic Physics by J. B. Rajam

Web reference: *https://share.google/kNdcwWNpfPtdUf8Es*

Course Code: PH-315

Course Title: Optics

Course Code: PH-315	**Course Category: Major Course (DSC)**
Course Title: Optics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop a clear understanding of interference phenomena and its applications in optical instruments.
2. To introduce the principles of diffraction and analyze various diffraction patterns and their applications.
3. To explain the concept of polarization and different methods of producing polarized light.
4. To relate optical phenomena such as interference, diffraction, and polarization to real-world applications and modern devices.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Explain and analyze various interference phenomena,
2. Evaluate diffraction patterns for single slit, double slit, and diffraction gratings, and apply them in practical situations.
3. Describe different states of polarization and apply laws such as Malus's law and Brewster's law.
4. Apply concepts of interference, diffraction, and polarization to understand their applications.

Course Content:

Unit I: Interference **(12 M & 12L)**

Basic Concept of interference, Intensity distribution in the interference pattern, Methods of producing interference. Young's double slit experiment, Mathematics of interference (formula constructive and distractive interference) Multiple Slit interference, Phase change on reflection: Stokes' treatment, Interference in Thin

Films: parallel and wedge-shaped films. Fringes of equal inclination; Newton's rings experiment and its application. The Michelson interferometer and its application

Reference: University Physics III Optics & Modern Physics, OpenStax.org

Unit II: Diffraction **(10M &10L)**

Concept of diffraction, Types of diffraction (Fresnel diffraction and Fraunhofer diffraction) Single Slit Diffraction, intensity in single slit diffraction, double slit diffraction, Diffraction gratings, Application of diffraction grating, Circular apertures and resolution, X-ray Diffraction, Bragg Equation, Holography, CD/DVD rainbow effect.

Reference: University Physics III Optics & Modern Physics, OpenStax.org

Unit III: Polarization **(8M & 8 L)**

Introduction, What is Polarisation? Simple States of Polarised Light: Linear Polarisation, Circular Polarisation, Elliptical Polarisation,

Principles of Producing Linearly Polarised Light: Ideal Polariser: Malus's Law, Polarisation by Reflection: Brewster's Law, Polarisation by Double Refraction,

Reference: https://egyankosh.ac.in/bitstream/123456789/80999/3/Unit-5.pdf

Application of polarization: Liquid Crystals and Other Polarization Effects in Materials

Reference: Douglas College Physics

https://pressbooks.bccampus.ca/introductorygeneralphysics2phys1207opticsfirst/chapter/27-8-polarization/

Reference Books:

1. Fundamentals of Optics by F A Jenkins and H E White
2. University Physics III Optics & Modern Physics by OpenStax.org (OER)
3. Optics by Ajoy Ghatak
4. Optics by Brijlal and Subramanyam

Web references:

1. https://egyankosh.ac.in/bitstream/123456789/80999/3/Unit-5.pdf
2. https://pressbooks.bccampus.ca/introductorygeneralphysics2phys1207opticsfirst/chapter/27-8-polarization/

Course Code: PH-316

Course Title: Laboratory-V

Course Code: PH-316	**Course Category: Major Course (DSC)**
Course Title: Laboratory-V	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop experimental skills for precise measurement of physical quantities such as elasticity, thermal conductivity, resistivity, and optical parameters using standard laboratory techniques.
2. To familiarize students with fundamental experimental methods in optics, electronics, thermal physics, and acoustics, including use of instruments like interferometers, goniometers, four-probe setups, and ultrasonic devices.
3. To cultivate scientific thinking through data analysis, error estimation, graphical interpretation, and correlation of experimental results with theoretical concepts.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Perform and analyze experiments to determine key physical constants (e.g., Young's modulus, Stefan's constant, solar constant, velocity of sound) with proper methodology and accuracy.
2. Handle and operate various laboratory instruments and setups (optical, electrical, and thermal) efficiently, while following safety and standard experimental procedures.
3. Interpret experimental data using appropriate mathematical and graphical techniques, evaluate errors, and present results in a scientific and systematic manner.

List of Experiments:

1. Moment of Inertia by Bifilar suspension.
2. Y and η by Searl's method.
3. Y by Koenig's method.

4. Y by Newton's rings.
5. Searl's Goniometer.
6. Lloyd's single mirror.
7. To estimate temperature of Na flame.
8. Measurement of resistivity by four probe method.
9. Frequency of AC/ Tuning fork by stroboscope.
10. Variation of resistance of a filament of a bulb with its temperature.
11. Determination of velocity of sound using ultrasonic Interferometer.
12. Electromagnetic Pendulum.
13. Determination of circular aperture of LASER.
14. Velocity of sound by phase shift method.
15. To determine the human audibility.
16. Stefan's constant.
17. To determine the solar constant.
18. Thermal conductivity of metal by Forbe's method.
19. Thermal conductivity of rubber by rubber tubing method.
20. To determine the melting temperature of wax / naphthalene using Calendar and Griffith Bridge.

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

1. A Text book of Practical Physics by Shrinivasan and Balasubranian.
2. B. Sc. Practical Physics by Harnam Singh and Dr. P. S. Hemne
3. Advanced Level Practical Physics by J. M. Nelkon, J. M. Ogloom
4. B. Sc. Practical Physics by C. L. Arora.
5. Advanced level Physics Practicals by Michael Nelson and Jon M. Ogborn

Course Code: PH-317

Course Title: Laboratory-VI

Course Code: PH-317	**Course Category: Major Course (DSC)**
Course Title: Laboratory-VI	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To provide experimental understanding of fundamental physical properties related to optics, thermal physics, and material science through standard laboratory techniques.
2. To develop practical skills in handling optical instruments, laser systems, and measurement devices for accurate data collection and analysis.
3. To train students in applying theoretical concepts to real experiments, including error analysis and interpretation of experimental results.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Students will be able to perform experiments to determine physical parameters such as wavelength, refractive index, thermal conductivity, surface tension, and optical properties of materials.
2. Students will demonstrate the ability to use and analyze data from optical instruments such as interferometers, polarimeters, diffraction gratings, and laser setups.
3. Students will be able to interpret experimental results, estimate errors, and correlate practical observations with underlying physical principles.

List of Experiments:

1. Determination of Surface Tension by Capillary Rise Method
2. Determination of Thermal Conductivity of Bad Conductor (Lee's Disc Method)
3. Study of Laser Characteristics

Measurement of wavelength and divergence.

4. Interferometer (Michelson/Fabry-Perot) – Wavelength measurement

5. Hall Effect – Carrier concentration and mobility

3. To study Lissajous Figures and demonstration of Lissajous figures by using C.R.O.

6. To determine the Resolving Power of a Prism.

7. To determine the value of Cauchy Constants of a material of a prism.

8. To determine the wavelength of sodium light using Fresnel Biprism.

9. To determine the wavelength of sodium light using Newton's Rings.

10. To determine the refractive index of a liquid by using Newton's rings apparatus.

11. Determination of specific rotation α of optically active substance using Polarimeter.

12. Measurement of beam size of a LASER beam.

13. Measurement of beam divergence of a LASER beam.

14. To determine the wavelength of light from LASER source using Diffraction grating.

15. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating

16. To determine the Resolving Power of a Plane Diffraction Grating.

17. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

Depending on the nature of the experiment, different reference books can be used as resource material.

Course Code: PH-318 (A)

Course Title: Technical Electronics-I

Course Code: PH-318 (A)	**Course Category: Major Course (DSE)**
Course Title: Technical Electronics-I	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop a fundamental understanding of basic electrical and electronic components such as resistors, capacitors, transformers, and wiring systems along with their characteristics and applications.
2. To introduce students to the structure, materials, and manufacturing processes of Printed Circuit Boards (PCBs), including soldering and mounting techniques.
3. To familiarize students with the concepts, parameters, and working principles of operational amplifiers and their practical configurations.
4. To build the ability to interpret circuit components and design basic electronic circuits using standard components and PCB techniques.

Course Outcomes:

After completing the course, the students will be able to:

1. Students will be able to identify, classify, and explain the working and specifications of common electronic and electrical components used in circuits.
2. Students will demonstrate understanding of PCB design concepts, types, fabrication processes, and soldering methods used in electronic assembly.
3. Students will analyze and apply operational amplifier concepts to design and evaluate basic analog circuits such as amplifiers, comparators, and summing circuits.
4. Students will be able to construct and troubleshoot simple electronic circuits using appropriate components and PCB techniques.

Course Content:

Unit 1: Basic electronic and Electrical components (8 L, 8 M)

Resistors: Types, color coding, variable resistors, rheostats and potentiometers, power rating; Capacitors: typical capacitors, electrolytic, coding; Transformers: basic characteristics, ratings

Wires: Standard Wire Gage Sizes, Types of Wire Conductors, Connectors, Printed Wiring, Switches, Fuses, Relays

Reference: Chapter 2, 11, 16,19 Grobe's Basic Electronics by Mitchel Schultz

Unit 2: Fundamentals of Printed Circuit Board (7 L, 7 M)

What's a PCB?, Composition, Terminology, Advantages of using PCB, Different parts of PCB, PCB materials, Types of PCB, Types of PCBs According to Mounting System, surface mount components, lamination, etching, soldering, Different Methods of Soldering

Reference: https://dspmuranchi.ac.in/pdf/Blog/pcb%201.pdf

https://share.google/CaowAEIdCgDFZjZk9

Unit 3: Introduction to Operational Amplifiers (10L, 10 M)

Block diagram of Opamp, Schematic symbol and Pin diagram of IC 741, Operational Amplifiers and Their Characteristics: Open-Loop Voltage Gain, Input Bias Currents, Frequency Response, Slew Rate, Common-Mode Rejection Ratio (CMRR), Op-Amp Circuits with Negative Feedback: The Inverting Amplifier, The Noninverting Amplifier, voltage follower, summing amplifier, differential amplifier, comparator

Reference: Chapter 33 Grobe's Basic Electronics by Mitchel Schultz

https://share.google/b6YqbiPZZRq2NzaWO

Unit 4: Data Converters (05 L, 05 M)

D to A Converters: Resistive divider network, Binary ladder network. Introduction to A to D Converters

Reference: DIGITAL PRINCIPLES A D APPLICATIONS Seventh Edition Donald P Leach Santa Clara University Albert Paul Malvino

Reference Books:

1. Grobe's Basic Electronics by Mitchel Schultz
2. Principles of Electronics by V. K. Mehta
3. Basic Electronics (Solid State) by B.L. Thereja
4. A Textbook of Applied Electronics by R S Sedha
5. DIGITAL PRINCIPLES A D APPLICATIONS by Donald P Leach, Albert Paul Malvino

Web references:

1. https://dspmuranchi.ac.in/pdf/Blog/pcb%201.pdf
2. https://share.google/CaowAEIdCgDFZjZk9
3. https://share.google/b6YqbiPZZRq2NzaWO

Course Code: PH-318 (B)

Course Title: Python for Physics-I

Course Code: PH-318 (B)	**Course Category: Major Course (DSE)**
Course Title: Python for Physics-I	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To introduce students to the fundamentals of Python programming, including syntax, data types, control structures, and object-oriented concepts.
2. To develop skills in using Python libraries for data visualization and graphical representation of scientific data.
3. To provide knowledge of numerical methods such as interpolation and curve fitting using Python.
4. To enable students to solve ordinary differential equations using computational techniques and numerical methods.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Write and execute Python programs using appropriate syntax, data structures, and control flow mechanisms.
2. Apply data visualization techniques using libraries like Matplotlib to represent and analyze data effectively.
3. Implement interpolation and curve fitting methods for analyzing experimental or scientific data.
4. Solve ordinary differential equations numerically, including boundary-value problems, using suitable computational approaches.

Course Content:

Unit 1: Basics of Python **(10 L, 10 M)**

Introduction to Python programming language, Python syntax and program structure; identifiers, constants, variables, and data types; dynamic typing and type conversion; operators and expressions; input and output operations; Python modules and packages; iterables and basic built-in functions; control flow statements, looping mechanisms, nested and compound statements; indentation and whitespace in Python; core data structures, introduction to classes and objects; and basic concepts of object-oriented programming including encapsulation, inheritance, and polymorphism.

Unit 2: Data Visualization Techniques **(6 L, 6 M)**

MatPlotLib and PyPlot 2D Plot; Interactive Plotting; Plot method; Labels; Log and Polar Plots; Multiple Figures and Curves; Subplots;

Unit 3: Interpolation and Curve Fitting **(8 L, 8 M)**

Interpolation Schemes: Nearest Neighbor; Linear; Quadratic; Spline. Least-Squares Fit: Linear and Polynomial

Unit 4: Ordinary Differential Equations **(6 L, 6 M)**

Simultaneous Differential Equations, Boundary-Value Problems: Shooting Method; Matrix Approach

Reference Books:

1. Scientific Computing in Python by Abhijit Kar Gupta
2. Computational Physics by Mark Newman
3. Numerical Recipes: The Art of Scientific Computing by William H. Press et al.
4. Python for Scientists by J. M. Stewart
5. A Primer on Scientific Programming with Python by Hans Petter Langtangen
6. Python for Data Analysis by Wes McKinney

Course Code: PH-318 (C)

Course Title: Sensors & Transducers-I

Course Code: PH-318 (C)	**Course Category: Major Course (DSC)**
Course Title: Sensors & Transducers-I	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop a fundamental understanding of measurement systems, instrument characteristics, and error analysis for accurate physical measurements.
2. To provide knowledge of various sensors and transducers used in industrial and scientific applications for measuring physical parameters such as temperature, pressure, and displacement.
3. To equip students with the ability to analyze and select appropriate transducers for measuring translational motion, velocity, acceleration, and vibration.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Explain the principles of measurement systems, classify instruments, and evaluate static and dynamic characteristics along with measurement errors.
2. Analyze the working principles and applications of temperature and pressure sensors, and select suitable sensors for specific measurement needs.
3. Apply concepts of transducers and motion measurement to determine displacement, velocity, acceleration, and vibration, and justify appropriate sensor selection.

Course Content:

Unit 1: Measurement systems and Errors **(08L, 08M)**

Review of instrument types: Active and passive, Null-type and deflection-type, analogue and digital, Indicating and instruments with a signal output, Smart and non-smart instruments, Static characteristics of instruments: Accuracy (measurement uncertainty), Precision/repeatability/reproducibility, Tolerance, Range or span, Linearity, Sensitivity, Threshold, Resolution, Hysteresis effects, Dead space, Dynamic characteristics of instruments

Reference: Measurement and Instrumentation Principles Alan S. Morris

Unit 2: Sensors (10L, 10M)

Control Systems - Measurement Devices: Industrial applications, Controls: temperature, pressure, composition, level, flow

Temperature Sensors: Introduction, thermometers, RTD, thermocouples, pyrometers, temperature regulation using temperature sensors, structure and operation

Pressure Sensors: Sensor selection criteria, Elastic sensors: Bourdon tube gauges, bellows, diaphragm, Electric sensors: capacitive, inductive, reluctive, piezoelectric, potentiometric, strain gauge

Reference: Chemical Process Dynamics and Controls, Peter Woolf et al. University of Michigan

Unit 3: Translational Motion Transducers (12L, 12M)

Displacement: The resistive potentiometer, Linear variable differential transformer (LVDT), Variable capacitance transducers, Variable inductance transducers, Strain gauges, Piezoelectric transducers, Nozzle flapper, Other methods of measuring small displacements, Measurement of large displacements (range sensors), Proximity sensors, Selection of translational measurement transducers

Velocity: Differentiation of displacement measurements, Integration of the output of an accelerometer, Conversion to rotational velocity,

Acceleration: Selection of accelerometers

Vibration: Nature of vibration, Vibration measurement

Shock

Reference: Measurement and Instrumentation Principles Alan S. Morris

Reference Books:

1. Measurement and Instrumentation Principles by Alan S. Morris
2. Chemical Process Dynamics and Controls by Peter Woolf et al.
3. Sensors and Transducers by D. Patranabis
4. Sensors and Transducers by Livin P. Wilson

Course Code: PH-319 (A)

Course Title: Laboratory on PH-318 (A)

Course Code: PH-319 (A)	**Course Category: Major Course (DSE)**
Course Title: Laboratory on PH-318 (A)	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop practical skills in designing, fabricating, and testing electronic circuits using discrete components, ICs, and PCB techniques.
2. To provide hands-on understanding of operational amplifier applications and waveform generation circuits used in analog electronics.
3. To familiarize students with electronic measurement techniques and instruments for analyzing circuit behavior and characteristics.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Students will be able to design, construct, and test basic electronic circuits including PCB-based circuits and Op-Amp applications.
2. Students will demonstrate the ability to analyze and verify characteristics of electronic devices and circuits such as photodiodes, transistors, and converters.
3. Students will be able to use electronic instruments (like CRO and function generator) to observe, measure, and interpret different electrical signals and waveforms.

Course Content:

1. To make two PCB's i) Using discrete components ii) Using IC components.
2. To study inverting and non inverting configuration of Op amp.
3. To study of OP AMP as an adder.
4. DAC (R- 2R ladder, without OP- AMP).
5. To study reverse bias characteristics of photodiode.
6. To study characteristics of photo transistor.
8. Designing and fabrication of transformer.

9. Triangular, square wave generator using OP AMP.
10. V to F converter using IC-741.
11. V to T converter using IC-741.
12. Study of function generator.
13. Study of CRO

(For more knowledge and understanding, one can help the students to study, understand and use the SCILAB software to write and execute programs to study output of inverting or non- inverting configuration of OPAMP, OAMP as adder or subtractor etc.)

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

1. Grobe's Basic Electronics by Mitchel Schultz
2. Principles of Electronics by V. K. Mehta
3. Basic Electronics (Solid State) by B.L. Thereja
4. A Textbook of Applied Electronics by R S Sedha
5. DIGITAL PRINCIPLES A D APPLICATIONS by Donald P Leach, Albert Paul Malvino

Web references:

1. https://dspmuranchi.ac.in/pdf/Blog/pcb%201.pdf
2. https://share.google/CaowAEIdCgDFZjZk9
3. https://share.google/b6YqbiPZZRq2NzaWO

Course Code: PH-319 (B)

Course Title: Laboratory on PH-318 (B)

Course Code: PH-319 (B)	**Course Category: Major Course (DSE)**
Course Title: Laboratory on PH-318 (B)	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To familiarize students with the Python programming environment, syntax rules, indentation, and execution of simple programs.
2. To understand dynamic typing, data types, and type conversion through simple physics calculations.
3. To plot physical variables such as displacement and velocity using Python.
4. To estimate unknown physical values using interpolation techniques.
5. To numerically solve first-order ODEs relevant to decay and cooling processes.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Write structured Python programs for physics problems
2. Visualize and analyze experimental and simulated data
3. Apply numerical methods to real physical systems
4. Develop computational and problem-solving skills essential for modern physics

Course Content:

Unit 1: Basics of Python Programming

Experiment 1:

Introduction to Python environment: writing and executing basic Python programs, understanding syntax, indentation, and comments.

Experiment 2:

Programs using variables, constants, dynamic typing, and type conversion for simple physics calculations (distance, velocity, acceleration).

Experiment 3:

Use of operators and expressions to evaluate physical formulae (kinetic energy, potential energy, work done).

Experiment 4:

Input–output operations and formatted output for experimental physics data.

Experiment 5:

Implementation of control flow using `if–elif–else` statements for decision-based physics problems (motion classification, energy conditions).

Experiment 6:

Programs using `for` and `while` loops to generate numerical sequences (time evolution, harmonic motion steps).

Experiment 7:

Use of lists, tuples, sets, and dictionaries to store and manipulate experimental data.

Experiment 8:

String operations and basic file handling for reading and writing physics data.

Experiment 9:

Introduction to classes and objects: creating simple classes for physical systems (Particle, Projectile).

Unit 2: Data Visualization Techniques

Experiment 10:

2D plotting of physical quantities using Matplotlib (displacement vs time, velocity vs time).

Experiment 11:

Plotting multiple curves and subplots for comparative analysis of physical data.

Experiment 12:

Logarithmic and polar plots for physics applications (radioactive decay, circular motion).

Unit 3: Interpolation and Curve Fitting

Experiment 13:

Interpolation of experimental data using nearest-neighbor and linear interpolation.

Experiment 14:

Quadratic and spline interpolation of physical datasets (temperature variation, potential curves).

Experiment 15:

Least-squares linear fitting for experimental data (Ohm's law, Hooke's law).

Experiment 16:

Polynomial curve fitting for nonlinear physical data.

Unit 4: Differential Equations

Experiment 17:

Numerical solution of first-order ordinary differential equations (radioactive decay, cooling law).

Experiment 18:

Solution of second-order ordinary differential equations (simple harmonic oscillator).

Experiment 19:

Numerical solution of simultaneous differential equations (coupled oscillators, predator–prey model).

Experiment 20:

Boundary-value problems using the shooting method (particle in a box, steady-state heat flow).

Notes:

1. Total eight experiments need to be compulsorily performed.
2. Any two experiments are to be performed from each unit.
3. The instructor can take more than 8 practical.
4. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

1. Computational Physics by Mark Newman
2. Numerical Recipes: The Art of Scientific Computing by William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery,
3. Python for Scientists by J. M. Stewart
4. A Primer on Scientific Programming with Python by Hans Petter Langtangen
5. Python for Data Analysis by Wes McKinney
6. Computational Physics: Problem Solving with Python R. H. Landau by M. J. Páez, and C. C. Bordeianu

Course Code: PH-319 (C)

Course Title: Laboratory on PH-318 (C)

Course Code: PH-319 (C)	**Course Category: Major Course (DSE)**
Course Title: Laboratory on PH-318 (C)	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

1. **Course Objectives**:
2. To provide hands-on experience with various transducers and sensors used for measuring physical parameters such as temperature, pressure, light, sound, and displacement.
3. To develop experimental skills in studying, verifying, and analyzing the characteristics and performance of different sensing devices.
4. To familiarize students with fabrication techniques and practical applications of sensors in real-world measurement and monitoring systems.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Students will be able to perform experiments and analyze the characteristics of different transducers and sensors used in instrumentation systems.
2. Students will demonstrate the ability to measure and interpret physical parameters such as temperature, pressure, light intensity, and sound using appropriate sensors.
3. Students will be able to design basic experimental setups, fabricate simple sensors, and evaluate their performance for practical applications.

Course Content:

1. To Study characteristics of Inductive Transducer LVDT.
2. To Study of Light Dependent Resistor (LDR).
3. To Study characteristics of Strain Gauge for Load Measurement.
4. To Study and verify the Characteristics of RTD.
5. To Study and verify the Characteristics of an N.T.C. Thermistor.
6. To verify the Characteristics of Thermocouple.

7. To measure of Sound Intensity using Microphone Transducer.
8. To fabricate thin/thick/pallet sensor (by any preparation method).
9. Study of gas sensor for air quality monitoring
10. Study of light intensity measurement using lux sensor
11. To study of capacitive pressure transducer
12. To study of potentiometric transducer for position measurement.
13. To study Hall effect sensor.
14. To study inductive sensor.

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

1. Measurement, Instrumentation, and Sensors Handbook: Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement by John G. Webster, Halit Eren
2. Transducers Handbook User's Directory of Electrical Transducers by H. B. Boyle
3. Sensors and Transducers: A Guide for Technicians by Ian R. Sinclair
4. Measurement, Instrumentation and Sensors Handbook- Spatial, Mechanical, Thermal and Radiation Measurement by John G. Webster, Halit Eren
5. Linear Variable Differential Transformer Model: LVDT-01, User's Manual, Techno Instruments, Roorkee, Website: www.sestechno.com.

Course Code: PH-320

Course Title: Introduction to Computational Physics

Course Code: PH-320	**Course Category: Major Course (SEC)**
Course Title: Introduction to Computational Physics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop programming skills in the students.
2. To introduce numerical methods to solve physics problems.
3. To learn Data Analysis and Visualization.
4. To learn Simulation Techniques such as Monte Carlo method, etc.
5. To prepare students to apply computational techniques to real-world problems in physics.

Course Outcomes:

After completing the course:

1. Students will be able to apply basic Python programming concepts, including data types, control structures, and object-oriented features, to develop simple programs.
2. Students will be able to perform array-based numerical computations and data handling using NumPy.
3. Students will be able to implement numerical techniques such as root-finding (Bisection and Newton-Raphson), numerical differentiation, and Monte Carlo simulations to solve physics-related problems.
4. Students will be able to apply numerical integration methods and solve ordinary differential equations using Euler and Runge-Kutta methods for modelling physical systems.

Course Contents:

Unit-I: Getting Started with Python **(8L, 8M)**

Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements, lists, set, tuples, classes, dictionaries and strings, basic ideas of object-oriented programming.

Unit-II: NumPy **(4L, 4M)**

Arrays; Indexing; Iterating. Creating Arrays : array(), arange(), linspace(), zeros(). Basic Operations : Add, Subtract, Multiply, Divide, and Exponentiation.

Unit-III: Roots of equations **(8L, 8M)**

Closed domain methods (bracketing): Bisection; Open domain methods: Newton-Raphson.

Monte Carlo Simulation: Random-Number Generation; Example: Random Walk.

Differentiation Forward Difference; Central Difference; Backward Difference.

(include physics related problems as an example)

Unit-IV: Integration **(10L, 10M)**

Trapezoid Rule; Simpson's Rule.

Ordinary Differential Equations Initial-Value Problems : Euler's Method; 2nd Order Runge-Kutta Methods.

(include physics related problems as an example)

Reference Books:

1. Beginning Python by Peter C. Norton, Alex Samuel, Dave Aitel, Eric Foster-Johnson, Leonard Richardson, Jason Diamon, Aleatha Parker, and Michael Roberts
2. Scientific Computing in Python by Abhijit Kar Gupta
3. Introduction to Computation and Programming Using Python by John V Guttag
4. Computational Physics-Problem solving with Python by Rubin H. Landau, Manuel J. Paez and Cristian C. Bordeianu
5. Python for physics: for deepest understanding of physics problems by Dr. Thiyagraj

Course Code: PH-321

Course Title: Field Project corresponding to the Major Subject

Course Code: PH-321	**Course Category: Major Course (FP)**
Course Title: Field Project corresponding to the Major Subject	**Type: Field Project**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To introduce students to the fundamentals of field-based research, including project selection, research methodology, and literature survey.
2. To develop skills in planning and executing field projects, including use of measuring instruments, data collection techniques, and teamwork.
3. To promote scientific documentation and ethical practices, including maintaining field records, safety awareness, and proper reporting of observations.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Design and plan a field project, including defining objectives, selecting appropriate methods, and conducting literature review.
2. Carry out field measurements and data collection, using basic instruments and applying concepts of error analysis and uncertainty.
3. Document and present field work effectively, including maintaining field notebooks, organizing data, and following ethical and safety practices

Course Contents:

Activity 1: Basic study related to the Field Project & Research Methodology

(20 Hours | 20 Marks)

- Meaning, scope, and importance of field projects in Physics
- Selection of project topic related to major subject

- Objectives and expected outcomes of the project
- Basics of research methodology
- Literature survey: books, journals, websites, and reports
- Safety measures and ethical practices in field work
- Project planning, time management, and teamwork
- Maintaining field notebook and documentation

Activity 2: Choice of topic and Planning of the field project (10 Hours | 10 Marks)

Any suitable topic (preferably related to social issues) can be chosen for the field project. A suggestive list is given below:

- Renewable energy studies (solar panel efficiency, wind energy basics)
- Environmental physics (noise pollution, radiation background, thermal studies)
- Electronics and instrumentation applications
- Optics or materials-based field study
- Energy audit of building or campus
- Physics in medical, industrial, or communication systems
- Socially relevant physics applications (energy conservation, sustainable technologies)

Accordingly, the second activity will be focused on

- Choice of suitable topic
- Planning and execution of field visits (industry, laboratory, energy plant, research center)
- Identification and use of basic measuring instruments and sensors essential
- Study of measurement of physical parameters (temperature, light intensity, sound level, radiation, electrical parameters, etc.)
- Experimental procedures and observation techniques
- Errors in measurements and uncertainty analysis
- Recording data in tabular form and field logs

Note: Experimental work/actual Filed work will be conducted in the next semester.

Course Code: PH-322

Course Title: Quantum Mechanics

Course Code: PH-322	Course Category: Major Course (DSC)
Course Title: Quantum Mechanics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA):20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To understand basic concepts of quantum mechanics.
2. To understand the fundamental of variables and operators in quantum mechanics.
3. To learn basic methods of quantum mechanics.
4. To learn how to use of quantum mechanics for solving microscopic system.

Course Outcomes:

After successful completion of the course,

1. Students will learn the uses of Schrodinger's equation.
2. Students will learn to apply quantum mechanics to solve real system problem.
3. Students will get knowledge of basic mathematical tools of quantum mechanics.
4. Students will be able to co-relate theory with practical of real system.

Course Contents:

Unit 1: Introduction to Quantum Mechanics (10 L, 10 M)

Requirement and Origin of Quantum Physics: Historical note, Particle aspect of radiation: Blackbody radiation, photoelectric effect. Wave aspect of particles: de Broglie's hypothesis, Matter waves, Davisson and Germer experiment. Particles versus Waves: Classical view of particles and waves, Quantum view of particles and waves

Reference: Quantum Mechanics: Concepts and Applications by Nouredine Zettili

wave function, wave and group velocity, Heisenberg's uncertainty principle and its different forms

Reference: Perspectives of Modern physics by Arthur Beiser

At least three problems based on above topics.

Unit 2: The Schrodinger Equation **(10 L, 10 M)**

Wave function and its Physical interpretation, normalized wave functions, the wave equation, Requirements of wave function, Schrodinger's equation: time-dependent form, Probability current density and equation of continuity, Expectation value, operators, Schrodinger equation: Steady state form, Energy eigenvalues and eigenfunctions equation

At least three problems based on above topics.

Reference: Chapter 7, Perspectives of Modern physics by Arthur Beiser

Unit 3: Application of Schrodinger's wave equation **(10L, 10M)**

Particle in a one-dimensional rigid box: energy quantization, wave function, momentum quantization, particle in a nonrigid box, Harmonic oscillator: energy levels, wave functions

Reference: Chapter 8, Perspectives of Modern physics by Arthur Beiser

At least three problems based on above topics.

Reference Books:

1. Perspectives of Modern physics by Arthur Beiser
2. Quantum Mechanics: Concepts and Applications by Nouredine Zettili
3. Introduction to Quantum Mechanics by D. Griffiths
4. ABC's of Quantum Mechanics by V. Rydnik
5. Advanced Quantum Mechanics by Satya Prakash, Kedarnath Ram Nath
6. Quantum Mechanics by Gupta, Kumar, Sharma

Course Code: PH-323

Course Title: Nuclear Physics

Course Code: PH-323	**Course Category: Major Course (DSC)**
Course Title: Nuclear Physics	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA):20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To introduce fundamental concepts of nuclear physics, including nuclear structure, properties of nuclei, nuclear forces, and models such as the liquid drop model.
2. To develop understanding of radioactive phenomena, including decay laws, half-life, radioactive series, and practical applications in various fields.
3. To explain nuclear energy processes, including nuclear fission, fusion, chain reactions, and the working principles of nuclear reactors.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Explain nuclear structure and properties such as binding energy, mass defect, and nuclear forces, and apply the liquid drop model to describe nuclear behavior.
2. Analyze radioactive decay processes quantitatively, including calculation of decay constants, half-life, and solving problems related to radioactive series and applications.
3. Evaluate nuclear energy systems, including fission, fusion, and reactor mechanisms, and discuss their practical applications and implications.

Course Contents:

Unit 1: Introduction to Nuclear Physics **(10 L, 10 M)**

Discovering the nucleus, Basic Nuclear Properties: constituents, charge, size, density, atomic mass of nucleus, classification of nuclei. Mass defects, nuclear binding energies, binding energy per nucleon, Problems.

Nuclear forces: Saturation and short-range nuclear forces, charge symmetry and charge independence, Meson exchange theory of nuclear forces, Elementary particles (List only).

Nuclear model: Liquid Drop Model.

Reference: Perspectives of Modern Physics by Arther Beiser, Nuclear Physics by D. C. Tayal, Nuclear and Particle Physics by Sanjay Kumar Chamoli, Web reference: https://ebooks.inflibnet.ac.in/phyp04/chapter/nuclear-models-1/

Unit 2: Radioactivity **(10 L, 10 M)**

Introduction, Statistics of Radioactive decay, law of radioactive decay, decay constant, lifetimes, half-life, mean life, specific activity, units of activity, partial radioactive decay, successive disintegration, radioactive series, introduction to beta decay, radioactive dating, measuring the radiation dosage, Applications of radioactivity (Agricultural, Biological, Medical and industrial),

Problems.

Reference: Principle of Physics by Walker, Halliday and Resnick; Perspectives of Modern Physics by Arther Beiser, Basic Nuclear Physics by B. N. Srivastava

Unit 3: Energy from the Nucleus **(10 L, 10 M)**

Introduction, Nuclear fission: Explanation on the basis of liquid drop model, energy available from fission: Estimation of energy from masses of fission fragments and from binding energy, Nuclear chain reaction.

Nuclear reactor: Basic principle, classification, constituent parts, swimming pool reactor.

Thermonuclear fusion: the basic process, thermonuclear fusion in the Sun and other stars, controlled thermonuclear fusion.

Reference: Principle of Physics by Walker, Halliday and Resnick, Nuclear Physics by D. C. Tayal,

Reference Books:

1. Principle of Physics by Walker, Halliday and Resnick
2. Concepts of Modern Physics by Arthur Beiser
3. The atomic Nucleus by R D Evans
4. Nuclear Physics by D C Tayal
5. Introductory Nuclear Physics by Kenneth S. Krane

Web reference: *https://ebooks.inflibnet.ac.in/phyp04/chapter/nuclear-models-1/*

Course Code: PH-324

Course Title: Statistical Thermodynamics

Course Code: PH-324	Course Category: Major Course (DSC)
Course Title: Statistical Thermodynamics	Type: Theory
Total Contact Hours: 30 (2/week)	Course Credits: 02
College Assessment (CA): 20 Marks	University Assessment (UA): 30 Marks

Course Objectives:

1. To develop a foundational understanding of probability concepts and their role in describing physical systems at the microscopic level.
2. To introduce thermodynamic quantities such as temperature, heat, and entropy from both macroscopic and statistical perspectives.
3. To familiarize students with thermodynamic potentials and their application in analyzing equilibrium and energy transformations in physical systems.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Apply probability distributions and statistical methods to analyze physical systems and fluctuations.
2. Explain thermodynamic concepts such as temperature, entropy, and energy using both classical and statistical approaches, including the Boltzmann distribution.
3. Use thermodynamic potentials and Maxwell's relations to solve problems related to equilibrium and predict system behavior under different constraints.

Course Contents:

Unit 1: Basic concepts In probability (7 L, 7 M)

Probability, Discrete probability distributions, Continuous probability distributions, Linear transformation, Variance, Linear transformation and the variance, Independent variables, Binomial distribution

Reference: Chapter 3, Concepts in Thermal Physics by Stephen Blundell and Katherine Blundell

Unit 2: Temperature: some concepts in Physics (8 L, 8 M)

A definition of heat, Heat capacity, Thermal equilibrium, Thermometers, The microstates and macrostates, A statistical definition of temperature, Ensembles and types, Canonical ensemble, Applications of the Boltzmann distribution

Reference: Chapter 4, Concepts in Thermal Physics by Stephen Blundell and Katherine Blundell

Unit 3: Concept of Entropy (7 L, 7 M)

The first law of thermodynamics, The second law of thermodynamics, Definition of entropy, irreversible change, The first law revisited, The Joule expansion, The statistical basis for entropy, The entropy of mixing, Entropy and probability

Reference: Chapter 11, 13,14, Concepts in Thermal Physics by Stephen Blundell and Katherine Blundell

Unit 4: Thermodynamic potentials (8 L, 8 M)

Internal energy, Enthalpy, Helmholtz function, Gibbs function, Constraints, Maxwell's relations

Reference: Chapter 16, Concepts in Thermal Physics by Stephen Blundell and Katherine Blundell

Reference Books:

1. Concepts in Thermal Physics by Stephen Blundell and Katherine Blundell
2. Statistical and thermal physics by Lokanathan and Gambhir
3. Thermodynamics & Statistical Physics by Sharma & Sarkar
4. Statistical Mechanics by Gupta and Kumar
5. Fundamentals of Statistical Mechanics by B.B. Laud
6. Fundamental of Statistical & Thermal Physics by F. Reif

Course Code: PH-325

Course Title: Materials Science

Course Code: PH-325	**Course Category: Major Course (DSC)**
Course Title: Materials Science	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To introduce students to the fundamental concepts of materials science, including classification, structure, and functional properties of engineering materials.
- To develop understanding of crystal imperfections, diffusion mechanisms, and their influence on material behavior and performance.
- To familiarize students with mechanical properties of materials and their relevance in materials selection and engineering applications.

Course Outcomes:

- Students will be able to classify materials based on structure, properties, and applications, and explain their significance in engineering contexts.
- Students will analyze the role of defects and diffusion processes in determining material properties and behavior.
- Students will evaluate mechanical properties such as stress–strain behavior and apply this knowledge for appropriate material selection in practical situations.

Course Contents:

Unit 1: Introduction to Materials Science and Engineering (8 L, 8M)

What is Materials Science and Engineering? Classification of Materials: metals and alloys; ceramics, glasses, and glass-ceramics; polymers (plastics); semiconductors; and composite materials, Functional Classification of Materials, Classification of Materials Based on Structure, Environmental and Other Effects, Materials Design and Selection

Reference: Chapter 1, The Science and Engineering of Materials by Askeland, D. R., Pradeep P. Fulay & Wright, W. J.

Unit 2: Imperfections in solids **(7 L, 7M)**

Introduction, point defects: Vacancies and Self-Interstitials, Impurities in Solids, Specification of Composition, miscellaneous imperfections: Dislocations—Linear Defects, Interfacial Defects, Materials of Importance—Catalysts (and Surface Defects), Bulk or Volume Defects, Atomic Vibrations, microscopic examination: Basic Concepts of Microscopy, Microscopic Techniques, Grain-Size Determination

Reference: Chapter 4, Materials Science and Engineering: An Introduction by Callister, William D. Jr. and David G. Rethwisch

Unit 3: Diffusion of Solid Material - **(8 L, 8M)**

Introduction, Diffusion Mechanisms, Fick's First Law, Fick's Second Law—Non steady-State Diffusion, Factors That Influence Diffusion, Diffusion in Semiconducting Materials, Materials of Importance—Aluminum for Integrated Circuit Interconnects, Other Diffusion Paths

Reference: Chapter 5, Materials Science and Engineering: An Introduction by Callister, William D. Jr. and David G. Rethwisch

Unit 4: Mechanical Properties of Metals **(7 L, 7M)**

Introduction, Concepts of Stress and Strain, elastic deformation: Stress–Strain Behavior, Anelasticity, Elastic Properties of Materials, plastic deformation: Tensile Properties, True Stress and Strain, Elastic Recovery After Plastic Deformation, Compressive, Shear, and Torsional Deformations, Hardness

Reference: Chapter 6, Materials Science and Engineering: An Introduction by Callister, William D. Jr. and David G. Rethwisch

Reference Books:

1. Materials Science and Engineering: An Introduction by Callister, William D. Jr. and David G. Rethwisch
2. The Science and Engineering of Materials by Askeland, D. R., & Wright, W. J.
3. Materials Science and Engineering: A First Course by Raghavan, V.
4. Foundations of Materials Science and Engineering by Smith, W. F., Hashemi, J., & Prakash, R.
5. Elements of Materials Science and Engineering by Van Vlack, L. H.

Course Code: PH-326

Course Title: Laboratory-VII

Course Code: PH-326	Course Category: Major Course (DSC)
Course Title: Laboratory-VII	Type: Practical
Total Contact Hours: 60 (4/week)	Course Credits: 02
College Assessment (CA): 20 Marks	University Assessment (UA): 30 Marks

Course Objectives:

1. To develop experimental skills in core areas of physics, including mechanics, optics, electronics, thermal physics, and modern physics through hands-on laboratory work.
2. To familiarize students with scientific instruments and measurement techniques, such as G.M. counters, optical fibers, calorimeters, and electronic components.
3. To cultivate analytical and problem-solving abilities, including data collection, error analysis, and verification of physical laws through experiments.

Course Outcomes:

After successful completion of this laboratory course, students will be able to:

1. Perform and analyze physics experiments accurately, such as determination of surface tension, viscosity, gravitational acceleration, and optical properties.
2. Apply theoretical concepts to practical situations, including experiments on nuclear physics (G.M. counter), electronics (PN diode, oscillatory circuits), and modern physics (photoelectric effect, Boltzmann constant).
3. Interpret experimental data and validate physical laws, including probability distributions, Stefan's law, diffraction, and total internal reflection, with proper error estimation and reporting

List of Experiments:

1. Surface tension by Quinke's method.
2. Surface tension by soap bubble method.
3. Characteristics of G.M. counter.

4. Diffraction by straight edge/cylindrical obstacle.

5. e/m using Thomson's method.

6. Viscosity by rotating cylinder method.

7. Determination of 'g' by conical pendulum.

8. Study of oscillatory charge and discharge through inductance and resistance.

9. To determine value of Boltzmann Constant using V-I characteristics of PN diode.

10. To determine work function of material of cathode using photocell.

11. Stefan's fourth power law.

12. To measure the numerical aperture of an optical fiber.

13. Study of bending loss in optical fiber.

14. Jolly's steam calorimeter.

15. To determine temperature coefficient of platinum resistance thermometer using Calendar and Griffith Bridge.

16. μ by total internal reflection.

17. Verification of certain laws of probability distribution.

18. Study of box type Solar cooker.

19. Resolving power of grating.

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

1. A Text book of Practical Physics by Shrinivasan and Balasubranian.
2. B. Sc. Practical Physics by Harnam Singh and Dr. P. S. Hemne
3. Advanced Level Practical Physics by J. M. Nelkon, J. M. Ogloom
4. B. Sc. Practical Physics by C. L. Arora
5. Advanced level Physics Practicals by Michael Nelson and Jon M. Ogborn

Course Code: PH-327

Course Title: Laboratory-VIII (Simulation Based Practicals)

Course Code: PH-327	Course Category: Major Course (DSC)
Course Title: Laboratory-VIII (Simulation Based Practicals)	Type: Practical
Total Contact Hours: 60 (4/week)	Course Credits: 02
College Assessment (CA): 20 Marks	University Assessment (UA): 30 Marks

Course Objectives:

1. To strengthen understanding of advanced scientific concepts through interactive simulations.
2. To visualize abstract phenomena in physics.
3. To verify scientific laws and models using computational experiments.
4. To introduce students to programming tools such as Python, Scilab and PhET etc.
5. To create graphical representations such as plots, animations, and models.

Course Outcomes:

1. Explain advanced scientific concepts using simulations.
2. Design and implement simulations for physical systems
3. Analyze simulation data and correlate with theory.
4. Generate and interpret graphical representations of data.
5. Utilize simulation software and scientific computing tools effectively

List of Experiments:

1. To study the wave functions, probability densities, and energy levels for bound state electron. (https://phet.colorado.edu/en/simulations/bound-states) (Python/Scilab)
2. To measure the probabilities of spin quantum state of the electrons. (Python or Scilab or https://phet.colorado.edu/sims/html/quantum-measurement/latest/quantum-measurement_all.html)
3. Visualization of 3D crystal structure of the polycrystalline materials by using VESTA software.

Crystallography open Database link to get CIF files for crystal structure: https://www.crystallography.net/cod/

(Tutorials on VESTA software link)

https://www.youtube.com/watch?v=6JDFcPM2iEI&list=PLUhYFZgYOn8fMK21B5DbP0f5ROYYQ2aX3

4. Study Characteristics of RC Low pass or high pass filter (Scilab/Python).
5. To Measure the Resistivity of a Semiconductor (Ge) Crystal with Temperature by 4-Probe Method and Determine its Band gap (Scilab/Python).
6. To Study the Variation of Dielectric Constant with Temperature & Determine the value of Curie Temperature of Barium Titanate. (Scilab/Python).
7. Determination of wavelength of laser using diffraction grating by using Scilab/Python.
8. Measure the beam divergence of laser by using Scilab/Python.
9. Study the Maxwell–Boltzmann Distribution Simulation by using Scilab/Python.
10. Study the Random Walk (1D & 2D) Simulation by using Scilab/Python.
11. Study the Heat Capacity versus temperature curve by using Scilab/Python.
12. Study the radioactive decay behavior of radioactive material by using Scilab/Python
13. Calculate the Binding Energy Curve of any given material by Scilab/Python.
14. Calculate the Nuclear Radius of any given material by using Scilab/Python.

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Web References:

1. https://phet.colorado.edu/en/simulations/bound-states
2. https://www.crystallography.net/cod
3. https://www.scilab.org/design-of-experiments-and-optimization-of-aircraft-design
4. https://jp-minerals.org/vesta/en/download.html
5. https://www.python.org/downloads/

Course Code: PH-328 (A)

Course Title: Technical Electronics-II

Course Code: PH-328 (A)	Course Category: Major Course (DSE)
Course Title: Technical Electronics-II	Type: Theory
Total Contact Hours: 30 (2/week)	Course Credits: 02
College Assessment (CA): 20 Marks	University Assessment (UA): 30 Marks

Course Objectives:

1. To develop understanding of sound systems and audio devices, including microphones, loudspeakers, and public address (P.A.) systems along with their practical installation aspects.
2. To introduce various types of transducers and sensors, their classification, working principles, and applications in measuring physical and environmental parameters.
3. To familiarize students with modern electronic appliances and medical instruments, focusing on their operating principles, block diagrams, and real-world applications.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Explain the working principles of sound systems, including microphones, speakers, and P.A. systems, and design basic audio setups for practical applications.
2. Analyze and select appropriate transducers and sensors (such as LVDT, strain gauges, thermistors, and gas sensors) for different measurement and control applications.
3. Describe the operation of modern electronic appliances and medical instruments, such as microwave ovens, washing machines, ECG, and infrared thermometers, and interpret their functional block diagrams.

Course Contents:

Unit 1: Sound System **(10 L, 10M)**

Microphones: Definition, Types (list only), carbon microphone and dynamic type microphone (Principle, construction and working), Loud speakers: Characteristics, Dynamic (Moving coil type) speaker, Multiway speaker system (woofer and tweeter), Connection type of speakers (series, parallel and series-parallel type), of Public Address (P.A.) system: Block diagram and its explanation, requirements of P. A. system, typical P.A. Installation planning (Auditorium having large capacity, college sports), [R1, R2, R6].

Unit 2: Transducers (10P, 10M)

Definition, Classification, Selection of transducer, Electrical transducer: Thermistor, Thermocouple, Pressure Transducer: Strain gauges (wire, foil, & semiconductor), Displacement transducer: LVDT, Peizo-electric Transducer, Optoelectronic transducers: LDR, Chemical sensors: Gas sensor (Fundamental aspects), Humidity sensor (Resistive). [R2 to R5].

Unit 3: Modern appliances and Medical Instruments (10P, 10M)

Remote Control: Operating principle, block diagram, features.

Microwave Oven: Operating principle, block diagram, features.

Washing Machine: Operating principle, block diagram, features, Fuzzy Logic (Idea only),

Electronic Weighing Systems: Operating principle, Block diagram, features.

Infrared Thermometer: Operating principle, Block diagram, features.

Electrocardiogram (ECG): Biopotential, Principle, Block diagram, features [R6 totR9]

References:

1. Audio and Video Engineering System by R.G. Gupta
2. Basic Electronics bY B. L. Thereja
3. Transducers and display systems BY B.S. Sonde
4. Solid state Gas sensors- edited by P. T. Moseley and B.C. Tofeld
5. Measurement and Instrumentation Principles by Alan S. Morris
6. Consumer Electronics BY J.S. Chintode
7. 7.Introduction to Bio-medical Electronics BY Joseph-Du-bary
8. 8.Medical instrumentation Application and design by J. C. Wobster
9. 9. Biomedical instruments and measurements by L. Cromwell, F. J. Weibell

Course Code: PH-328 (B)

Course Title: Python for Physics-II

Course Code: PH-328 (B)	**Course Category: Major Course (DSE)**
Course Title: Python for Physics-II	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To introduce fundamental concepts of scientific computing using Python, focusing on numerical methods applicable to physics.
2. To develop understanding of key numerical techniques such as root finding, differentiation, and integration for solving physical problems.
3. To enable students to analyze and interpret computational results using array-based operations and vector methods.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Understand and apply Python-based numerical methods to solve equations, evaluate derivatives, and compute integrals relevant to physics.
2. Analyze and compare different numerical techniques (e.g., Bisection, Newton-Raphson, Trapezoidal, Simpson's methods) in terms of accuracy and efficiency.
3. Utilize array operations and vector concepts to model and solve scientific problems computationally.

Course Contents:

Unit 1: NumPy **(7 L, 7 M)**

Arrays; Indexing; Creating Arrays: array(), arrange(), linspace(). Basic Operations: Add, Subtract, Multiply and Divide. Introduction to Vector Operations.

Unit 2: Roots of equations **(7 L, 7 M)**

Real roots of single variable function; iterative approach; Closed domain methods (bracketing): Bisection; Open domain methods: Newton-Raphson.

Unit 3: Differentiation **(8 L, 8 M)**

Forward Difference; Central Difference; Backward Difference; Second Derivatives.

Unit 4: Integration **(8 L, 8 M)**

Trapezoid Rule; Simpson's Rule; Gaussian Quadrature; One and Multidimensional Monte Carlo Integration (Basic idea).

Reference Books:

1. Scientific Computing in Python by Abhijit Kar Gupta
2. Computational Physics by Mark Newman
3. Numerical Recipes: The Art of Scientific Computing by William H. Press et al.
4. Python for Scientists by J. M. Stewart
5. A Primer on Scientific Programming with Python by Hans Petter Langtangen
6. Python for Data Analysis by Wes McKinney

Course Code: PH-328 (C)

Course Title: Sensors & Transducers-II

Course Code: PH-328 (C)	**Course Category: Major Course (DSE)**
Course Title: Sensors & Transducers-II	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To provide fundamental knowledge of analog and digital transducers, including their types, principles, and applications in measurement systems.
2. To develop understanding of specialized sensors, such as flow measurement and magnetic sensors, along with their working mechanisms and performance characteristics.
3. To introduce the concept of smart sensors, including their structure, features like self-calibration and communication, and their role in modern technological applications.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Classify and explain different types of transducers, including analog, digital, electromechanical, and optical transducers, with their operating principles.
2. Analyze the working of flow and magnetic sensors, such as Coriolis flow meters, Hall effect sensors, and Villari effect-based devices, for real-world measurement applications.
3. Evaluate smart sensor systems, including their architecture, advanced features (self-testing, self-calibration), and applications in smart cities, robotics, and healthcare.

Course Contents:

Unit 1: Transducer **(8 L, 8M)**

Analog transducers**:** Electromechanical type, Potentiometric Resistance-type, **I**nductive type, Self-generating type, Non-self generating type, Capacitance type, Opto-electric transducer, Digital transducers: Frequency domain transducers, Digital encoders, Optical encoders, Shaft encoders.

Unit 2: Flow measurement Sensors **(7L, 7M)**

Flow measurement Transducer: Mass flow rate, Conveyor-based methods, Coriolis flow meter, Thermal mass flow measurement, Joint measurement of volume flow rate and fluid, density Volume flow rate.

Unit 3: Magnetic sensors **(7 L, 7 M)**

Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics.

Unit 4: Smart Sensors: **(8 L, 8M)**

General structure of smart sensors & its components, characteristics of smart sensors, self-calibration, self-testing & self-communicating, Application of smart of smart sensors: smart city, industrial robots & electric vehicles, body temperature and blood oxygen measurement using smart sensors.

Reference Books:

1. Transducers & Instrumentation by D.V.S. Murty
2. Transducers and display systems by B. S. Sonde
3. Measurement and instrument principle by Allen S. Morris
4. Sensor & transducers by D. Patranabis
5. Instrument transducers by H.K.P. Neubert
6. Measurement systems: application & design by E.A.Doebelin
7. Sensor & transducers by Ian R. Sinclair
8. Understanding Smart Sensors by Randy Frank
9. Smart Sensor Systems: Emerging Technologies and Applications by Gerard Meijer, Kofi Makinwa, and Michiel Pertijs

Course Code: PH-329 (A)

Course Title: Laboratory on PH-328 (A)

Course Code: PH-329 (A)		Course Category: Major Course (DSE)
Course Title: Laboratory on PH-328 (A)		Type: Practical
Total Contact Hours: 60 (4/week)		Course Credits: 02
College Assessment (CA): 20 Marks		University Assessment (UA): 30 Marks

Course Objectives:

1. To develop practical skills in electronic measurement and instrumentation, including the use of CRO, sensors, and operational amplifiers.
2. To provide hands-on experience with electronic components and systems, such as LDRs, thermocouples, LVDTs, and audio systems.
3. To understand the application of electronics in real-world systems, including medical instruments (ECG), sound systems, and temperature measurement devices.

Course Outcomes:

After successful completion of this laboratory course, students will be able to:

1. Operate and use electronic instruments effectively, such as CRO for measuring electrical parameters and analyzing waveforms.
2. Design and analyze basic electronic circuits, including OP-AMP applications (integrator, differentiator, subtractor) and sensor-based measurement systems.
3. Evaluate the performance of electronic devices and systems, such as loudspeakers, LDRs, thermistors, and ECG setups, and interpret their characteristics.

List of experiments:

1. To study characteristics of LDR.
2. Study of P. A. system (series and parallel connection of two speakers) and measurement of equivalent resistance.
3. Use of C.R.O as a measurement tool for different electrical parameters (frequency, a. c. /d. c. voltage, pulse height, pulse width, rise time and fall time).
4. Use of thermocouple for measurement of temperature.

5. Study of OP AMP as subtractor.
6. Study of OP- AMP as a differentiator.
7. Study of OP- AMP as an integrator.
8. Displacement measurement using LVDT.
9. Frequency response of loudspeaker (twitter, woofer, mid-range).
10. Study of E.C.G.
11. Thermistor as a thermometer using IC 741.

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference books:

1. Transducers and Instrumentation by D. V. S. Murty
2. Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney
3. Measurement Systems: Application and Design by Ernest O. Doebelin

Course Code: PH-329 (B)

Course Title: Lab on PH-328 (B)

Course Code: PH-329 (B)	Course Category: Major Course (DSE)
Course Title: Lab on PH-328 (B)	Type: Practical
Total Contact Hours: 60 (4/week)	Course Credits: 02
College Assessment (CA): 20 Marks	University Assessment (UA): 30 Marks

Course Objectives:

1. To introduce students to scientific computing using Python, with emphasis on numerical methods relevant to physics problems.
2. To develop programming skills for implementing mathematical techniques such as root finding, numerical differentiation, and integration.
3. To enable visualization, analysis, and comparison of numerical results using appropriate computational tools and libraries (e.g., NumPy, plotting tools).

Course Outcomes:

After successful completion of this course, students will be able to:

1. Apply Python programming and numerical methods to solve physical and mathematical problems such as equation roots, derivatives, and integrals.
2. Implement and compare various numerical techniques (e.g., Bisection, Newton-Raphson, Trapezoidal, Simpson's methods) and analyze their accuracy and efficiency.
3. Use scientific libraries (like NumPy) for array operations, vector calculations, data visualization, and perform computational experiments relevant to physics.

List of experiments

[A] Unit 1: NumPy

Experiment 1:

Write a Python program to create one-dimensional and two-dimensional arrays using NumPy.

Experiment 2:

Write a program to perform indexing and slicing operations on NumPy arrays.

Experiment 3:

Write a program to generate arrays using arange() and linspace() functions.

Experiment 4:

Write a program to perform addition, subtraction, multiplication, and division of two arrays.

Experiment 5:

Write a program to calculate dot product and cross product of two vectors.

[B] Unit 2: Roots of Equations

Experiment 6:

Write a Python program to find the root of an equation using **Bisection Method**.

Experiment 7:

Write a Python program to find the root of an equation using **Newton-Raphson Method**.

Experiment 8:

Write a Python program to compare roots obtained by Bisection and Newton-Raphson methods.

Experiment 9:

Write a Python program to plot a function graphically and estimate its root.

[C] Unit 3: Differentiation

Experiment 10:

Write a Python program to calculate derivative using **Forward Difference Method**.

Experiment 11:

Write a Python program to calculate derivative using **Backward Difference Method**.

Experiment 12:

Write a Python program to calculate derivative using **Central Difference Method**.

Experiment 13:

Write a Python program to evaluate second derivative numerically.

Experiment 14:

Write a Python program to compare exact derivative with numerical derivative.

[D] Unit 4: Integration

Experiment 15:

Write a Python program to evaluate definite integral using **Trapezoidal Rule**.

Experiment 16:

Write a Python program to evaluate definite integral using **Simpson's Rule**.

Experiment 17:

Write a Python program to evaluate definite integral using **Gaussian Quadrature Method**.

Experiment 18:

Write a Python program to evaluate integral using **Monte Carlo Method**.

Experiment 19:

Write a Python program for two-dimensional Monte Carlo integration.

Notes:

1. Perform any two experiments in every unit. Thus, total eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)
4. Enough PCs are essential to perform these Practicals.

Reference Books:

1. Computational Physics by Mark Newman
2. Numerical Recipes: The Art of Scientific Computing by William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery
3. Python for Scientists by J. M. Stewart
4. A Primer on Scientific Programming with Python by Hans Petter Langtangen
5. Python for Data Analysis by Wes McKinney
6. Computational Physics: Problem Solving with Python by R. H. Landau, M. J. Páez, and C. C. Bordeianu

Course Code: PH-329 (C)

Course Title: Lab on PH-328 (C)

Course Code: PH-329 (C)	**Course Category: Major Course (DSE)**
Course Title: Lab on PH-328 (C)	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To develop practical understanding of various sensors and transducers, including electromechanical, capacitive, piezoelectric, optical, and digital types.
2. To provide hands-on experience in measurement techniques, such as displacement, flow, pressure, and magnetic sensing using different transducers.
3. To introduce modern smart sensor systems and interfacing, including Arduino-based applications and real-time monitoring systems.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Operate and analyze different sensors and transducers, such as LVDT, encoders, Hall sensors, and flow meters, for measuring physical parameters.
2. Perform experiments and interpret sensor characteristics, including sensitivity, linearity, accuracy, hysteresis, and efficiency (e.g., solar cell, Hall effect).
3. Design and implement basic smart sensor systems, including Arduino-based projects like traffic light controllers and environmental monitoring systems.

List of experiments:

1. Study and demonstration of electromechanical transducers.
2. Measurement of displacement using potentiometric (resistive) transducer.
3. Study of capacitive transducer for displacement/level measurement.
4. Demonstration of piezoelectric transducer for pressure/vibration sensing.
5. Study of digital encoders (incremental and absolute).

6. Experiment on optical shaft encoder for angular position measurement.
7. Study of frequency domain transducers (frequency as output parameter).
8. Study of mass flow measurement techniques.
9. Demonstration of Coriolis flow meter (working principle).
   https://youtu.be/31jYXlnu-hU
10. Study of thermal mass flow sensor.
11. Measurement of flow using differential pressure method (Orifice/Venturi).
12. Study of rotameter (variable area flow meter).
13. Measurement of change in permeability with applied stress
14. Hall Effect Study: Performance Characteristics of Hall Sensor, Sensitivity, Linearity, Temperature dependence
15. Photovoltaic Effect in Solar Cell: V-I characteristics of photovoltaic cell, Determine efficiency
16. Smart Sensor Calibration & Performance: Accuracy, repeatability, hysteresis study
17. Smart Traffic light Controller
18. Smart Health Monitoring System
19. Design of Traffic Light Simulator using Arduino/ any other platform.
20. Interfacing LED. DHT11- Temperature and, humidity sensor using Arduino

Notes:

1. Any eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

1. Measurement and Instrumentation Principles (Butterworth-Heinemann) by Morris, Alan S. - Covers sensors, transducers, signal conditioning, and data acquisition.
2. A Course in Electrical and Electronic Measurements and Instrumentation by Sawhney, A.K. - Detailed text for industrial instrumentation.
3. Transducer Engineering by Renganathan, S. - Focuses on transducer applications and characteristics.
4. Transducers and Instrumentation by Murty, D.V.S.
5. Manual of Internet of things, LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

Course Code: PH-330

Course Title: Microcontrollers: Basics and application

Course Code: PH-330	**Course Category: Major Course (VSC)**
Course Title: Microcontrollers: Basics and application	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To introduce the fundamental concepts of microprocessors, microcontrollers, and embedded systems, along with their architecture and working principles.
2. To develop understanding of the 8051 Microcontroller architecture, memory organization, and basic programming for simple interfacing applications.
3. To familiarize students with modern embedded platforms like Arduino Uno and enable them to design basic real-world applications using sensors and communication modules.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Explain the working principles, architecture, and differences between microprocessors and microcontrollers, and identify components of embedded systems.
2. Develop simple programs and interface basic devices (LED, switches, LCD) using the 8051 Microcontroller.
3. Design and implement basic embedded applications using Arduino Uno, including sensor interfacing and communication through Bluetooth/WiFi modules.

Course Contents

Unit 1: Basics of Microcontrollers **(6L, 6 M)**

Introduction to Microprocessor & Microcontroller, Difference between Microprocessor and Microcontroller, Concept of Embedded System, General Block Diagram of Microcontroller, (CPU, RAM, ROM, I/O Ports, Timer, Serial Port, Clock), Working of Microcontroller (simple explanation), Applications of Embedded Systems (List only)

Unit 2: 8051 Microcontroller **(12 L, 12 M)**

Overview of 8051 microcontroller, Architecture and Block Diagram of 8051, (ALU, Registers,

RAM, ROM, Ports, Timer, Serial Communication), Pin diagram and functions (Port 0–3, Vcc, GND, XTAL), Internal memory organization (RAM, ROM), Basic programming (Embedded C / Assembly), Simple programs: LED blinking, switch interfacing, Interfacing: LED, Switch, LCD

Unit 3: Arduino (Advanced & Applications0 **(12 L, 12 M)**

Overview of Arduino Uno, Features and board structure, Block Diagram of Arduino System, (Microcontroller, USB interface, Power, I/O pins), Introduction to Arduino IDE, Arduino program structure (setup(), loop()), Programming basics: variables, operators, if-else, loops, Built-in functions: pinMode(), digital Write(), delay(), Interfacing: LED, Sensors (IR, Temperature), LCD, Communication: Bluetooth/WiFi module

Reference Books:

1. The 8051 microcontrollers (architecture, programming and applications) by Kenneth J. Ayala
2. The 8051 microcontroller and embedded systems by MA Mazidi and JG Mazidi
3. Arduino Book for Beginners: Getting started with Arduino and basic programming with projects by Arsath Natheem S.
4. Getting Started with Arduino by Massimo Banzi, O'Reilly

Course Code: PH-331

Course Title: Lab on PH-330

Course Code: PH-331	Course Category: Major Course (VSC)
Course Title: Lab on PH-330	Type: Practical
Total Contact Hours: 60 (4/week)	Course Credits: 02
College Assessment (CA): 20 Marks	University Assessment (UA): 30 Marks

Course Objectives:

1. To provide hands-on experience with microcontroller simulation and development environments such as EDSIM51 and Arduino IDE.
2. To develop programming skills for basic microcontroller operations including arithmetic tasks, input/output control, and simple interfacing.
3. To enable students to design and implement basic embedded applications using 8051 Microcontroller and Arduino Uno.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Use simulation tools like EDSIM51 and programming platforms like Arduino IDE for developing and testing microcontroller programs.
2. Write, execute, and debug simple programs for tasks such as LED blinking, switch interfacing, and pattern generation using both 8051 Microcontroller and Arduino Uno.
3. Implement basic embedded system applications by interfacing input and output devices, demonstrating understanding of real-time control and hardware interaction.

List of experiments:

[A] Experiments list: 8051 using EDSIM51

1. Study of EDSIM51 interface and features
2. Write program to add two numbers
3. Write and simulate program for LED blinking
4. Write program to turn ON/OFF LED using switch
5. Write program for LED pattern (running lights)

[B] Experiments list: Arduino

1. Study of Arduino IDE interface and installation
2. Study of Arduino Uno board and pin configuration
3. Write and upload program for LED blinking
4. Write program to control LED using push button
5. Write program for LED pattern (running LEDs)

Notes:

1. Perform any 4 experiments in [A] and any four experiments in [B]. Thus, total eight experiments need to be compulsorily performed.
2. The instructor can take more than 8 practical.
3. New experiments can be added to this list with prior permission from BOS (Physics)

Reference Books:

1. The 8051 microcontrollers (architecture, programming and applications) by Kenneth J. Ayala
2. The 8051 microcontroller and embedded systems by MA Mazidi and JG Mazidi
3. Arduino Book for Beginners: Getting started with Arduino and basic programming with projects by Arsath Natheem S.
4. Getting Started with Arduino by Massimo Banzi, O'Reilly.

Course Code: PH-332

Course Title: Field Project corresponding to the Major Subject

Course Code: PH-332	**Course Category: Major Course (FP)**
Course Title: Field Project corresponding to the Major Subject	**Type: Field Project**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

1. To provide hands-on field experience by enabling students to carry out the planned project work through site visits, observations, and interaction with stakeholders.
2. To develop skills in data analysis and scientific interpretation, including the use of graphs, charts, and systematic evaluation of results.
3. To train students in scientific report writing and presentation, including documentation, communication, and defense of project work

Course Outcomes:

After successful completion of this course, students will be able to:

1. Execute field work effectively, including data collection, use of instruments, and meaningful engagement with real-world systems or industries.
2. Analyze and interpret experimental/field data, using appropriate graphical and analytical methods to draw valid conclusions.
3. Prepare and present a comprehensive project report, and communicate findings clearly through oral/poster presentations and viva-voce.

Course Contents:

These activities are in connection with the study performed in Semester 5, related to the Course PH-321

Activity 1: Field work **(15 Hours | 15 Marks)**

In this activity it is expected that the student will do the field work in the topic chosen in the previous semester.

- The field work may include
- Visit to specific field/site/industry

    - Taking observations
    - Discussions with the stakeholders
    - Actual contribution in the activity
    - Use of suitable instruments if necessary
    - Recording the observations

Activity 2: Data Analysis, Report Writing & Presentation (15 Hours | 15 Marks)

- Data analysis using graphs, charts, and tables
- Interpretation of results and discussion
- Writing the Field Project Report with following structure:
    - Title, abstract, objectives
    - Methodology
    - Observations
    - Results and discussion
    - Conclusion and future scope
    - References and acknowledgements
- Oral presentation / poster / PPT preparation
- Viva-voce based on project work

*These are suggestive guidelines.