Faculty of Science

Department of Physics

Syllabus

For

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

in Physics

For Academic Year 2021-2022

Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE AND COMMERCE, BARAMATI

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

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T.Y.B. Sc. Sem-V [Physics] 2021-2022

Semester	Paper Code	Title of Paper	No of Credits
V	PHY 3501	Mathematical Methods of Physics-II	3
	PHY 3502	Classical Mechanics	3
	PHY 3503	Advanced Optics	3
	PHY 3504	Solid State Physics	3
	PHY 3505	Atomic and Molecular Physics	3
	PHY 3506	Elective-I (Select anyone)	3
		A] Elements of Material Science	
		B] Renewable Energy Sources	
		C] Physics and Technology of sensors	
	PHY 3507	Practical I	2
	PHY 3508	Practical II	2
	PHY 3509	Project I	2
Total			24
VI	PHY 3601	Classical Electrodynamics	3
	PHY 3602	Quantum Mechanics	3
	PHY 3603	Statistical Physics	3
	PHY 3604	Nuclear Physics	3
	PHY 3605	Electronics II/ Advanced Electronics	3
	PHY 3606	Elective-II (Select anyone)	3
		A] Physics of Nanomaterials	
		B] Solar Energy Conversion Devices	
		C] Sensors and its Applications	
	PHY 3607	Practical III	2
	PHY 3608	Practical IV	2
	PHY 3609	Project II	2
Total			24

T. Y. B. Sc. Physics

PHY 3501: Mathematical Methods in Physics-II

Class: **T.Y. B. Sc. (Semester-V)** Paper: **I**

Credit: **3** No. of lectures: **48**

Learning Objectives:

1. To learn mathematical tools required to solve physical problem.
2. To understand mathematical concepts related to physics.
3. To understand generalized coordinate system

Learning Outcomes:

After successful completion of the course student will be able to

1. Learn some mathematical techniques required to understand the physical phenomena at the undergraduate level.

2. The students will solve nonhomogeneous differential equations and partial differential equations using simple methods.

3. The students are expected to be able to solve simple problems on Matrix.

4. Understand the generalized coordinate system and transformation equation between cartesian coordinate and generalized coordinates.

1. Curvilinear Co-ordinates (12 L)

1.1 Introduction to Cartesian

1.2 Spherical polar and Cylindrical co-ordinate systems

1.3 Transformation equations, General Curvilinear co-ordinate system

1.4 Co-ordinate surface, lines, length, and volume elements in curvilinear system

1.5 Orthogonal Curvilinear co-ordinate system,

1.6 Expressions for: a) gradient b) divergence c) Laplacian d) Curl in Cartesian system

2. Special Theory of Relativity (12 L)

2.1 Introduction of Special Theory of Relativity and its limitations.

2.2 Newtonian relativity Galilean transformation equation

2.3 Lorentz transformations

2.4 Length contraction, Transformation of velocities

2.5 Variation of mass with velocity, Mass-energy relation

2.6 Problems

3. Differential Equations (12 L)

3.1 Partial differential equations

3.2 Degree, order, linearity, and homogeneity (Revision)

3.3 Method of separation of variables, Singular points

3.4 Frobenius method for power series

3.5 Solution of Legendre, Hermite and Bessel differential equation

3.6 Problems

4. Special Functions (8 L)

4.1 Generating function for Legendre, Hermite Polynomials

4.2 Recurrence relations, differential equations, and properties of special functions

4.3 Bessel function of first kind and their properties

4.4 Problems

5. Matrix (4 L)

5.1 Definition and Types of Matrix

5.2 Matrix representation

5.3 Caley -Hamilton theorem of matrix

5.4 Problems

References Books:

1. Mathematical method for Physicists, Arfken and Weber, Academic press New York.
2. Mathematical Physics, Rajput, Pragati Prakashan
3. Mathematical methods in the Physical sciences – Marry L. Boas, John Willy and Sons Publication.
4. Introduction to special relativity, Robert Resnick, Willyeastrn Ltd.
5. Mathematical Physics, B. D. Gupta
6. Mathematical Physics, H. K. Dass

T.Y.B.Sc. Physics

PHY 3502: Classical Mechanics

Class: T.Y. B. Sc. Sem: V **Paper II**

Credit: 3 **No of lectures: 48**

Learning Objectives:

1. To understand the newtons laws and applications of newtons laws of motion
2. To understand the central forces, types of central forces and Kepler's laws of planetary Motion.
3. To know the Langrangian approach in classical mechanics.
4. To understand theory of scattering in detail

Learning Outcomes:

After completion of the course, the student should be able to:

1. The students will introduce about the newton's laws of motion, linear momentum, angular momentum, and knowledge about the applications of newton's laws of motion.
2. The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws.
3. This paper enables the students to understand the Langrangian approach in classical mechanics.
4. The students should be able to understand theory of scattering, types of scattering and differential cross section.

1. Mechanics of System of Particles (12 L)

1.1 Introduction –newton's laws, Limitations of Newton's Laws

1.2 Applications of Newton's laws of motion: Projectile motion in various medium, Rocket motion, Motion of a charged particle in constant electric, magnetic and electromagnetic field.

1.3 System of particles, Centre of mass, Conservation of linear momentum, angular momentum, energy of system of particles (statements only)

1.4 Problems

2. Motion in Central Force Field (12 L)

2.1 Types of forces: Forces of Gravitation, Lorentz force, Hooks Force, Frictional Force, Fundamental Forces of Nature Central force, equivalent one body problem

2.2 Motion in central force field

2.3 General features of motion, equation of orbit

2.4 Deduction of Kepler's laws of planetary motion

2.5 Orbits of artificial satellite

2.6 Problems

3. Scattering Theory of Particles (12 L)

3.1 Introduction, Elastic, and Inelastic Scattering

3.2 Laboratory and Centre of mass system

3.3 Relation between scattering angles in Lab and CM system

3.4 Inelastic scattering

3.5 Differential cross section, impact parameter and total cross section

3.6 Problems

4. Langrangian Formulation (12 L)

4.1 Limitations of Newtonian mechanics

4.2 Types of constraints, degrees of freedom, generalized coordinates, configuration space.

4.3 D'Alemberts principle, Virtual displacement, Principal of virtual work

4.4 Langrage's equation of motion from D'Alemberts principle

4.5 Equation of motion of Simple pendulum, spring mass arrangement, Attwood's machine, particle under gravity by using Langrangian formulation.

4.6 Problems.

Reference Books:

1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House.
2. Classical mechanics by N.C. Rana and P.S. Joag, Tata Mc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V. Panat, Narosa publishing Home, New Delhi.
4. Classical Mechanics by Kumar, Gupta, Sharma.
5. Classical Mechanics by H. Goldstein, Narosa Publishing Home, New Delhi.
6. Classical Mechanics by D. S. Mathur.
7. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

T.Y.B.Sc. Physics

PHY 3503: Advanced Optics

Class: T.Y. B. Sc. Sem: V **Paper III**

Credit: 3 No. of lectures: **48**

Learning Objectives:

1. Understand the diffraction and polarization processes and applications of them in physical situations.
2. Understand the applications of interference in design and working of interferometers.
3. Understand the resolving power of different optical instruments.

Learning Outcomes:

1. Describe how light can constructively and destructively interfere.
2. Explain why a light beam spreads out after passing through an aperture.
3. Analyze simple examples of interference and diffraction phenomena.
4. Be familiar with a range of equipment used in modern optics.

1. Interference (13 Lecture)

1.1 Revision to Interference

1.2 Phase change on reflection (Stokes Treatment)

1.3 Interference by parallel sided thin films

1.4 Interference due to reflected light

1.5 Interference due to refracted light

1.6 Interference due to Wedge Shaped thin film

1.7 Principle construction and working of Michelson Interferometer & its applications.

1.8 Problems.

2. Diffraction (13 Lecture)

2.1 Types of Diffraction: Fresnel's diffraction and Fraunhoffer's diffraction

2.2 Fraunhoffer's diffractions at a double slit

2.3 Plane diffraction grating

2.4 Newton's Rings

2.5 Rayleigh's criterion for resolution

2.6 Resolving power of telescopes and microscopes.

2.7 Dispersive and resolving power of grating.

2.8 Problems.

3. Polarization (13 Lecture)

3.1 Introduction

3.2 Brewster's law

3.3 Law of Malus

3.4 Polarization by double refraction.

3.5 Nicol prism.

3.6 Elliptically and circularly polarized light

3.7 Quarter wave plate

3.8 Polarimeter

3.9 Problems

4. Optical Fibber (09 Lecture)

4.1 Introduction

4.2 Structure and types of fibres

4.3 Numerical Aperture (Definition only)

4.4 Pulse dispersion in step index fiber

4.5 Optical communication system (Qualitative treatment only)

4.6 Advantages and disadvantages of optical fiber

4.7 Fiber materials, photonic crystal, fiber optic cables

4.8 Problems

References Books:

1. Textbook of Optics: N. Subrahmanyam and Brij Lal: S. Chand Publication.
2. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
3. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
4. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, S. Chand publication
5. University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986.Addison-Wesley
6. Fiber optic communication-Joseph C. Palais 4 th edition, Pearson Education

T. Y. B. Sc. Physics

PHY3504: Solid State Physics

Class: T.Y. B. Sc. Sem V **Paper IV**

Credit: 3 **No of lectures: 48**

Learning objectives:

1. Understand the basics of crystallography.
2. Understand electrical properties of metals and Band theory of solids.
3. Understand the basics of magnetism.
4. To study the basics of Solid-State Physics and Semiconductor Physics

Learning Outcomes:

This syllabus will also help students to lay a foundation for Materials science, electronics, and more advanced subjects like condensed matter in future.

1. Free Electron Theory of Solids (15 L)

1.1 Classical free electron theory of metals

1.2 Drawbacks of classical theory

1.3 Energy levels and Density of orbital in 1D and 3D

1.4 Bloch theorem (only statement and properties)

1.5 Nearly free electron model, Fermi energy, Fermi level

1.6 Hall Effect, Origin of energy gap

1.7 Energy bands in Solids,

1.8 Effective mass of electron (with derivation),

1.9 Distinction between metal,

1.10 Semiconductor and insulator

1.11 Problems

2. Crystalline Solids (16 L)

2.1 Introduction: Classification of solids (crystalline, amorphous & polycrystalline),

2.2 Lattice, Basis, Translational vectors

2.3 Primitive unit cell, Symmetry operations

2.4 Different types of lattices 2D and 3D (Bravais lattices)

2.5 Miller indices inter planer distances.

2.6 Number of atoms per unit cell,

2.7 Co-ordination number,

2.8 Atomic radius and packing fraction for SC, BCC and FCC structures

2.9 Study of NaCl, diamond, CsCl, ZnS and HCP crystals,

2.10 Concept of reciprocal lattice and its properties with proof.

2.11 X-ray diffraction: Crystal as a grating,

2.12 Bragg's law and Bragg's Diffraction condition in direct and reciprocal lattice

2.13 Ewald's construction,

2.14 Experimental methods of X-ray diffraction: Laue method, Rotating Crystal method, Powder (Debye Scherer) method

2.15 Problems

3. Semiconductor (6 L)

3.1 Intrinsic semiconductor

3.2 Conductivity

3.3 Carrier concentrations

3.4 Donor and Acceptor impurities

3.5 Extrinsic Semiconductor

3.6 Charge densities in a Semiconductor

3.7 Diffusion,

3.8 Carrier lifetime, the p-n junction as a diode

3.9 Volt-Ampere characteristics

3.10 Problems

4. Magnetism (11 L)

4.1 Diamagnetism,

4.2 Langevin theory of Diamagnetism

4.3 Application of diamagnetic material

4.4 Superconductor, Occurrence of Superconductivity,

4.5 Critical magnetic field and Meissner effect

4.6 Paramagnetism, Langevin theory of Para magnetism

4.7 ferromagnetism, ferromagnetic domains

4.8 Hysteresis, Curie temperature

4.9 Anti-ferromagnetism, Neel temperature,

4.10 Problems

Reference Books:

1. Solid State Physics-S.O.Pillai, 3rd Edition, New Age International (P) Ltd, Publisher, (1999).
2. Solid State Physics – Kakani and Hemrajani, S. Chand Publication.
3. Solid State Physics BySaxena, Gupta and Saxena, PragatiPrakation.
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics-A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Problems in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
8. Solid State Physics-Palanyswamy.
9. Solid State Physics- David, Snoke, Pearson Publication.
10. Semiconductor Physics and Devices: Donald Neamen (3rd Ed.) TMH.
11. S. M. Sze, 2nd ed, Semiconductor Devices: Physics and Technology. John Wiley & Sons.

T. Y. B. Sc. Physics

PHY 3505: Atomic and Molecular Physics

Class: **T.Y. B. Sc. (Semester- V)** Paper**: V**

Credit: **3** No. of lectures: **48**

Learning Objective:

After successful completion of the course students will be able to

1 The subject of Atomic and Molecular Physics has reached a significant advancement in high–precision experimental measurement techniques.

2 This area covers a wide spectrum ranging from conventional to new emerging multidisciplinary areas like molecular physics, optical science, especially spectroscopy.

3 In the present syllabus sequence of articles in each chapter enables the student to understand the gradual development of the subject.

Learning Outcomes:

Upon successful completion of this course, the student will understand.

1. The application of quantum mechanics in atomic physics
2. The importance of electron spin, symmetric and antisymmetric wave functions, and vector atom model
3. Effect of magnetic field on atoms and its application
4. Learn Molecular physics and its applications.
5. This course will be useful to get an insight into spectroscopy.

1. Atomic structure (8 L)

1.1 Rutherford model of atom

1.2 Electron orbits

1.3 Bohr atom and Sommer field atomic Model

1.4 Energy levels and spectra (1 to 4 Revision)

1.5 Vector atom model (Concepts of space and quantization and electron spin)

1.6 Atomic excitation and atomic spectra,

1.7 Problems Ref 1 ch4

2. One Valence Electron System (8 L)

2.1 Pauli Exclusion principle and electron configuration, quantum states, Spectral notations of quantum states.

2.2 Energy levels of Na atom, selection rules, spectra of sodium atom.

3. Two valence electron systems (8 L)

3.1 Spectral terms of two electron atoms, LS and JJ coupling schemes.

3.2 Lande's Interval rule, spectra of Helium atom

3.3 Problems, Ref 1: ch7, Ref. 2: ch8 and ch12

4. Zeeman Effect (8 L)

4.1 Early discoveries and developments

4.2 Experimental arrangement

4.3 Normal and anomalous Zeeman Effect

4.4 Stark effect (Qualitative discussion)

4.5 Problems Ref 2 ch10

5. X ray spectroscopy (8 L)

5.1 Nature of X rays

5.2 Discrete and continuous Xray spectra, Daune and Hunt's Rule

5.3 Xray emission spectra

5.4 Mosley's law and its applications

5.5 Auger effect

5.6 Problems Ref 2 ch16

6. **Raman spectroscopy (8 L)**

6.1 Classical theory of Raman Effect. Molecular polarizability

6.2 Quantum theory of Raman Effect

6.3 Experimental set up for Raman Effect

6.4 Applications of Raman spectroscopy Ref 3 ch4

Reference Books:

1. Concepts of Modern Physics 4 th edition Arthur Baiser (McGraw Hill International ed)
2. Introduction to Atomic spectra White. H. E (McGraw Hill International edition)
3. Fundamentals of Molecular spectroscopy, C.N. Banwell and E.M Mc Cash (McGraw Hill International edition)
4. Modern Physics, J.B. Rajam

T. Y. B. Sc. Physics

PHY 3506: A] Elements of Material Science

Class: T.Y. B. Sc. Sem V (Elective) **Paper VI**

Credit: 3 **No of lectures: 48**

Learning objectives:

1. Students will demonstrate an understanding of core graduate-level theoretical knowledge in materials science.
2. An ability to use modern techniques, skills, and engineering tools appropriate to materials science.
3. An integrated understanding of structure, properties, processing, and performance of materials systems.

Learning Outcomes:

1. Students are able to apply knowledge of advanced science and engineering principles to materials systems.
2. Students will demonstrate proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.
3. An ability to apply knowledge of mathematics, science, and engineering to materials issues.
4. An ability to design and conduct experiments and critically analyse and interpret data.

1. Introduction to Materials Science (12 L)

1.1 Historical perspectives of materials science

1.2 Classification of materials

1.3 Smart materials

1.4 Nano structured Materials

1.5 Organic Materials: Chemistry of polymer molecule, Molecular weight, Molecular structure

1.6 Material Properties: Mechanical, Electrical, Thermal and Magnetic

2. Defects in Solids (12L)

2.1 Types of materials: Conductors, Semiconductors, and Insulators

2.2 Defects in solids: Point, Line, Surface, and Volume

2.3 Solid solutions and their applications, Rules of solid solubility

2.4 Hume-Rothery's Rules of formation of solid solution

2.5 Diffusion in Solids: Introduction, Mechanisms of diffusion, Fick's laws of diffusion, Solution to Fick's second law, Few applications of diffusion process,

2.6 Kirkendall effect with example

3. Phase Diagram (12L)

3.1 Basic terms: System, Surrounding, Component, Coordinates, Phase, Equilibrium.

3.2 Phase Diagram: definition, importance, and objective

3.3 Lever rule, Gibb's phase rule

3.4 Phase diagram of a) Sugar water b) NaCl water

3.5 Types of phase diagrams with construction

3.6 Type-I: Lens type CuNi phase diagram

3.7 Type-II: Only introduction

3.8 Type-III: Eutectic type Pb-Sn phase diagram

3.9 Some applications of phase diagrams

4. Ceramic and Ferrite Materials (12L)

4.1 Ceramic Phases, Classification of ceramic materials, Ceramic crystals (AX)

4.2 Mechanical behavior of ceramics

4.3 Electric properties of ceramics: dielectrics, semiconductors, piezoelectric

4.4 Magnetic Properties of ceramics: Magnetic Ceramics, hard and soft ferrites.

Reference books:

1. Elements of materials science and Engineering: H. Van Vlach
2. Materials Science and Engineering: V. Raghavan
3. Material Science: S. L. Kakani and Amit Kakani
4. Solid State Physics: A. J. Dekker
5. Materials Science & Engineering: An Introduction (6th Edition): William D. Callister

List of experiments:

1. Determination of the yield point and the breaking point of an elastic material
2. To determine magnetic susceptibility of $FeCl_3$
3. To determine the dipole moment of a given liquid
4. To determine the specific heat of graphite
5. Ionic conductivity of NaCl
6. Synthesis of metal oxide ceramic powder by solid state route
7. Plotting Pb-Sn phase diagram

T. Y. B. Sc. Physics

PHY 3506: B] Renewable Energy Sources

Class: **T.Y. B. Sc. Semester-V** (Elective) **Paper: VI**

Credit: **3** No. of lectures: **48**

Learning Objectives:

1. To create awareness of environment quality
2. To develop skills in handling equipment's related to solar energy, biogas etc
3. To create manpower in renewable energy
4. Understand the various forms of conventional energy resources.
5. Learn the present energy scenario and the need for energy conservation.
6. Explain the concept of various forms of renewable energy.

Learning Outcomes:

1. Know the need of renewable energy resources and latest developments.
2. Use of solar energy in the energy production with different applications like - heating, cooling, desalination, power generation, drying, cooking etc
3. Appreciate the need of Wind Energy and the various components used in energy generation.
4. Understand the concept of Biomass energy resources and their classification.

1. **Solar Energy** **(12 L)**

1.1 Energy resources and forms of energy, Energy from sun

1.2 Solar constant, solar thermal collectors, solar pond, Solar boiler

1.3 Principle of Photovoltaic cell

1.4 IV characteristics of solar cell

1.5 Large solar PV system,

1.6 Solar PV power system for space station

1.7 Assembly and maintenance

1.8 Solar charging, solar air heating and cooling system, Thermal pad

1.9 Solar water heaters, solar cookers, solar drying

1.10 Solar photovoltaic system

1.11 Solar energy pumps.

2. Energy Storage System **(10 L)**

2.1 **Battery:** Introduction

2.2 Battery Energy Storage Systems

2.3 Lead Acid Battery Cells,

2.4 Nickel-Cadmium Battery

2.5 Li-ion Battery,

2.6 Advanced Batteries.

2.7 **Fuel Cell:** Introduction,

2.8 Advantages of Fuel cell power sources,

2.9 Principle and operation of Fuel Cell

2.10 Classification and Types of Fuel Cells

3. Biomass energy (10 L)

3.1 Introduction

3.2 Biomass for urban waste and rural waste to biogas energy

3.3 Agricultural waste and agricultural energy crops, fruit farms

3.4 Anaerobic fermentation process in biogas plants

3.5 Principal of marine bioenergy resources

3.6 Bio-hydrogen production

3.7 Isolation of methane from Biogas & packing and its utilization.

3.8 Introduction to gasifiers.

4. Wind Energy (10 L)

4.1 Introduction, Basic concept, and component of wind energy conversion

4.2 Types of wind machines

4.3 Application of wind machine

4.4 Hybrid wind energy systems wind + diesel power

4.5 Wind + conventional grid

4.6 Wind + Photovoltaic system etc.

4.7 Wind to electrical energy conversion alternatives

4.8 Wind map of India,

4.9 Wind electrical energy stations in India.

5. Energy Audit (06 L)

5.1 Introduction

5.2 Types of energy audits

5.3 Walk through energy audit

5.4 Case Study, Audit report

5.5 Intermediate & Compressive Energy audit

5.6 Procedure of energy auditing.

Case Study: 1. Solar PV Panel

2. Biogas production from kitchen waste

References:

1 Biomass Renegerable Energy – D.O.hall and R.P. Overeed (John Wiley and Sons, New york, 1987)

2 Biomass for energy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss (Pergamon Press Ltd. 1982)

3 Thermo chemical processing of Biomass, Bridgurater A V.

4 Biomass as Fuel – L.P.White (Academic press1981)

5 Biomass Gasification Principles and Technology, Energy technology review No. 67, T.B. Read (Noyes Data Corp., 1981)

List of experiments:

1. Study of solar cell characteristics
2. PV- IV characteristics of solar cell
3. Performance evaluation of box type Solar Cooker
4. Recording the amount of sunlight receives throughout a day using Sunshine recorder.
5. Utilizing the latent heat absorbed by the condensing water steam using Solar Still.
6. Measure the solar radiation flux density using Pyrometer.

T.Y.B.Sc. Physics

PHY 3506: C] Physics and Technology of Sensor

Class: T.Y. B. Sc. Sem: V (Elective) Paper VI

Credit: 3 No of lectures: 48

Learning objectives:

1. Select the right sensor for a given application.
2. Understand physics behind sensor fabrication.
3. Simulate, synthesize, and layout a complete sensor or sensor system, a device or microsystem.

Learning Outcome:

At the end of this course, students will be able to:

1. Understand the concept of sensors and its characteristics.
2. Understand the practical approach in design of technology based on different sensors.
3. Learn various sensor materials and technology used in designing sensors.

1. Sensors Classification and Characteristics (8 L)

1.1 Fundamentals and Characteristics Sensors

1.2 Signals and Systems

1.3 Sensor Classification

1.4 General specifications of sensors and transducers

1.5 Sensor Characteristics

1.6 Selection Criteria for sensors and transducers

1.7 Problems

2. Physical Principles of Sensing (12 L)

2.1 Resistive Sensors

2.2 Pressure Inductive sensor

2.3 Magnetic flow meter

2.4 Piezo electric sensors

2.5 Photo electric and Photo voltaic

2.6 Temperature and Thermal Properties of Material

2.7 Heat Transfer

2.8 Problems

3. Acceleration and Pressure Sensors (12 L)

3.1 Accelerometer characteristics

3.2 Capacitive accelerometers

3.3 Piezo-resistive accelerometers

3.4 Piezoelectric accelerometers

3.5 Thermal accelerometers heated plate accelerometer, heated gas accelerometer.

3.6 Gyroscopes, rotor gyroscope, optical gyroscopes, piezoelectric cables.

3.7 Strain Gauges, piezoelectric force sensors

3.8 Pressure gauges: mercury pressure sensor, bellows, membranes and thin plates, optoelectronic sensors.

4. Flow, Acoustic and Humidity Sensors (12 L)

4.1 Basics of flow dynamics

4.2 Pressure gradient technique

4.3 Thermal transport sensors

4.4 Ultrasonic sensors

4.5 Electromagnetic Sensors

4.6 Acoustic sensors: resistive microphones, condenser microphones

4.7 Fiber optic microphone Piezoelectric microphones, electric microphones

4.8 Solid state acoustic detectors

4.9 Humidity and moisture sensors, concept of humidity

4.10 Capacitive sensors,

4.11 Electrical conductivity sensors – thermal conductivity sensor.

5. Sensor Materials and Technologies (4 L)

5.1 Sensor Materials

5.2 Surface Processing

5.3 Technology of Sensors

Reference Books:

1. D. Patranabis, Sensors and Transducers, 2nd ed., Prentice-Hall of India (2005).
2. Jacob Fraden, Handbook of Modern Sensors: Physics, Design, and Application, 3rd edition, Springer (2004).
3. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer

4. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).
5. Sensors and Transducers- Dr. A. D. Shaligram

List of Experiments:

1. Characteristics of Piezo-electric Transducer
2. Characteristics of Thermocouple
3. Operation of digital humidity sensor
4. Study of resistive soil moisture sensor
5. Study of digital response an IR motion sensor

T.Y.B.Sc. Physics

PHY 3507: Practical -I

Class: T.Y. B. Sc. Sem: V **Paper VII**

Credit: 2 **No of Practical: 10**

Student has to perform any EIGHT experiments from the list given below plus any TWO experiments from the optional subject. (TOTAL 10 experiments)

1. Moment of Inertia by Bifilar suspension
2. Young's modulus by Koeing method
3. Katter's pendulum
4. Y by vibration of wooden scale
5. Determination of Resolving Power of grating
6. Determination of wavelength of light by Michelson's interferometer
7. Young's modulus by Newton's rings
8. Determination of wavelength by Constant deviation spectrometer
9. Determination of refractive index of liquid using hollow prism.
10. Llyod's mirror
11. Study of diffraction using a reflection grating (metal ruler)
12. Determination of wavelength of given source by Newton's rings.

T.Y.B.Sc. Physics

PHY 3508: Practical -II

Class: T.Y. B. Sc. Sem: V **Paper VIII**

Credit: 2 **No of Practical: 10**

Student has to perform any EIGHT experiments from the list given below plus any TWO experiments from the optional subject. (TOTAL 10 experiments)

1. Energy gap of a semiconductor
2. Resistivity by Four probe method
3. Platinum resistance thermometer
4. Core losses in transformers
5. Hall Effect
6. Electromagnetic pendulum
7. Study of damped oscillations of physical pendulum and finding log decrement.
8. Verification of Stefan's law by torch bulb filament
9. Thermal conductivity by Forbes Method.
10. Thermal conductivity of rubber tubing
11. Determination of Rydberg's constant
12. Dielectric constant of a non-polar liquid

T.Y.B.Sc. Physics

PHY 3509: Project -I

Class: T.Y. B. Sc. Sem: V Paper IX

Credit: 2

The student will have to perform the project course for both semesters V and VI. The continuous evaluation of the project will be done during each semester. Student must complete 50% project work in semester V and evaluation will be done at the end of semester and credit will be assigned to the students according to their performance.

T. Y. B. Sc. Physics

PHY 3601: Classical Electrodynamics

Class: **T.Y. B. Sc. (Semester-VI)** Paper: **I**

Credit: **3** No. of lectures: **48**

Learning Objectives

a) To understand the meaning of Maxwell's equations.

b) To understand concept of Polarization & magnetization of materials.

a) To understand dielectrics and effect of dielectric on electric field.

Learning Outcomes

After successful completion of the course student will be able to

a) Solving electromagnetic problems.

b) Students can get idea and able to take interest in the research concerning synthesis & application of dielectrics & Magnetic materials.

1. Electrostatics: (18 L)

1.1. Coulomb's law, Gauss law, Electric field, Electrostatic Potential
1.2. Potential energy of system of charges.
1.3. Statement of Poisson's equation, Boundary Value problems in electrostatics- Solution of Laplace equation in Cartesian system,
1.4. Method of image charges: Point charge near an infinite grounded conducting Plane, Point charge near grounded conducting sphere.
1.5. Polarization **P**, Electric displacement **D**, Electric susceptibility, and dielectric Constant, bound volume and surface charge densities.
1.6. Electric field at an exterior and interior point of dielectric.
1.7 Problems.

2.Magnetostatics: (14 L)

2.1. Magnetic induction, magnetic flux, magnetic field and static magnetic fields
2.2. Magnetic induction due to straight current carrying conductor, Energy density in magnetic field, magnetization of matter. Relationship between **B, H** and **M.**
2.3 Biot-Savart's law, Ampere's law for force between two current carrying loops, Ampere's circuital law,
2.4 Equation of continuity, Magnetic vector potential **A**.
2.5. Magnetic susceptibility and permeability, Hysteresis loss, B-H curve.
2.6 Problems.

3. Electrodynamics: (16 L)

3.1. Concept of electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law
3.2. Maxwell's equations (Differential and Integral form) and their physical Significance
3.3 Maxwell's equations in terms of scalar and vector potentials.
3.4. Polarization, reflection & refraction of electromagnetic waves through media

3.5. Wave equation and plane waves in free space.
3.6. Poynting theorem & Poynting vector, Polarizations of plane wave.
3.7. Microscopic form of ohm's law ($\mathbf{J}=\sigma\mathbf{E}$)
3.8 Problems.

Reference Books:

1) Introduction to Electrodynamics - By D. J. Griffith
2) Classical Electrodynamics – By J. D. Jackson.
3) Introduction to Electrodynamics - By A. Z. Capri, Panat P. V.
4) Electricity and magnetism – By Reitz and Milford
5) Electrodynamics - By Gupta, Kumar, Singh (PragatiPrakashan)
6) Electromagnetic field and waves - By Paul-Lorrain and Dale R Corson
7) Electricity and magnetism – By Murugeshan (S. Chand)

T. Y. B. Sc. Physics

PHY 3602: Quantum Mechanics

Class: **T.Y. B. Sc. (Semester-VI)** Paper: **II**

Credit: **3** No. of lectures: **48**

Learning Objectives

a) To understand and learn Theoretical aspects at Quantum Level.

b) To know more about the insight of the microscopic world.

Learning Outcomes

After successful completion of the course student will be able to

a) Understand the necessity of Quantum Mechanics.

b) Understand the behavior of particles under Classical and Quantum conditions.

c) Understand the Operators in Quantum Mechanics.

d) Learn about Schrodinger's equations.

1. Origin of Quantum Mechanics: (10 L)

1.1: Historical Background a) Review of Black body radiation.

1.2: Matter waves - De Broglie hypothesis. Davisson and Germer experiment.

1.3: Wave particle duality

1.4: Wave function of a particle having definite momentum.

1.5: Concept of wave packet, phase velocity, group velocity and their relations

1.6: Heisenberg's uncertainty principle with thought experiment. - Electron diffraction experiment, different forms of uncertainty.

1.7: Problems

2. The Schrodinger equation:(12 L)

2.1: Introduction,

2.2: Physical interpretation of wave function

2.3: Schrodinger time dependent equation.

2.4: Schrodinger time independent equation. (Steady state equation).

2.5: Probability current density, equation of continuity

2.6: Eigen function and Eigen values, Expectation value – Ehrenfest's theorem

2.7: Problems

3. **Applications of Schrodinger Steady state equation: (12 L)**

    3.1: Free particle.

    3.2: Particle in infinitely deep potential well (one - dimension).

    3.3: Particle in three-dimension rigid box.

    3.4: Step potential

    3.5: Potential barrier penetration and tunnelling effect.

    3.6: Harmonic oscillator (one-dimension),

    3.7: Problems

4. **Spherically symmetric potentials: (6L)**

    4.1: Schrodinger's equation in spherical polar co-ordinate system.

    4.2: Rigid rotator (free axis).

    4.3: Hydrogen atom: radial and angular parts of the bound state energy, energy state functions, Quantum numbers n, l, m_l , m_s .

    4.4: Problems

5. **Operators in Quantum Mechanics: (8L)**

    5.1: Definition of an operator in Quantum mechanics. - Eigen function and Eigen values.

    5.2: Position, Momentum operator, energy operator, angular momentum operator, and total energy operator (Hamiltonian).

    5.3: Commutator algebra.

    5.4: Commutator brackets using position, momentum and angular momentum. operator.

    5.5: Problems

REFERENCES:

1. Quantum Mechanics by Noureddine Zettili, A John Wiley and Sons, Ltd.
2. Modern Quantum Mechanics by J. J. Sakurai.
3. A Textbook of Quantum Mechanics by P. M. Mathews and K. Venkatesan.
4. Quantum mechanics by A. Ghatak and S. Lokanathan.
5. Quantum Mechanics by L. I. Schiff.
6. Quantum Physics by R. Eisberg and R. Resnick.
7. Introduction to Quantum Mechanics by David J. Griffiths.

T. Y. B. Sc. Physics

PHY 3603: Statistical Physics

Class: **T.Y. B. Sc. (Semester-VI)** Paper: **III**

Paper Code: **PHY3603** Title of Paper: **Statistical Physics**

Credit: **3** No. of lectures: **48**

Learning Objectives

a) To understand various concepts of statistics and to apply them in thermodynamics.

b) To understand the necessity of studying Statistical Mechanics in light of knowledge of Classical and Quantum Mechanics.

c) To understand the behavior of particles under Classical and Quantum condition.

Learning Outcomes

After successful completion of the course student will be able to

a) Understand the relevant quantities used to describe macroscopic systems, thermodynamic potentials and ensembles.

b) Understand the concepts of partition functions by taking into account the different types of ensemble.

c) Describe the consequences in classical and quantum statistics.

d) Embracing the concepts of ideal Bose and fermi systems through the principle of statistical Mechanics.

e) Show an analytic ability to solve the statistical mechanics problems.

1. Elementary Concepts of Statistics: [6 L]

1.1 Revision of concepts and laws of thermodynamics

1.2 Probability, distribution functions

1.3 Random Walk and Binomial distribution

1.4 Calculation of mean values,

1.5 Probability distribution for large-scale N

1.6 Problems

2. Statistical Distribution of System of Particles: [8 L]

2.1 Specification of state of system,

2.2 Microstate and Macrostates

2.3 Thermodynamic Probability

2.4 Constraints on a system

2.5 Basic Postulates of statistical mechanics

2.6 Postulate of equal a priori probability

2.7 Probability Calculations

2.8 Problems

3. Interactions in the systems [9 L]

3.1: Density of state

3.2: Behaviour of density of state of a system

3.3: Equilibrium and constraints

3.4: Systems in thermal equilibrium

3.5: Boltzmann Canonical Distribution

3.6: Thermal Interaction

3.7: Mechanical Interaction

3.8: General Interaction

3.9: Problems

4. Statistical Ensembles: (8 L)

4**.1** Micro canonical Ensemble (Isolated System)

4.2 Characteristics of microcanonical ensemble

4.3 Canonical ensembles

4.4 Grand canonical ensemble

4.5 Simple application of canonical ensemble

4.6 Molecules in an Ideal gas

4.7 Problems

5. Mean Values, Entropy and Partition function: (9 L)

5.1 Mean values in canonical ensemble

5.2 Mean energy

5.3 Mean square energy

5.4 Mean Square Deviation

5.5 Mean Pressure

5.6 Entropy and Partition Function Definition

5.7 Entropy in terms of Partition Function and Mean Energy

5.8 Entropy and probability

5.9 Problems

6. **Quantum Statistics: (8L)**

6.1 Symmetric and Anti-Symmetric Wave Functions

6.2 Quantum distribution function

6.3 Introduction to:

6.3.1 Maxwell-Boltzmann's statistics

6.3.2 Bose-Einstein Statistics

6.3.3 Fermi-Dirac Statistics

6.4 Problems

REFERENCES:

1 Statistical and Thermal physics - By Lokanathan, R.S. Gambhir,

2. Fundamentals of statistical and thermal physics - By F. Reif

3. Perspectives of modern physics - By A. Beiser

4. Fundamental of Statistical Mechanics - By B.B. Laud

5. A primer of Statistical Mechanics - By R.B. Singh

6. Statistical Mechanics - By Gupta, Kuma

T. Y. B. Sc. Physics

PHY 3604: Nuclear Physics

Class: **T.Y. B. Sc. (Semester- VI)** Paper**: IV**

Credit: **3** No. of lectures: **48**

Learning Objectives:

a) The present Nuclear Physics course is designed to cover all areas of the subject with research and application of nuclear energy.

b) In India, courses on nuclear physics are provided on different levels like bachelor, master, and doctoral.

c) The subject is mainly applied in nuclear power generation and nuclear weapons.

d) A few other applications of the subject are nuclear medicine, magnetic resonance imaging and radiocarbon dating in geology and archaeology which we have tried to incorporate.

Learning Outcomes:

a) Upon successful completion of this course, the student will be able to understand the fundamental principles and concepts governing classical nuclear and particle physics and have a knowledge of their applications interactions of ionizing radiation with matter the key techniques for particle accelerators the physical processes involved in nuclear power generation.

b) Knowledge on elementary particles will help students to understand the fundamental constituents of matter and lay foundation for the understanding of unsolved questions about dark matter, antimatter, and other research-oriented topics.

1. Basic Properties of Nucleus (06 L)

1.1 Composition, charge, size, density of nucleus

1.2 Nuclear Angular momentum

1.3 Nuclear magnetic dipole moment

1.4 Mass defect and Binding energy

1.5 Packing fraction

1.6 Classification of nuclei

1.7 Stability of nuclei

1.8 Problems

2. Radioactivity (10 L)

2.1 Radioactivity disintegration (concept of natural and artificial radioactivity)

2.2 Properties of α, β, γ rays

2.3 Laws of radioactive decay

2.4 Half-life, mean life

2.5 Specific activity and its units

2.6 Application of radioactivity (Agricultural, Medical, Industrial, Archaeological)

2.7 Problems

3. Nuclear forces (09 L)

3.1 Meson theory of nuclear forces

3.2 Properties of nuclear forces

3.3 Elementary particles

3.4 Quarks model for elementary particles

3.5 Problems

4. Particle Accelerator and Detectors (08 L)

4.1 Introduction to particle Accelerators

4.2 Linear (electron/proton Linac) Cyclic (Cyclotron)

4.3 Classification of Nuclear Detector

4.4 Gas filled Detectors (G. M. counter)

4.5 Problems

5. Nuclear Reactions (09 L)

5.1 Introduction to Nuclear reactions

5.2 Q value equation

5.3 Exothermic and Endothermic reaction

5.4 Conservation laws

5.5 Problems

6. Nuclear Energy (06L)

6.1 Nuclear fission

6.2 Chain reaction and critical mass

6.3 Nuclear reactor and its basic components

6.4 Homogeneous and heterogeneous reactors

6.5 Power reactor

6.6 Nuclear fusion

6.7 Stellar energy

6.8 Problems

Reference Books

1 Introduction to Nuclear Physics H.A. Enge (Addition Wesley co.)

2 The Atomic Nucleus R.D. Evans (Tata McGraw Hill co.)

3 Concepts of Nuclear Physics – B.L. Cohen (Tata McGraw Hill co.)

4 Schum's Outline Series Modern Physics R. Gautrearu (McGraw Hill co.)

5 Introduction to Nuclear Physics, S. B. Patel

6 Atomic and Nuclear Physics Shatendra Sharma (Pearson Education,1 st Edition)

7 Nuclear Physics Kaplan (Narosa Publishing House)

8 Introduction to Nuclear Physics Y.R. Waghmare (Oxford IBH.)

T. Y. B. Sc. Physics

PHY 3605: Electronics-II (A)

Class: **T.Y. B. Sc. (Semester-VI)** Paper: **V**

Credit: **3** No. of lectures: **48**

Learning Objectives

a) To understand the operation of UJT, JFET and their applications.
b) To understand basic application circuits of opamp.
c) To understand combinational logical circuits
d) To understand active filters using opamp.
e) To understand basics of timer IC 555 and its applications
f) To understand different types of flip-flops and their operation.
g) To understand sequential logical circuits

Learning Outcomes

After successful completion of the course student will be able to

a) To analyze performance parameters based on study of characteristics of electronic devices like UJT, JFET and their applications.
b) To understand opamp circuits and its usefulness in different applications
c) To know operating principle of IC 555 in different configurations
d) Evaluate frequency response to filter circuits.
e) Build and test digital circuits using universal/basic logic gates and flip flops.
f) Analyze, design and implement sequential logic circuits.

1. UNI- JUNCTION TRANSISTOR: [4L]

1.1: Symbol, types

1.2: Construction and working.

1.3: I-V characteristics

1.4: UJT as a relaxation oscillator

1.5: Problems

2. FIELD EFFECT TRANSISTOR: (6L)

2.1: Introduction,

2.2: Classification, principle,

2.3: Working and IV characteristics of JFET.

2.4: Application of JFET: -as Variable resistor, electronic switch and analog multiplexer.

2.5: Problems

3. APPLICATIONS OF OPERATIONAL AMPLIFIER: (8L)

3.1: Comparator, Schmitt Trigger

3.2: Instrumentation Amplifier

3.3: Current to voltage Converter

3.4: Voltage to current convertors

3.5: Filters: First order LPF and HPF with design

3.6: Problems

4. TIMER (IC555): (6L)

4.1: Block diagram of IC 555 Timer

4.2: Astable Multivibrator

4.3: Monostable Multivibrator

4.4: Bistable Multivibrator

4.5: Problems

5. FLIPFLOPS: (12L)

5.1: RS flip flop using NAND/NOR Gate

5.2: Clocked R-S flip-flop (Latch)

5.3: Preset and clear inputs

5.4: J-K /M-S J-K flip-flop

5.5: D and T flip flops

5.6: Problems

6. **COUNTERS: (12L)**

6.1: Asynchronous counter

6.2: Synchronous counter

6.3: A Mod-5 Counter

6.4: Decade counter

6.5: IC7490 TTL Decade Counter

REFERENCES:

1 Electronics Principles (8th edition), Malvino (Tata McGraw Hill, New Delhi).

2 Digital Principles and Applications, 8th Edition, Donald P Leach, Albert Paul Melvino, Shah McGraw-Hill Education,

3 Modern Digital Electronics (3rd Edition), R. P. Jain, (Tata McGraw Hill, New Delhi)

4. OP-Amps and Linear Integrated circuits, Ramakant A. Gayakwad Prentice-Hall of India, New Delhi 4th Edition

T.Y.B.Sc. Physics

PHY 3605: B] Advanced Electronics

Class: T.Y. B. Sc. **Sem: VI** **Paper V**

Credit: 3 **No of lectures: 48**

(Important Note: This course is designed for the student who has offered Electronics as one of the subjects at S.Y.B.Sc. level)

Course Objectives:

1. To familiarize with different sensors.
2. To elucidate sensors and signal conditioning circuits.
3. To explain signal conditioning circuits.
4. To familiarize with process control system and its objectives.

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

1. Apply different methods for the measurement of various physical quantities.
2. Describe signal conditioning circuits.
3. Differentiate between signal conditioning processes.
4. Identify various process control systems.

1. Sensors: (14 L)

1.1 Metal resistance versus Temperature devices: Metal resistance versus Temperature devices, resistance versus temperature approximation, resistance temperature detectors.

1.2 Semiconductor resistance versus Temperature, Thermistor characteristics.

1.3 Thermocouples: Thermoelectric effects, Thermocouple characteristics, Thermocouple sensors.

1.4 Other Thermal Sensors: Gas thermometers, Vapour pressure thermometers, Liquid expansion thermometers, solid state temperature sensors.

1.5 Motion sensors: Types of motions, Accelerometers' principles, Types of accelerometers, applications

1.6 Optical sensors: Photo detectors: Photo detector characteristics, photoconductive detectors, photo voltaic detectors, photo diode detectors, photo emissive detectors.

1.7 Optical sources: Conventional light sources, Laser principles

1.8 Problems

2. Analog Signal Conditioning using OP-AMP: (12 L)

2.1 Principles of Analog Signal Conditioning: Signal level and bias changes,

linearization, conversions, filtering and impedance matching, concept of loading.

2.2 Passive circuits: Divider circuits, bridge circuits, RC filters,

2.3 Operational Amplifier, characteristics

2.4 Specification of OP-AMP Circuits in Instrumentation, Voltage Follower, Inverting and Non-Inverting Amplifier, Instrumentation Amplifier, I to V Converter and V to I converter, Integrator, Differentiator.

3. Digital signal conditioning (12 L)

3.1 Review of digital fundamentals, digital information,

3.2 Fractional Binary System, Boolean algebra, and expressions

3.3 Combinational Circuits, Multiplexer, De- Multiplexer, Encoder, Decoder

3.4 Converters: DAC, ADC,

3.5 Data Acquisition System, characteristics of digital data, sampled data systems, linearization.

4. Introduction to Process Control: (10 L)

4.1 Control systems: Process control principles,

4.2 servo mechanism,

4.3 Discrete state Control of systems

4.4 Process control block diagram Identification of elements, block diagram

4.5 Control system evaluation: Stability, steady state regulation, Transient regulation,

4.6 Evaluation criteria

4.7 Numerical Problems On Above Lectures

Reference Books:

1. Process Control Instrumentation Technology by C.D. Johnson Pearson Education 8th edition (Economic Edition).

2. Computer Based Industrial Control by Krishna Kant (Eastern Economic Edition)

3. Instrument of Device System by Rangan, Mani, Sharma 4. Instrument measurement and analysis by B. C. Nakra, K. K. Chaudhari

4. Electronic Instrumentation- H S Kalsi Tata McGraw Hill

5. Instrumentation, Measurement and Analysis, TMH (2003) Nakra, B.C. and Chaudhry, K.K.,

6. Doebelin, E.O. and Manic, D.N., Measurement Systems: Applications and Design, McGraw Hill (2004).

T. Y. B. Sc. Physics

PHY3606: A] Physics of Nanomaterials

Class: T.Y. B. Sc (Sem VI) **Paper VI**

Credit: 3 **No of lectures: 48**

Learning objectives:

1. To foundational knowledge of the Nanoscience and related fields.
2. The main objectives of course are to introduce the basic physics behind size effect of nano materials and to understand the working principle of equipment used in nanostructures.
3. To make the students acquire an understanding the Nanoscience and Applications.
4. To help them understand in broad outline of Nanoscience and Nanotechnology.

Learning outcomes:

1. Learn about the background on Nanoscience.
2. Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment.
3. Apply their knowledge to develop Nanomaterials.
4. Can apply the knowledge to develop new applications.

1. Nanomaterials (06L)

1.1 Introduction and structures of nano materials

1.2 Brief history of nano materials and challenges in nanotechnology

1.3 Significance of nano-size and properties

1.4 classification of nano structured materials

1.5 Properties of nano materials: Mechanical, Electrical, Thermal, Optical, solubility, melting point, and Magnetic properties

2. Introduction to methods of synthesis of nano materials (14L)

2.1 Bottom-up and Top-down approaches

2.2 Physical methods:

a) High energy ball milling,

b) Physical vapour deposition,

c) Ionized cluster beam deposition,

d) sputter deposition,

2.3 Chemical methods:

a) colloidal method,

b) co-precipitation and

c) sol-gel method

d) spray pyrolysis

e) Chemical bath deposition (CBD)

2.4 Hybrid method: Electrochemical and chemical vapour deposition.

3. Introduction to Characterization Techniques (14L)

3.1 Introduction,

3.2 X-ray diffraction**:**

a) Basic principle,

b) Experimental methods of X-ray diffraction: Rotating Crystal method, Powder (Debye Scherer) method,

c) Analysis of cubic structure by powder method,

3.3 **Thermo gravimetric analysis (TGA)-** Principle, Working and Applications,

3.4 **Ultra-Violet (UV) Spectroscopy** - Principle, Working and Applications,

3.5 **Electron microscopy (SEM)-** Principle, Working and Applications,

3.6 RAMAN: Principle, Working and Applications,

Problems

4. Special nano materials and applications (14L)

4.1 Nano materials:

a) Carbon based material

b) Quantum dots

c) Nano tubes

d) Nano rods

e) Thin Film

4.2 Applications:

a) Nano electronics,

b) Medical,

c) Biological,

d) Automobiles,

e) Space,

f) Defence,

g) Sports,

h) Cosmetics,

i) Textile industry

Reference Books:

1. Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
2. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
3. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
4. Nanostructure and nanomaterials synthesis, Properties, and applications, by G. Cao, Imperials College Press, London.

List of Practicals

1. Crystallite size determination using Xray diffraction (Debye Scherrer Equation) from the given XRD data.
2. To determine the optical band gap of the material from the given UV-visible spectroscopy data.
3. To prepare the nano powder using the wet chemical method (co-precipitation method).
4. To prepare the nano powder using sol gel method
5. To deposit nano crystalline CdS thin film using chemical bath deposition method.
6. To measure the thickness of the deposited film using gravimetric method.
7. Demonstration of thin film deposition method using thermal evaporation technique.

T. Y. B. Sc. Physics

PHY3606: B] Solar Energy Conversion Devices

Class: T.Y. B. Sc (Sem VI) **Paper VI**

Credit: 3 **No of lectures: 48**

Learning Objectives

1. Define sustainable development including its three pillars.
2. Referring to the energy conversion matrix, identify the conversion steps taken by various renewable energy technologies

Learning Outcomes

1. The course providing a basic understanding of theory and practice of various photovoltaic technologies and design concepts.
2. To understand the physical principles of the photovoltaic (PV) solar cell
3. Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.

Unit 1: Photovoltaic converters (12L)

Photovoltaic effect, types of solar cell, equivalent circuit diagram of a solar cell, determination of series resistance (Rs) and shunt resistance (Rsh), solar cell output parameters: RL, Voc, Isc, Pm, FF, efficiency, performance dependence of a solar cell on band gap energy, Types of heterojunction, construction of energy band diagram of heterojunction, Mott – Schottky relation, problems.

Unit 2: Materials and Solar cell Technology (12L)

Fabrication technology of Silicon solar cell, Single, poly – and amorphous silicon, GaAs, CdS, Cu_2S, $CuInSe_2$, CdTe etc. technologies for fabrication of single and polycrystalline silicon solar cells, solar cell modules, photovoltaic systems, dye-sensitized solar cell, perovskite solar cell, problems

Unit 3: Photochemical Converters (12L)

Semiconductor – electrolyte interface, Helmholtz double layer, Gouy-Chapman model, Stern model, Principle of photoelectrochemical solar cells, photoelectrolysis cell, driving force of photoelectrolysis, alkaline fuel cell, semiconductor- septum storage cell, concept of photocatalysis and photoelectrocatalysis process, problems.

Unit 4: Thermoelectric Converters (12L)

Thermoelectric effects, solid state description of thermoelectric effect, Kelvin's thermodynamic relations, analysis of thermoelectric generators, basic assumptions, temperature distribution and thermal energy transfer for generator, co-efficient of performance for thermoelectric cooling, problems.

Reference Books:

1. Solar energy conversion: The solar cell, by Richard C. Neville.
2. Photoelectrochemical solar cells – Suresh Chandra
3. Solar energy conversion – A. E. Dixon and J. D. Leslie.
4. Solar cells – Martin A. Green
5. Heterojunction and metal – semiconductor junctions – A.G. Milnes and D. L.Feucht.
6. Solid state electronic devices - B.G. Streetman.
7. Principles of solar engineering – Frank Kreith and Janf Kreider.
8. Direct energy conversion (4th edition) – Stanley W Angrist

Practical List:

1. Solar Still
2. Solar Dryer
3. Solar Cooker
4. PV-IV Characteristics
5. PV-Water Pumping System
6. PV-Spray System
7. Wind Energy Conversion

T.Y.B.Sc. Physics

PHY 3606: C] Sensor and Its Applications

Class: T.Y. B. Sc. Sem: V **Paper VI**

Credit: 3 **No of lectures: 48**

Course Objectives:

5. To elucidate sensors and signal conditioning circuits.
6. To introduce different error analysis methods.
7. To familiarize with different sensors and transducers.
8. To explain signal conditioning circuits.

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

5. Apply different methods for the measurement of various physical quantities.
6. Ability to Analyse, formulate and select suitable sensor for the given industrial applications.
7. Describe signal conditioning circuits.
8. Differentiate between different types of smart sensors.
9. Identify various optical transducer.

1. SENSORS/TRANSDUCERS: 12L

1.1 Definition, Types, Basic principle and applications of Resistive, Inductive, Capacitive, Piezoelectric and their Dynamic performance.

1.2 Fiber optic sensors, Bio-chemical sensors, Hall-Effect, Photoemissive, Photo Diode/ Photo Transistor, Photovoltaic, LVDT, Strain Gauge

1.3 Digital transducers: Principle, Construction, Encoders, Absolute and incremental encoders, Silicon micro transducers.

2. SIGNAL CONDITIONING: 12L

2.1 Operational Amplifiers: application in instrumentation, Charge amplifier, Carrier amplifier

2.2 Introduction to active filters, Classification, Butterworth, Chebyshev, First order, Second order and higher order filters

2.3 Voltage to frequency and frequency to voltage converters.

3. OPTICAL TRANSDUCERS: 12L

3.1 Theory of photo emission

3.2 classification of photo electric devices

3.3 vacuum photo tube, Gas photo tube, Photo multiplier tube, photo conductive cell, photo diode, photo transistor

3.4 Opto-coupler and their applications,

3.5 Optical Fibre sensors.4

4. SMART SENSORS & ITS APPLICATIONS 12L

4.1 Introduction, Definition,

4.2 Block Diagram of Smart Sensors,

4.3 Difference between non smart Sensors & Smart Sensors,

4.4 Smart Transducers,

4.5 Introduction to Internet of Things (IoT) Sensors and actuators

Reference Books:

1. Doebelin, E.O. and Manic, D.N., Measurement Systems: Applications and Design, McGraw Hill (2004).
2. Sawhney, A.K. and Sawhney, P., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai (2008).
3. Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India (2003).
4. Nakra, B.C. and Chaudhry, K.K., Instrumentation, Measurement and Analysis, TMH (2003)

List of Experiments:

1. To draw I/O characteristics of the following photo transducers.
    1. LDR
    2. Photodiode
    3. Photo Transistor
    4. Optocoupler
2. Fabricate an application circuit using photo transducers as a switch and as a
3. To measure density of given solution using simple hydrometer.
4. To measure vibration of motor or compressor system using a vibration meter and piezoelectric sensors.
5. To perform noise measurement using condenser microphone.

T.Y.B.Sc. Physics

PHY 3607: Physics Practical-I

Class: T.Y. B. Sc. Sem: VI Paper VII

Credit: 2

Total-10 Experiments

Students has to perform any **EIGHT** experiments from the list given below plus any **TWO** experiments from the optional subject **(TOTAL 10 experiments).**

1. Viscosity of liquid by rotating cylinder method.
2. Youngs modulus of steel by flexural vibrations of a bar
3. Study of XRD spectrum of any material
4. Thermal & electrical conductivity of Cu
5. Characteristics of G. M. tube
6. e/m by Thomson method
7. Study of Gaussian distribution by G.M. tube
8. Determination of the diameter of a thin wire using a laser beam
9. Rigidity modulus of Brass
10. Calibration of Si diode & a Copper constantan thermocouple temperature sensors

Practical From Optional Course (Any-2)

1. Demonstrations: Any 2 demonstrations equivalent to 2 experiments
2. Study tour with report equivalent to 2 experiments
3. Mini project equivalent to 2 experiments
4. Computer aided demonstrations (Simulations or animations)

T.Y.B.Sc. Physics

PHY 3608: Physics Practical-II

Class: T.Y. B. Sc. Sem: VI Paper VIII

Credit: 2

Total-10 Experiments

Students must perform any **EIGHT** experiments from the list given below plus any **TWO** experiments from the optional subject **(TOTAL 10 experiments).**

11. Characteristics of JFET
12. Design and built astable multivibrator using IC 555/IC 741
13. Integrator and differentiator using IC 741
14. Instrumental amplifier using three op-amps
15. Digital to Analog Converters
16. Schmidt trigger
17. Plotting of graph using MS-Excel
18. Plotting of graph using origin software
19. Study of Multiplexer and Demultiplexer
20. Active Filters
21. Temperature controller using AD590
22. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter

Practical From Optional Course (Any-2)

5. Demonstrations: Any 2 demonstrations equivalent to 2 experiments
6. Study tour with report equivalent to 2 experiments
7. Mini project equivalent to 2 experiments
8. Computer aided demonstrations (Simulations or animations)

T.Y.B.Sc. Physics

PHY 3609: Project -Part II

Class: T.Y. B. Sc. Sem: VI Paper IX

Credit: 2

The student will have to perform the project course for both semesters V and VI. The continuous evaluation of the project will be done during each semester. Student must complete 50% project work in semester V and evaluation will be done at the end of semester and credit will be assigned to the students according to their performance.

T.Y.B.Sc. (Physics) (Sem-VI) Physics Project-II (PHY3609)

Guidelines:

It is expected that,

1. The student does work equivalent to about 10 laboratory experiments.

2. The project work is a practical course, and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.

3. The project must have a clear and strong link with the principles of basic physics and/or their applications.

4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.

5. The evaluation of the project work must give due credit to the amount of the project work done by a student, skills shown by the student, understanding of the physics concepts involved and the presentation of the final report at the time of viva voce.

6. The viva voce should be conducted at the time of evaluation of project work at least for twenty minutes per student. Extra care must be taken in the evaluation of projects done in a pair or group. Delegation of the work done by individuals must be sought from the students in such cases.

7. Any ready-made material used in the report (such as downloaded pages from the web) must be clearly referred to and acknowledged.

8. It is also recommended that a teacher will look after 4 projects at one time.

9. Any non-adherence to this norm should attract a penalty by way of deduction in the marks awarded to a student. It is recommended that the College will provide consumables/contingencies for every project, to the tune of Rs. 750 /- each. (*If the students paid extra fee other than laboratory fee then college will provide financial assistance for the Project work.)

The Project work shall consist of the following Criterions.

1) Working model (Experimental or Concept based simulation/Demonstration Related to Physics).

2) Understanding of the project.

3) Experimental Details.

4) Data collection and Data Analysis.

5) Innovation.

6) Outcomes/Result.

7) Conclusion.