Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS,

SCIENCE AND COMMERCE, BARAMATI

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Faculty of Science

Department of Physics

Syllabus

For

S.Y. B.Sc. in Physics

From Academic Year 2020-2021

INDEX

Preamble:

Physics is concerned with the study of the universe from the smallest to the largest scale: it is about unraveling its complexities to discover the way it is and how it works. Discoveries in physics have formed the foundation of countless technological advances and play an important role in many scientific areas. Many techniques used in medical imaging, nanotechnology and quantum computing are derived from physics instrumentation. Even the World Wide Web was a spin-off from the information processing and communications requirements of high-energy particle physics. The contributions of physics to solving global problems such as energy production, environmental protection, global warming and public health are essential and have an enormous impact on our society.

The systematic and planned curricula from first year to the third year shall motivate and encourage the students for pursuing higher studies in Physics and for becoming an entrepreneur.

Objectives:

- To provide in depth knowledge of scientific and technological aspects of Physics
- To familiarize with current and recent scientific and technological developments
- To enrich knowledge through problem solving, hand on activities, study visits, projects etc.
- To train students in skills related to research, education, industry, and market.
- To create foundation for research and development in Electronics
- To develop analytical abilities towards real world problems
- To help students build-up a progressive and successful career in Physics

Eligibility:

1. First Year B.Sc.: Higher Secondary School Certificate (10+2) Science stream or its equivalent Examination as per the University of Pune eligibility norms.
2. Second Year B.Sc.: Keeping terms of First Year of B.Sc. with Physics as one of the subjects. Other students if they fulfill the conditions approved by the equivalence Committee of Faculty of Science of the University of Pune are also eligible.
3. Third Year B.Sc: Student shall pass all First Year B.Sc. courses and satisfactorily keeping terms of Second Year of B. Sc. with Physics as one of the subjects.

Admissions will be given as per the selection procedure/policies adopted by the Tuljaram Chaturchand College , in accordance with conditions laid down by the Academic Council of Anekant Education Society's, Tuljaram Chaturchand College, Baramati, Reservation and relaxation will be as per the Government rules for minority institution.

Proposed Structure of B.Sc. degree in physics and syllabus for first year degree in Physics as follows:

Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

F.Y, S.Y, T.Y.B. Sc. [Physics]

Class	Semester	Paper-I	Paper-II	Paper-III
F.Y.B.Sc.	I	Mechanics & Properties of Matter	Electromagnetics	Practical-I
	II	Heat and Thermodynamics	Waves and Optics	Practical-II
S.Y.B.Sc.	III	Electronics-I/ Instrumentation	Thermal Physics	Practical-I
	IV	Mathematical Methods of Physics-I	Elements of Modern Physics	Practical-II

T.Y.B.Sc.		**Sem-I**	**Sem-II**
	1	Mathematical Methods of Physics-II	Electrodynamics
	2	Classical Mechanics	Quantum Mechanics
	3	Optics	Statistical Physics
	4	Solid State Physics	Nuclear Physics
	5	Atomic and Molecular Physics	Electronics II/ Advanced Electronics
	6	Elective-I (Select any One) i) Elements of Material Science ii) Renewable Energy Sources iii) Physics and Technology of sensors. iv) Electronic instrumentation-I	Elective-II (Select any One) i) Physics of Nanomaterials ii) Solar Energy Conversion Devices iii) Sensors and its Applications iv) Electronic instrumentation-II
	7	Practical -I	Practical –III
	8	Practical -II	Practical -IV
	9	Project-I	Project-II

Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce,Baramati

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Course Structure for S.Y.B.Sc. Physics

Semester	Paper Code	Title of Paper	No. of Credits
I	PHY 2301	A] Electronics-I/ B] Instrumentation	3
	PHY 2302	Thermal Physics	3
	PHY 2303	Practical-I	2
II	PHY 2401	Mathematical Methods of Physics-I	3
	PHY 2402	Elements of Modern Physics	3
	PHY 2403	Practical-II	2

Class : S.Y.B.Sc. (Semester- I)
Paper code : PHY 2301
Paper : A Title of Paper: Electronics-I
Credit : 3 No. of lectures: 48

Learning outcomes:
On successful completion of this course the students will be able to

1. Apply laws of electrical circuits to different circuits.
2. Understand the properties and working of transistors.
3. Understand the functions of operational amplifiers.
4. Design circuits using transistors and operational amplifiers.
5. Understand the Boolean algebra and logic circuits.

UNIT-1: NETWORK THEOREMS [8]

1.1 Kirchhoff's laws (revision)

1.2 Voltage and Current divider circuits

1.3 Thevenin's theorem

1.4 Norton's theorem

1.5 Super-position theorem

1.6 Maximum power transfer theorem

1.7 Problems.

UNIT-2: Transistors [12]

2.1 Bipolar junction transistors, n-p-n and p-n-p Transistors

2.2 Transistor biasing

2.3 CB, CC, CE configurations and their Characteristics- Active, saturation and cut-off regions.

2.4 Current gains α, β, γ and their relationships.

2.5 DC operating point and AC and DC Load line, Q-Point.

2.6 Problems

UNIT-3: Operational Amplifiers [10]

3.1 Operational Amplifier

3.2 Characteristics of an Ideal and Practical Op-Amp (IC 741),

3.3 Concept of Virtual ground.

3.4 Applications of Op-Amps: Inverting and Non-inverting Amplifiers, Adder, Subtractor, Differentiator, Integrator, Problems

UNIT-4: Feed Back and Oscillator [6]

4.1 Basic principles of feedback,

4.2 Positive & negative feedback, Advantages of negative feedback,

4.3 Feedback circuits – voltage series & shunt, current series & shunt.

4.4 Oscillators, Types, Barkhausen Criterion

4.5 RC Oscillator -Phase Shift Oscillator

UNIT-5: Digital Electronics **[12]**

5.1 Binary Number system.

5.2 Decimal to Binary and Binary to Decimal Conversion,

5.3 Octal Numbers,

5.4 Hexadecimal Numbers,

5.5 ASCII code, Excess-3 code, Gray Code.

5.6 Basic Gates- AND, OR and NOT Gates. XOR and XNOR Gates

5.7 NAND and NOR Gates as Universal Gates. De Morgan's Theorems.

5.8 Boolean Laws. Simplification of Logic Circuit using Boolean algebra.

5.9 Binary Addition. Binary Subtraction using 2's Complement Method.

Reference Books:

1. Electronics Principles, Malvino, 8th Edition Tata Mc-Graw Hills.
2. Principles of Electronics, V. K. Mehta, S. Chand Publication New Delhi.
3. Op Amp and Linear integrated circuits, Ramakant Gaikwad, Prentice Hall of India Pub.
4. Integrated Circuts, K.R. Botkar, Khanna Publications, New Delhi
5. Digital Principles and Applications, Malvino and Leech Tata Mc-Graw Hills Pub

Class : S.Y.B.Sc. (Semester- I)
Paper code : PHY 2301
Paper : B Title of Paper: Instrumentation
Credit : 3 No. of lectures: 48

(For the students who have offered Electronic Science at F. Y. B. Sc.)

Learning outcomes: -

After successful completion of this course the students will be able to-

1. Understand the principles and functions of different instruments.
2. Use different instruments for measurement of various parameters.
3. Design experiments using sensors.

Unit 1: Fundamentals of Measurement (10)

1.1 Aims of measurement [Ref 1, Pages: 1-2]

1.2 Functional elements of typical measurement system (block diagram and its explanation) [Ref 1, Pages: 6-8]

1.3 Standard measurements and types of calibration methods [Ref 1, Pages: 19-27]

1.4 Static characteristics (accuracy, precision, sensitivity, linearity, repeatability, reproducibility, drift, hysteresis, resolution) [Ref 1, Pages: 29-33]

1.5 Dynamic characteristics: concepts of zero, first and second order systems, examples of first-order resistance thermometer and thermal element, examples of second order: U-tube manometer and seismic motion [Ref 1, Pages: 81-106]

1.6 Errors in measurement. (Definition and types)

1.7 Problems.

Unit 2: Transducers (10)

2.1 Measurement of displacement: variable resistance, inductance and capacitance methods. Variable capacitance transducers [Ref 1, Pages: 815-825]

2.2 Measurement of force: Load cell, cantilever beam

2.3 Measurement of temperature: I) Scales of temperature (Kelvin, Celsius, Fahrenheit etc.)
II) Methods of temperature measurement:

a. Non-electrical method – liquid filled thermometer, bimetallic thermometer.
b. Electrical method – Platinum resistance thermometer
c. Thermistor – PTC and NTC with characteristics
d. Radiation method – Type of pyrometers, selective and total radiation pyrometer

2.4 Problems [Ref 1, Pages: 739-758, 788-793].

Unit 3: Measurement of Pressure and Flow (10)

3.1 Unit of pressure, concept of vacuum, absolute gauge, and differential pressure

3.2 Elastic transducer – diaphragm, corrugated diaphragm, bellows, Bourdon tube

3.3 Electric type - LVDT, strain gauge

3.4 Flow meters- Introduction, definition and units, classification of flow meters

3.5 Mechanical type flow meter- orifice plate, venture tube, flow nozzle

3.6 Electric type flow meter-electromagnetic flow meter, ultrasonic flow meters.

3.7 Problems.

Unit 4: Analog Signal Conditioning (10)

4.1 Steps involved in Signal Conditioning, impedance matching

4.2 OP-AMP and its characteristics (ideal and practical), basic modes of operation

4.3 OP-AMP circuit used in instrumentation –precision rectifier, comparator, logarithmic amplifier, current to voltage and voltage to current converters

4.4 Instrumentation amplifier (Three OP-AMP configuration) [Ref 1, Pages: 873-903]

4.5 Active Filters-Low pass, High pass, band pass and band reject filter [Ref 1, Pages: 913-918]

4.6 Problems.

Unit 5: Display Devices (08)

5.1 Cathode ray Oscilloscope (CRO)- block diagram of general purpose oscilloscope and its basic applications

5.2 Digital storage oscilloscope (DSO)

5.3 LED display-OLED and AMOLED

5.4 LCD display

Reference Book:

1. A course in Electrical and Electronic Instrumentation [19th edition, 2012]- A. K. Sawhney (DhanpatRai& Co. Pvt. Ltd., New Delhi)
2. Instrumentation devices and systems- Rangan, Sarma, Mani [Tata McGraw Hill]
3. Instrumentation Measurement and Analysis – Nakra, Choudhari [Tata McGraw Hill]
4. Electronics Instrumentation – H.S.Kalsi [Tata McGraw Hill]
5. Sensor and Transducers – Patranabis [PHI]
6. Fundamental of Industrial Instrumentation- AlokBarua [Wiley India]
7. Instrumentation, measurement and systems-Nakra andChaudhary.

Class : S.Y.B.Sc. (Semester- I)
Paper code : PHY 2302
Paper : II Title of Paper: Thermal Physics
Credit : 3 No. of lectures: 48

Learning Outcome:

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

1. Describe the thermodynamic properties of a material.
2. Understand the ideal & real gas equation
3. Apply the laws of thermodynamics to formulate the relations necessary to analyse a thermodynamic process.
4. Understand the principle of the refrigerators to calculate coefficient of performance
5. Identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, chemical potential, Free energies, partition functions.
6. Apply the concepts and principles of black-body radiation to analyse radiation phenomena in thermodynamic systems

Unit 1: Kinetic Theory of gases and Transport Phenomena (12L)

Review, Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path, Transport phenomena-Transport of momentum (viscosity), Transport of thermal energy (conduction), Transport of mass (diffusion), Degrees of freedom, Law of equipartition of energy and its application to specific heat of gases (mono and diatomic).

Unit 2: Thermodynamic Potentials (10L)

Enthalpy, Gibbs free energy, Helmholtz and Internal Energy functions, Maxwell's relations & applications, Throttling process, Clausius- Clapeyron Equation (First and second order) , Expression for (CP – CV), CP/CV, TdS equations and its applications

Unit 3: Low temperature Physics (13L)

Joule-Thomson effect, porous plug experiment, liquefaction of gases, adiabatic demagnetization, practical applications of low temperatures , refrigerating machines, electroflux refrigerator, Frigidaire, air conditioning machines, effects of CF_2Cl_2 on Ozone layer.

Unit 4: Theory of radiation (13L)

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Reference Books:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press
3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications
4. Heat and Thermodynamics, M. W. Zemasky and R. Dittman, 1981, McGraw Hill
5. Thermodynamics, Kinetic theory & Statistical thermodynamics, F. W. Sears &

G. L. Salinger. 1988, Narosa
6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications
8. Heat and Thermodynamics - J. B. Rajam & C. L. Arora
9. Thermal Physics, A.B. Gupta and H. Roy, Books and Allied (P) Ltd., (2002.)

Class : S.Y. B. Sc. (Semester- I)
Paper code : PHY 2303
Paper : III Title of Paper: Practical-I
Credit : 2 No. of Practical: 10

Learning Outcome:
After successfully completing this laboratory course, the students will be able to do the following:

1. Acquire technical and manipulative skills in using laboratory equipment, tools, and materials.
2. Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.
3. Demonstrate an understanding of laboratory procedures including safety and scientific methods.
4. Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.
5. Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

List of Experiments: (Students have to perform Any 10 Experiments)

1. Circuit Theorems (Thevenin's, Norton's and Maximum power transfer theorem)
2. Transistor characteristics (CE configuration)
3. Thermal conductivity of rubber tube
4. OPAMP as inverting and non inverting amplifier
5. Study of logic gates (using IC) and verification of De Morgan's theorem
6. Use of CRO (AC/DC voltage measurement, frequency measurement)
7. Measurement of displacement (linear and angular) using potentiometer/variable inductor
8. Measurement of force using load cell.
9. Measurement of pressure using elastic diaphragm (in variable Capacitor/Bourdon Tube)
10. OPAMP as an adder and subtractor
11. Platinum Resistance Thermometer
12. Integrator and differentiator using IC 741
13. Temperature controller using Thermistor
14. Temperature controller using Thermocouple
15. Study of thermal conductivity by Lee's method
16. Phase shift Oscillator using IC 741

Class : S.Y.B.Sc. (Semester- II)
Paper code : PHY 2401
Paper : I Title of Paper: Mathematical Methods in Physics -I
Credit : 3 No. of Lectures: 48

Learning Outcomes: After the completion of this course students will be able to

- Understand the complex algebra useful in physics courses
- Understand the concept of partial differentiation.
- Understand the role of partial differential equations in physics
- Understand vector algebra useful in mathematics and physics
- Understand the singular points of differential equation
- Understand the Functions Fourier series and analysis

UNIT 1: Complex Numbers (12)

1.1 Introduction to complex numbers.
1.2 Rectangular, polar and exponential forms of complex numbers.
1.3 Argand diagram.
1.4 Algebra of complex numbers using mathematical and Argand diagram
1.5 De-Moivre's Theorem.
1.6 Powers, roots and log of complex numbers.
1.7 Trigonometric, hyperbolic and exponential functions.
1.8 Applications of complex numbers to determine velocity and acceleration in curved motion.
1.9 Problems.

UNIT 2: Vector Algebra and Vector Analysis (16)

2.1 Introduction to scalars and vectors.
2.2 Dot product and cross product of two vectors and its physical significance
2.3 Scalar triple product and its geometrical interpretation.
2.4 Vector triple product and its proof.
2.5 Scalar and vector fields.
2.6 Differentiation of vectors with respect to scalar.
2.7 Vector differential operator and Laplacian operator.
2.8 Gradient of scalar field and its physical significance.
2.9 Divergence of scalar field and its physical significance.
2.10 Curl of vector field.
2.11 Different vector identities.
2.12 Problems.

UNIT 3: Partial Differentiation and Differential Equation (12)

3.1 Definition of partial differentiation.
3.2 Successive differentiation.
3.3 Total differentiation.
3.4 Exact differential.
3.5 Chain rule.
3.6 Theorems of differentiation.
3.7 Change of variables from Cartesian to polar co-ordinates.

3.8 Implicit and explicit functions.
3.9 Conditions for maxima and minima (without proof).
3.10 Degree, order, linearity and homogeneity of differential equation.
3.11 Concept of Singular points. Example of singular points ($x = 0$, $x = x_0$ and $x = \infty$) of differential equation.
3.12 Problems.

UNIT4: Fourier series **(08)**

4.1 Definition
4.2 Evaluation of coefficient of Fourier series
4.3 Dirichlet's condition
4.4 Sine and cosine series
4.5 Graphical representation of even and odd function
4.6 Physical application of Fourier series analysis, square wave, half wave rectifier

Reference Books:

1. Methods of Mathematical Physics by Laud, Takwale and Gambhir
2. Mathematical Physics by B. D. Gupta
3. Mathematical Physics by Rajput and Gupta
4. Mathematical Methods in Physical Science by Mary and Boas
5. Vector analysis by Spiegel and Murrey
6. Mathematical Methods for Physicists by Arfken and Weber, 5th Edition, Academic Press.

Class : S.Y.B.Sc. (Semester- II)
Paper code : PHY 2402
Paper : II Title of Paper: Elements of Modern Physics
Credit : 3 No. of Lectures: 48

Learning Outcomes:
After the completion of this course students will be able to

1. Demonstrate understanding of the scientific method of work and the evolution of physics from the classical to its modern era.
2. Demonstrate knowledge and understanding of electric and magnetic phenomena in everyday life.
3. Discuss the nature of light and the electromagnetic spectrum and outline practical applications.
4. Demonstrate knowledge of the fundamentals of important physics theories (e.g. relativity, quantum) and discuss the way they challenge our preconceptions.
5. Explain radioactivity and discuss different aspects of nuclear energy in nuclear reactors and in the universe.

UNIT 1: Structure of Atom (16)

1.1 Introduction
1.2 Thomson Model
1.3 Rutherford Atom Model
    1. Theory of alpha particle scattering
    2. Rutherford scattering formula
    3. Experimental verification of Rutherford's scattering theory
1.4 Bohr Atom Model
    1. Basic postulates
    2. The Bohr Radius formula
    3. Hydrogen spectrum
    4. Effect of Nuclear motion on Atomic spectra
    5. Equation for the wave number of spectral lines of the atom
    6. Evidence in favor of Bohrs theory
1.5 Sommerfield Relativistic Atom Model
    1. Elliptical orbit for hydrogen and total energy
    2. Sommerfield relativistic theory
    3. Fine structure of the H line
1.6 The Vector Atom Model
    1. Introduction
    2. Spatial quantization
    3. Spinning electron
    4. Quantum numbers associated with vector atom model

UNIT 2: Nuclear Physics **(08)**

2.1 Introduction
2.2 Classification of nucleus
2.3 General properties of nucleus
2.4 Binding energy and nuclear stability
2.5 Theories of nuclear composition
2.6 Nuclear forces
2.7 Introduction to Semi-empirical mass formula

UNIT 3: Radioactivity **(12)**

3.1 Introduction
3.2 Fundamental laws of radioactivity
3.3 Half life and mean life
3.4 Radioactive dating : the age of the earth
3.5 Biological effects of nuclear radiation
3.6 Alfa, beta, and gamma decay and their properties
3.7 Concept of Fission and fusion

UNIT 4: Molecular spectra and lasers **(12)**

4.1 Introduction
4.2 Theory of origin of pure rotational spectrum of a molecule
4.3 Theory of origin of vibrational –rotational spectrum of molecule
4.4 Electronic spectra of molecule
4.5 Fluorescence and phosphorescence
4.6 Lasers
  4.6.1. Introduction
  4.6.2 Induced, Absorption, Spontaneous emission and stimulated emission
  4.6.3 Principle of lasers
  4.6.4 Types of lasers: Ruby laser, He-Ne Laser, semiconductor laser
  4.6.5 Properties of laser beam

Reference Books:

1. Elements of Modern Physics- Arther Baiser
2. Nuclear Physics- D. C. Tayal
3. Fundamentals of atomic structure and atomic model- Gerhard Hertzberg
4. Atomic Structure and Atomic Spectra- White
5. Atomic and Nuclear Physics- Subramanyam
6. Nuclear Physics- S. N. Ghoshal

Class : S.Y.B.Sc. (Semester-II)
Paper code : PHY 2403
Paper : III Title of Paper: Practical-II
Credit : 2 No. of Practical: 10

Learning Outcome:
After successfully completing this laboratory course, the students will be able to do the following:

1. Use various instruments and equipment.
2. Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
3. Investigate the theoretical background to an experiment.
4. Set up experimental equipment to implement an experimental approach.
5. Analyze data, plot appropriate graphs and reach conclusions from your data analysis.
6. Work in a group to plan, implement and report on a project/experiment

List of Experiments: (Students have to perform Any 10 Experiments)

1. Determination of Plank's constant
2. e/m by magnetic focusing
3. Millikan oil drop method to determine the charge on electron.
4. Work function of filament of directly heated vacuum diode.
5. Stefan's constant
6. Study of laser beam diversity
7. Determine the wavelength of Laser
8. Measurement of value of Boltzmann constant using I-V characteristic of PN diode
9. Thickness of sharp blade by laser diffraction
10. Wavelength of H-alpha emission line of Hydrogen atom
11. Determination of beta particle range
12. Verification of inverse square law
13. Plotting various trigonometric functions using MS-excel software: sin x, cos x, tan x, e^{x} , e^{-x} , log x, ln x, x^{n}
14. Equations and Graphs using MS-excel for the following figures: circle, ellipse, parabola, hyperbola.