

**Dr YSR GDC, VEDURUKUPPAM**  
**DEPARTMENT OF PHYSICS**  
**B.Sc. (Honors) in Physics (MINOR)**

w.e.f. AY 2023-24

**COURSE STRUCTURE**

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	II	1	Mechanics and Properties of Matter	3	3
			Mechanics and Properties of Matter Practical Course	2	1
II	III	2	Optics	3	3
			Optics Practical Course	2	1
	IV	3	Electricity and Magnetism	3	3
			Electricity and Magnetism Practical Course	2	1
		4	Modern Physics	3	3
			Modern Physics Practical Course	2	1
III	V	5	Applications of Electricity & Electronics	3	3
			Applications of Electricity & Electronics Practical Course	2	1
		6	Electronic Instrumentation	3	3
			Electronic Instrumentation Practical Course	2	1

**SEMESTER-II**  
**COURSE 1: MECHANICS AND PROPERTIES OF MATTER**

Theory

Credits: 3

3hrs/week

**COURSE OBJECTIVE:**

The course on Mechanics and Properties of Matter aims to provide students with a fundamental understanding of the behaviour of physical systems, both in terms of mechanical motion and in terms of the properties of matter

**LEARNING OUTCOMES:**

1. Students will be able to understand and apply the concepts of scalar and vector fields, calculate the gradient of a scalar field, determine the divergence and curl of a vector field.
2. Students will be able to apply the laws of motion, solve equations of motion for variable mass systems
3. Students will be able to define a rigid body and comprehend rotational kinematic relations, derive equations of motion for rotating bodies, analyze the precession of a top and gyroscope, understand the precession of the equinoxes
4. Students will be able to define central forces and provide examples, understand the characteristics and conservative nature of central forces, derive equations of motion under central forces. **5.** Students will be able to differentiate between Galilean relativity and the concept of absolute frames, comprehend the postulates of the special theory of relativity, apply Lorentz transformations, understand and solve problems

**UNIT-I VECTOR ANALYSIS**

**9hrs**

Scalar and vector fields, gradient of a scalar field and its physical significance. Divergence and curl of a vector field with derivations and physical interpretation. Vector integration (line, surface and volume), Statement and proof of Gauss and Stokes theorems.

**UNIT-II MECHANICS OF PARTICLES**

**9hrs**

Laws of motion, motion of variable mass system, Equation of motion of a rocket. Conservation of energy and momentum, Collisions in two and three dimensions, Concept of impact parameter, scattering cross-section, Rutherford scattering-derivation.

**UNIT-III MECHANICS OF RIGID BODIES AND CONTINUOUS MEDIA**

**9hrs**

Definition of rigid body, rotational kinematic relations, equation of motion for a rotating body, Precession of a top, Gyroscope, Precession of the equinoxes. Elastic constants of isotropic solids and their relations, Poisson's ratio and expression for Poisson's ratio. Classification of beams, types of bending, point load, distributed load.

#### **UNIT-IV CENTRAL FORCES**

Central forces, definition and examples, characteristics of central forces, conservative nature of central forces, conservative force as a negative gradient of potential energy, equations of motion under a . Derivation of Kepler's laws. Motion of satellites

#### **UNIT-V SPECIAL THEORY OF RELATIVITY**

9hrs

Galilean relativity, Absolute frames. Michelson-Morley experiment, The negative result. Postulates of special theory of relativity. Lorentz transformation, time dilation, length contraction, addition of velocities, mass-energy relation.

#### **REFERENCE BOOKS:**

1. BSc Physics -Telugu Akademy, Hyderabad
2. Mechanics - D.S. Mathur, Sulthan Chand & Co, New Delhi
3. Mechanics - J.C. Upadhyaya, Ramprasad & Co., Agra
4. Properties of Matter - D.S. Mathur, S.Chand & Co, New Delhi ,11th Edn., 2000
5. Physics Vol. I - Resnick-Halliday-Krane ,Wiley, 2001
6. Properties of Matter – Brijlal & Subrmanyam, S. Chand &Co. 1982
7. Dynamics of Particles and Rigid bodies– Anil Rao, Cambridge Univ Press, 2006
8. Mechanics-EM Purcell, Mc Graw Hill
9. University Physics-FW Sears, MW Zemansky & HD Young, Narosa Publications, Delhi
10. College Physics-I. T. Bhima sankaram and G. Prasad. Himalaya Publishing House. 11. Mechanics, S. G. Venkata chalapathy, Margham Publication, 2003.

**SEMESTER-II**  
**COURSE 1: MECHANICS AND PROPERTIES OF MATTER**

Practical

Credits: 1

2hrs/week

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**COURSE OBJECTIVE:**

To develop practical skills in the use of laboratory equipment and experimental techniques for measuring properties of matter and analyzing mechanical systems.

**LEARNING OUTCOMES:**

1. Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques to measure properties of matter and analyze mechanical systems.
2. Application of theory to practice: Students should be able to apply theoretical concepts learned in lectures to real-world situations, and understand the limitations of theoretical models.
3. Accurate recording and analysis of data: Students should be able to accurately record and analyze experimental data, including understanding the significance of error analysis and statistical methods.
4. Critical thinking and problem solving: Students should be able to identify sources of error, troubleshoot experimental problems, and develop critical thinking skills in experimental design and analysis.
5. Understanding of physical principles: Students should develop an understanding of the physical principles governing mechanical systems and the properties of matter, including elasticity, viscosity, and thermal expansion.

**Minimum of 6 experiments to be done and recorded**

1. Viscosity of liquid by the flow method (Poiseuille's method)
2. Young's modulus of the material of a bar (scale) by uniform bending
3. Young's modulus of the material a bar (scale) by non- uniform bending
4. Surface tension of a liquid by capillary rise method
5. Determination of radius of capillary tube by Hg thread method
6. Viscosity of liquid by Searle's viscometer method
7. Bifilar suspension –moment of inertia of a regular rectangular body.
8. Determination of moment of inertia using Fly-wheel
9. Determination of the height of a building using a sextant.
10. Rigidity modulus of material of a wire-dynamic method (torsional pendulum)

**SEMESTER-II**  
**COURSE 1: MECHANICS AND PROPERTIES OF MATTER**

**STUDENT ACTIVITIES**

Unit I: Vector Analysis  
Activity: Field Mapping

Students can choose a physical field (e.g., temperature, magnetic field) and create a field map by taking measurements at different points. They can then calculate the gradient of the field and analyse the variations. This activity helps them understand the concept of gradient in a scalar field.

Unit II: Mechanics of Particles  
Activity: Collision Experiments

Students can set up simple collision experiments using marbles, carts, or other objects. They can measure the initial and final velocities, masses, and analyze the momentum conservation. By varying the conditions (e.g., masses, initial velocities), they can observe the effects on the collision outcomes.

Unit III: Mechanics of Rigid Bodies and Continuous Media  
Activity: Balancing Act

Students can experiment with balancing various objects (e.g., rulers, books) on different points to understand the concept of center of mass and stability. They can analyse the equilibrium conditions and explore how the position of the center of mass affects the stability.

Unit IV: Central Forces  
Activity: Pendulum Motion

Students can investigate the motion of a simple pendulum by varying its length and measuring the time period. They can analyze the relationship between the period and the length, and discuss the concept of centripetal force and its role in circular motion.

Unit V: Special Theory of Relativity  
Activity: Time Measurement

Students can perform a time measurement experiment using simple devices like water clocks or sand timers. They can compare the measured time between two events at different relative speeds and discuss the concept of time dilation

**SEMESTER-III**  
**COURSE 2: OPTICS**

Theory

Credits: 3

3 hrs/week

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**COURSE OBJECTIVE:**

The course on Optics aims to provide students with a fundamental understanding of the behaviour and properties of light and its interaction with matter.

**LEARNING OUTCOMES:**

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

1. Explain about the different aberrations in lenses and discuss the methods of minimizing them 2. Understand the phenomenon of interference of light and its formation in (i) Lloyd's single mirror due to division of wave front and (ii) Thin films, Newton's rings and Michelson interferometer due to division of amplitude.
3. Distinguish between Fresnel's diffraction and Fraunhofer diffraction and observe the diffraction patterns in the case of single slit and the diffraction grating and to describe the construction and working of zone plate and make the comparison of zone plate with convex lens
4. Explain the various methods of production of plane, circularly and polarized light and their detection and the concept of optical activity.
5. Comprehend the basic principle of laser, the working of He-Ne laser and Ruby lasers and their applications in different fields. To understand the basic principles of fibre optic communication and explore the field of Holography and Nonlinear optics and their applications.

**UNIT-I Aberrations**

**9Hrs**

Introduction – monochromatic aberrations, spherical aberration, methods of minimizing spherical aberration, coma, astigmatism and curvature of field, distortion. Chromatic aberration-the achromatic doublet. Achromatism for two lenses (i) in contact and (ii) separated by a distance.

**UNIT-II Interference**

**9Hrs**

Principle of superposition – coherence Conditions for interference of light. Fresnel's biprism determination of wavelength of light –change of phase on reflection. Oblique incidence of a plane wave on a thin film due to reflected light (cosine law) –colors of thin films- Interference by a film with two non-parallel reflecting surfaces (Wedge shaped film). Determination of diameter of wire, Newton's rings in reflected light. Determination of wavelength of monochromatic light using Newton's rings and Michelson Interferometer.

**UNIT-III Diffraction**

**9Hrs**

Introduction, distinction between Fresnel and Fraunhofer diffraction, Fraunhofer diffraction – Diffraction due to single slit-Fraunhofer, Fraunhofer diffraction pattern with N slits (diffraction grating). Resolving power of grating, Determination of wavelength of light in normal incidence using diffraction grating. Fresnel's half period zones-area of the half period zones-zone plate-comparison of zone plate with convex lens-difference between interference and diffraction.

#### **UNIT-IV Polarisation**

**9Hrs**

Polarized light: methods of polarization by reflection, refraction, double refraction, Brewster's law Malus law-Nicol prism polarizer and analyser, Quarter wave plate, Half wave plate-optical activity, determination of specific rotation by Laurent's half shade Polarimeter. Idea of elliptical and circular polarization

#### **UNIT-V Lasers and Holography**

**9Hrs**

Lasers: introduction, spontaneous emission, stimulated emission. Population Inversion, Laser principle Einstein Coefficients-Types of lasers-He-Ne laser, Ruby laser- Applications of lasers. Holography: Basic principle of holography-Gabor hologram and its limitations, Applications of holography. .

#### **REFERENCE BOOKS:**

1. BSc Physics, Vol .2, Telugu Academy, Hyderabad
2. A Text Book of Optics-N Subramanyam, L Brijlal, S. Chand & Co.
3. Unified Physics Vol. II Optics & Thermodynamics – Jai Prakash Nath & Co. Ltd., Meerut
4. Optics, F.A. Jenkins and H.G. White, Mc Graw-Hill
5. Optics, Ajay Ghatak, Tata Mc Graw-Hill.
6. Introduction of Lasers – Avadhanulu, S. Chand & Co.
7. Principles of Optics- BK Mathur, Gopala Printing Press, 1995

**SEMESTER-III**  
**COURSE 2: OPTICS**

Practical

Credits: 1

2hrs/week

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**COURSE OBJECTIVE:**

To develop practical skills in the use of laboratory equipment and experimental techniques for studying light and its interactions with matter.

**LEARNING OUTCOMES:**

1. Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques for studying light and its interactions with matter.
2. Application of theory to practice: Students should be able to apply theoretical concepts learned in lectures to real-world situations, and understand the limitations of theoretical models.
3. Accurate recording and analysis of data: Students should be able to accurately record and analyze experimental data, including understanding the significance of error analysis and statistical methods.
4. Critical thinking and problem solving: Students should be able to identify sources of error, troubleshoot experimental problems, and develop critical thinking skills in experimental design and analysis.
5. Understanding of physical principles: Students should develop an understanding of the physical principles governing optics, including reflection, refraction, diffraction, interference, and polarization.

**Minimum of 6 experiments to be done and recorded**

1. Determination of radius of curvature of a given convex lens-Newton's rings.
2. Resolving power of grating.
3. Study of optical rotation –polarimeter.
4. Dispersive power of a prism.
5. Determination of wavelength of light using diffraction grating-minimum deviation method.
6. Determination of wavelength of light using diffraction grating-normal incidence method.
7. Determination of wavelength of laser light using diffraction grating.
8. Resolving power of a telescope.
9. Refractive index of a liquid-hallow prism
10. Determination of thickness of a thin wire by wedge method
11. Determination of refractive index of liquid-Boy's method.

**SEMESTER-III**  
**COURSE 2: OPTICS**

**STUDENT ACTIVITIES**

**Suggested student activities**

**UNIT-I Aberrations:**

Ask students to observe and sketch the different images produced by the lens at different distances. Build a simple optical system with two lenses in contact and ask students to calculate the focal length and magnification of the system. Then, introduce a thin glass plate between the lenses to simulate the effects of chromatic aberration and ask students to observe and discuss the changes in the image produced.

**UNIT-II Interference:**

Ask students to measure the diameter of the central bright spot and the diameter of the  $n$ th ring for different values of  $n$ , and then calculate the wavelength of light.

**UNIT-III Diffraction:**

Build a simple diffraction grating using a piece of cardboard and some sewing needles. Ask students to measure the distance between the needles, count the number of lines per unit length, and then calculate the grating spacing and the wavelength of light.

**UNIT-IV Polarisation:**

Ask students to measure the angle of rotation of the polarized light before and after passing through the sample, and then calculate the specific rotation of the sample.

**UNIT-V Lasers and Holography:**

Demonstrate the principle of holography using a laser beam, a beam splitter, and a photographic plate. Ask students to record a hologram of a simple object and then reconstruct the image using a laser beam.

**SEMESTER-IV**  
**COURSE 3: ELECTRICITY AND MAGNETISM**

Theory Credits: 3 3 hrs/week **COURSE OBJECTIVE:**

The course on Electricity and Magnetism aims to provide students with a fundamental understanding of the principles of electricity, magnetism, and their interactions

**LEARNING OUTCOMES:**

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

1. Understand the Gauss law and its application to obtain electric field in different cases and formulate the relationship between electric displacement vector, electric polarization, Susceptibility, Permittivity and Dielectric constant.
2. To learn the methods used to solve problems using loop analysis, Nodal analysis, Thvenin's theorem, Norton's theorem, and the Superposition theorem
3. Distinguish between the magnetic effect of electric current and electromagnetic induction and apply the related laws in appropriate circumstances.
4. Understand Biot and Savart's law and Ampere's circuital law to describe and explain the generation of magnetic fields by electrical currents.
5. Develop an understanding on the unification of electric, and magnetic fields and Maxwell's equations governing electromagnetic waves.
6. Phenomenon of resonance in LCR AC-circuits, sharpness of resonance, Q- factor, Power factor and the comparative study of series and parallel resonant circuits

**UNIT-I Electrostatics and Dielectrics 9hrs**

Gauss's law-Statement and its proof, Electric field intensity due to (i) uniformly charged solid sphere, Electrical potential-Equipotential surfaces, Potential due to a uniformly charged sphere. Dielectrics-Polar and Non-polar dielectrics- Effect of electric field on dielectrics, Dielectric strength, Electric displacement D, electric polarization Relation between D, E and P, Dielectric constant and electric susceptibility.

**UNIT-II Current electricity 9hrs**

Electrical conduction-drift velocity-current density, equation of continuity, ohms law and limitations, Kirchhoff's Law's, Wheatstone bridge-balancing condition - sensitivity. Branch current method, Nodal Analysis, star to delta & delta to star conversions. Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem.

**UNIT-III Magneto statics 4hrs**

Biot-Savart's law and its applications: (i) circular loop and (ii) solenoid, Ampere's Circuital Law and its application to Solenoid, Hall effect, determination of Hall coefficient and applications.

**Electromagnetic Induction: 5 hrs** Faraday's laws of electromagnetic induction, Lenz's law, Self-induction and

Mutual induction, Self-inductance

of a long solenoid, Magnetic Energy density. Mutual inductance of a pair of coils. Coefficient of Coupling

#### **UNIT-IV Electromagnetic waves-Maxwell's equations: 9hrs**

Basic laws of electricity and magnetism- Maxwell's equations- integral and differential forms Derivation, concept of displacement current. Plane electromagnetic wave equation, Hertz experiment-Transverse nature of electromagnetic waves. Electromagnetic wave equation in conducting media. Pointing vector and propagation of electromagnetic waves

#### **UNIT-V Varying and alternating currents: 9 hrs**

Growth and decay of currents in LR, CR, LCR circuits-Critical damping. Alternating current - A.C. fundamentals, and A.C through pure R, L and C. Relation between current and voltage in LR and CR circuits, Phasor and Vector diagrams, LCR series and parallel resonant circuit, Q -factor, Power in ac circuits, Power factor.

#### **REFERENCE BOOKS**

1. BSc Physics, Vol.3, Telugu Akademy, Hyderabad.
2. Electricity and Magnetism, D.N. Vasudeva. S. Chand & Co.
3. Electricity, Magnetism with Electronics, K.K.Tewari, R.Chand & Co.,
4. "Electricity and Magnetism" by Brijlal and Subramanyam Ratan Prakashan Mandir, 1966
5. "Electricity and Magnetism: Fundamentals, Theory, and Applications" by R. Murugesan, Kiruthiga Siva prasath, and M. Saravanapandian
6. "Electricity and Magnetism: Theory and Applications" by Ajoy Ghatak and S. Lokanathan
7. Electricity and Magnetism: Problems and Solutions" by Ashok Kumar and Rajesh Kumar
8. Electricity and Magnetism, R.Murugesan, S. Chand & Co.

**SEMESTER-IV**  
**COURSE 3: ELECTRICITY AND MAGNETISM**  
Practical Credits: 1 2 hrs/week

**COURSE OBJECTIVE:**

The course objective for a practical course in electricity and magnetism may include to develop practical skills in handling electrical and electronic components, such as resistors, capacitors, inductors, transformers, and oscillators.

**LEARNING OUTCOMES:**

Demonstrate a thorough understanding of the fundamental concepts and principles of electricity and magnetism.

Apply the laws and principles of electricity and magnetism to analyze and solve electrical and magnetic problems.

Design, construct, and test electrical circuits using various components and measuring instruments.

Measure and analyze electrical quantities such as voltage, current, resistance, capacitance, and inductance using appropriate instruments.

Apply the principles of electromagnetism to understand and analyze the behavior of magnetic fields and their interactions with electric currents

**Minimum of 6 experiments to be done and recorded**

1. Figure of merit of a moving coil galvanometer.
2. LCR circuit series/parallel resonance, Q factor.
3. Determination of ac-frequency –Sonometer.
4. Verification of Kirchhoff's laws and Maximum Power Transfer theorem.
5. Verification of Thevenin's and Norton's theorem
6. Field along the axis of a circular coil carrying current-Stewart & Gee's apparatus.
7. Charging and discharging of CR circuit-Determination of time constant
8. A.C Impedance and Power factor
9. Determination of specific resistance of wire by using Carey Foster's bridge.

**SEMESTER-IV**  
**COURSE 3: ELECTRICITY AND MAGNETISM**

**STUDENT ACTIVITIES**

**UNIT-I Electrostatics and Dielectrics:**

Conduct a simulation to visualize equipotential surfaces for a given charge distribution. Conduct a group discussion on the significance of electric field lines and how they can be used to predict the motion of charged particles in electric fields.

**UNIT-II Current electricity:**

Conduct a Wheatstone bridge experiment in class and discuss the balancing condition and sensitivity. Conduct a group activity where students are divided into groups and assigned a different circuit analysis method (nodal analysis, mesh analysis, superposition theorem, etc.) and asked to present their findings to the class.

**UNIT-III Magneto statics and Electromagnetic Induction:**

Conduct a demonstration to show the Hall effect and measure the Hall coefficient of a given material. Conduct a group activity where students are divided into groups, and assigned a different application of Faraday's law (electromagnetic induction, transformers, etc.) and asked to present their findings to the class.

**UNIT-IV Electromagnetic waves:**

Conduct a group activity where students are asked to research the history of the development of Maxwell's equations and present their findings to the class.

Conduct a simulation to visualize the propagation of electromagnetic waves in different media (vacuum, air, water, etc.) and discuss the differences in the behaviour of waves in different media.

**UNIT-V Varying and alternating currents:**

Conduct a demonstration to show the resonance in an LCR circuit and measure the Q-factor. Conduct a group activity where students are divided into groups and assigned a different power factor correction method (capacitor banks, synchronous condensers, etc.) and asked to present their findings to the class.

**SEMESTER-IV**  
**COURSE 4: MODERN PHYSICS**  
Theory Credits: 3 3 hrs/week

**COURSE OBJECTIVE:**

The course on Modern Physics aims to provide students with an understanding of the principles of modern physics and their applications in various fields.

**LEARNING OUTCOMES:**

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

1. Understand the principles of atomic structure and spectroscopy.
2. Understand the principles of molecular structure and spectroscopy
3. Develop critical understanding of concept of Matter waves and Uncertainty principle.
4. Get familiarized with the principles of quantum mechanics and the formulation of Schrodinger wave equation and its applications.
5. Increase the awareness and appreciation of superconductors and their practical applications

**Introduction to Atomic Structure and Spectroscopy: (9 hrs)**

Bohr's model of the hydrogen atom -Derivation for radius, energy and wave number - Hydrogen spectrum, Vector atom model – Stern and Gerlach experiment, Quantum numbers associated with it, Coupling schemes, Spectral terms and spectral notations, Selection rules. Zeeman effect, Experimental arrangement to study Zeeman effect.

**UNIT-II: Molecular Structure and Spectroscopy (9 hrs)**

Molecular rotational and vibrational spectra, electronic energy levels and electronic transitions, Raman effect, Characteristics of Raman effect, Experimental arrangement to study Raman effect, Quantum theory of Raman effect, Applications of Raman effect. Spectroscopic techniques: IR, UV-Visible, and Raman spectroscopy

**UNIT-III: Matter waves & Uncertainty Principle: (9 hrs)**

Matter waves, de Broglie's hypothesis, Properties of matter waves, Davisson and Germer's experiment, Heisenberg's uncertainty principle for position and momentum & energy and time, Illustration of uncertainty principle using diffraction of beam of electrons (Diffraction by a single slit) and photons (Gamma ray microscope).

**UNIT-IV: Quantum Mechanics: (9 hrs)**

Basic postulates of quantum mechanics, Schrodinger time independent and time dependent wave equations  
Derivations, Physical interpretation of wave function, Eigen functions, Eigen values, Application of  
Schrodinger wave equation to (one-dimensional potential box of infinite height (Infinite Potential Well)

#### **UNIT-V: Superconductivity: (9 hrs**

Introduction to Superconductivity, Experimental results-critical temperature, critical magnetic field, Meissner effect, London's Equation and Penetration Depth, Isotope effect, Type I and Type II superconductors, BCS theory, high Tc super conductors, Applications of superconductors

#### **REFERENCE BOOKS**

1. BSc Physics, Vol.4, Telugu Akademy, Hyderabad
2. Atomic Physics by J.B. Rajam; S.Chand & Co.,
3. Modern Physics by R. Murugesan and Kiruthiga Siva Prasath. S. Chand & Co.
4. Concepts of Modern Physics by Arthur Beiser. Tata McGraw-Hill Edition.
5. Nuclear Physics, D.C.Tayal, Himalaya Publishing House.
6. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publ.Co.)
7. K.K.Chattopadhyay & A.N.Banerjee, Introd.to Nanoscience and Technology (PHI Learning Priv. Limited).
8. Nano materials, A K Bandopadhyay. New Age International Pvt Ltd (2007)
9. Textbook of Nanoscience and Nanotechnology, BS Murthy, P Shankar, Baldev Raj, BB Rath and J Murday-Universities Press-IIM

**SEMESTER-IV**  
**COURSE 4: MODERN PHYSICS**  
Practical Credits: 1 2 hrs/week

***COURSE OBJECTIVE:***

The course objective for a practical course in Modern Physics may provide hands-on experience with experimental techniques and equipment used in modern physics experiments.

**LEARNING OUTCOMES:**

1. Apply experimental techniques and equipment to investigate and analyze phenomena related to modern physics, such as quantum mechanics, relativity, atomic physics, and nuclear physics. 2. Demonstrate a deep understanding of the principles and theories of modern physics through hands-on experimentation and data analysis.
3. Develop proficiency in using advanced laboratory instruments and techniques specific to modern physics experiments, such as spectroscopy, interferometry, particle detectors, and radiation measurement.
4. Analyze and interpret experimental data using statistical methods and error analysis, drawing meaningful conclusions and relating them to theoretical concepts.
5. Design and conduct independent experiments or investigations related to modern physics, demonstrating the ability to plan, execute, and analyze experimental procedures and results.

**Minimum of 6 experiments to be done and recorded**

1.  $e/m$  of an electron by Thomson method.
2. Determination of Planck's Constant (photocell).
3. Verification of inverse square law of light using photovoltaic cell.
4. Determination of the Planck's constant using LEDs of at least 4 different colours. 5. Determination of work function of material of filament of directly heated vacuum diode.

6. Determination of M & H.
7. Energy gap of a semiconductor using junction diode.
8. Energy gap of a semiconductor using thermistor.

## SEMESTER-IV COURSE 4: MODERN PHYSICS

### STUDENT ACTIVITIES:

#### **UNIT-I: Introduction to Atomic Structure and Spectroscopy**

##### **Spectroscopy Experiment:**

Divide the students into small groups and provide each group with a spectrometer or spectroscope, a light source, and different samples or elements for analysis.

Instruct the students to carefully observe the spectra produced by the samples using the spectrometer. Encourage them to note the presence of specific spectral lines or patterns.

##### **Data Collection:**

Have the students record their observations in their lab notebooks or worksheets. They should note the wavelengths or colors of the observed spectral lines and any patterns they observe. Analysis and

##### **Discussion:**

Guide a class discussion on the observed spectra and their significance. Discuss how the observed spectral lines correspond to specific energy transitions in the atoms.

Ask students to compare the spectra of different samples or elements and identify any similarities or differences.

Discuss the concept of energy levels and how electrons transition between them, emitting or absorbing photons of specific wavelengths.

#### **UNIT-II: Molecular Structure and Spectroscopy**

Begin the activity with a brief introduction to molecular structure, discussing concepts such as chemical bonds, molecular geometry, and the importance of molecular structure in determining the properties and behavior of substances.

Explain the principles of spectroscopy, focusing on vibrational and rotational spectra and how they relate to molecular vibrations and rotations.

#### **UNIT-III: Matter waves & Uncertainty Principle:**

Begin the activity by introducing the concept of matter waves and the uncertainty principle. Discuss how the wave-particle duality of matter is a fundamental principle in quantum mechanics. Provide a brief overview of the historical development of the uncertainty principle and its implications for our understanding of the behavior of particles on a microscopic scale.

#### **UNIT-IV: Quantum Mechanics:**

Begin the activity by providing an overview of quantum mechanics and its significance in understanding the behavior of particles on a microscopic scale. Discuss key concepts such as wave

particle duality, superposition, quantization, and the probabilistic nature of quantum systems

### **UNIT-V: Superconductivity:**

Begin the activity by providing an overview of superconductivity, including its definition, properties, and significance in scientific and technological applications.

Discuss key concepts such as zero electrical resistance, Meissner effect, critical temperature, and type I and type II superconductors

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## **SEMESTER-V**

### **COURSE 5: APPLICATIONS OF ELECTRICITY AND MAGNETISM Theory**

Credits: 3 3 hrs/week

#### **COURSE OBJECTIVE:**

The objective of the course on Applications of Electricity and Magnetism is to provide students with a comprehensive understanding of the practical applications of electricity and magnetism in various fields. The course aims to develop students' knowledge and skills in applying electrical and magnetic principles to real-world problems and technologies.

#### **LEARNING OUTCOMES:**

Students after successful completion of the course will be able to:

1. Identify various components present in Electricity & Electronics Laboratory.
2. Acquire a critical knowledge of each component and its utility (like resistors, capacitors, inductors, power sources etc.).
3. Demonstrate skills of constructing simple electronic circuits consisting of basic circuit elements.
4. Understand the need & Functionality of various DC & AC Power sources.
5. Comprehend the design, applications and practices of various electrical & Electronic devices and also their trouble shooting.

#### **Unit-I: Introduction to Passive Elements 9 hrs**

##### **a) Passive elements**

Resistor - Types of Resistors, Color coding, Combination of Resistors – Series combination (Voltage division), Parallel combination (Current division), Ohms Law and its limitation. Inductor - Principle, EMF induced in an Inductor, Energy stored in Inductor, Phase relation between V and I, Combinations of Inductors, Types of Inductors. Capacitor - Principle, Charging and discharging of a Capacitor, Types of Capacitors, Color coding

##### **b) Applications of Passive elements:**

Applications of a Resistor as a heating element in heaters and as a fuse element. Open circuit, Short circuit, Applications of Inductors, Application of choke in a fan and in a radio tuning circuit, Series resonance circuit as a Radio tuning circuit. Applications of Capacitor in power supplies, motors (Fans) etc.

#### **Unit-II Power Sources (Batteries) 9 hrs**

##### **a) Power sources:**

Types of power sources-DC & AC sources, Different types of batteries, Rechargeable batteries –Lead acid batteries, Li-ion batteries **Series, Parallel & Series-Parallel configuration of batteries,**

## b) Network Theorems for DC circuits

Thevenin's theorem, Norton's theorem, Maximum Power transfer theorem, Constant Voltage source-Constant Current Source-Applications of Current sources & Voltage sources, SMPS used in computers.

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**Unit-III Alternating & Direct Currents** (9hrs a) A.C Generator, Construction and its working principle, Types of AC Generators, DC Generator, Construction and its working principle, advantages and disadvantages, Applications, Types of DC Generators, Losses associated with DC generators, Differences between DC and AC generators

b) Transformers- Construction and its working principle, EMF equation, Open circuit and short circuit tests, Types of Transformers - Step-down and Step-up Transformers, Relation between primary turns and secondary turns of the transformer with emf, Use of a Transformer in a regulated Power supplies, Single phase motor – working principle, Applications of motors (like water pump, fan etc).

## **Unit-IV Modulation Circuits** 9 hrs

a) Need for modulation, Types of modulation, Amplitude modulation, modulation index, Waveforms, Power relations, Demodulation, Diode detector, AM transmitter, AM Receiver, Frequency modulation, modulation index, Waveforms, FM Transmitter, FM Receiver

## b) Transmitters and Receivers:

AM transmitter, AM Receiver, Frequency modulation, modulation index, Waveforms, FM Transmitter, FM Receiver

**Unit-V Applications of EM Induction & Power Supplies** 9 hrs a) DC motor – Construction and operating principle, Calculation of power, voltage and current in a DC motor, Design of a simple Motor (for example Fan) with suitable turns of coil

b) Working of a DC regulated power supply, Construction of a 5 volts regulated power supply, Design of a step down (ex:220-12V) and step-up (ex:120-240V) transformers-Simple Design of FM Radio circuit using LCR series resonance (tuning) circuit, Checking the output voltage of a battery eliminator using a Multimeter. (Trouble shooting), Design of a simple 5 volts DC charger, Power supply for computers (SMPS)

## **References:**

1. Grob's Basic Electronics by [Mitchel Schultz](#), TMH or McGraw Hill
2. Electronic and Electrical Servicing by Ian Robertson Sinclair, John Dunton, Elsevier Publications
3. Troubleshooting Electronic Equipment by R.S.Khandapur, TMH
4. Web sources suggested by the teacher concerned and the college librarian including reading material.

**SEMESTER-V**  
**COURSE 5: APPLICATIONS OF ELECTRICITY AND MAGNETISM**  
Practical Credits: 1 2 hrs/week

**COURSE OBJECTIVE:**

The objective of the practical course on Applications of Electricity and Magnetism is to provide students with hands-on experience and practical skills in applying electrical and magnetic principles to real-world applications. The course aims to develop students' proficiency in working with electrical circuits, electromagnetic devices, and related technologies through practical experimentation and project-based activities.

**LEARNING OUTCOMES:**

On successful completion of this practical course, students shall be able to:

1. List out, identify and handle various equipment in Electrical & Electronics laboratory.
2. Learn the procedures of designing simple electrical circuits.
3. Demonstrate skills on the utility of different electrical components and devices.
4. Acquire the skills regarding the operation, maintenance and troubleshooting of various Devices in the lab.
5. Understand the different applications of Electromagnetic induction.

**Practical (Laboratory) Syllabus:**

1. Acquainting with the soldering techniques
2. Design and Construction of a 5 Volts DC unregulated power supply
3. Construction of a Step down Transformer and measurement of its output voltage.  
And to compare it with the calculated value.
4. Connect two or three resistors or capacitors or inductors and measure the Series, Parallel Combination values using a Multimeter and compare the values with the  
Calculated values.
5. Use the Digital Multimeter and Analog Multimeter to measure the output voltage of an AC & DC power supply and also the voltage and frequency of a AC signal using CRO.
6. Use the Multimeter to check the functionality of a Diode and Transistor. Also test whether the given transistor is PNP or NPN.

7. Construct a series electric circuit with R, L and C having an AC source and study the frequency response of this circuit. Find the Resonance Frequency.
8. Construct a Parallel electric circuit with R, L & C having an AC source and study the frequency response of this circuit .Find the resonant frequency.
9. Test whether a circuit is a Open circuit or Short Circuit by measuring continuity with a Multimeter and record your readings.

**I. Lab References:**

1. Laboratory Manual for Introductory Electronics Experiments by Maheshwari, L.K. Anand, M.M.S., New Age International (P) Ltd.
2. Electricity-Electronics Fundamentals: A Text-lab Manual by [Paul B. Zbar](#), Joseph Sloop, & Joseph G. Sloop , McGraw-Hill Education
3. Laboratory Manual Basic Electrical Engineering by Umesh Agarwal, Notion Press 4. Basic Electrical and Electronics Engineering by [S.K. Bhattacharya](#), Pearson Publishers.
5. Web sources suggested by the teacher concerned.

**SEMESTER-V**  
**COURSE 5: APPLICATIONS OF ELECTRICITY AND MAGNETISM**  
**STUDENT ACTIVITIES**

**Co-Curricular Activities:**

**(a) Mandatory:** *(Training of students by teacher in field related skills: (lab:10 + field: 05)* 1. **For Teacher:** Training of students by the teacher (if necessary, by a local expert) in laboratory/field for not less than 15 hours on the understanding of various electronic & electrical components and devices. And also understand the functional knowledge of these components and devices so that the student can safely handle these electronic components.

2. **For Student:** Students shall (individually) visit a local Radio, TV or Mobile repair shop to

understand the testing and soldering techniques and different electronic components in the devices that we use daily life. And also to understand the troubleshooting and working of domestic appliances such as cell phone chargers, fan, electric iron, heater, inverter, micro oven, washing machine etc.(Or)Students shall also visit the Physics/Electronics or Instrumentation Labs of nearby local institutions and can get additional knowledge by interacting with the technical people working there. (Or)Students shall also visit the local motor winding shop to understand the motor winding and working of different types of motors. After the observations, a hand- written Fieldwork/Project work not exceeding 10 pages in the given format to be submitted to the teacher.

3. Max marks for Fieldwork/Project work: 05.

4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5. Unit tests (IE).

**(b) Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.

2. Assignments (including technical assignments like identifying various electrical and electronic components & devices and their handling, operational techniques with safety and security)

3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).

4. Preparation of videos on tools and techniques in Electrical & Electronic Appliances in daily life.

5. Collection of material/figures/photos related to Electrical products like Heaters, Motors, Fans etc. and writing and organizing them in a systematic way in a file. 6.

Visits to nearby electrical or electronic industries or laboratories in universities, research organizations, private firms, etc.

7. Invited lectures and presentations on related topics by field/industrial experts

**SEMESTER-V**

**COURSE 16: ELECTRONIC INSTRUMENTATION**

Theory Credits: 3 3 hrs/week

**COURSE OBJECTIVE:**

The objective of the course on Electronic Instrumentation is to provide students with a comprehensive understanding of various electronic instruments used for measurement, data acquisition, and control applications. The course aims to develop students' knowledge and skills in the design, operation, calibration, and application of electronic instruments.

**LEARNING OUTCOMES:**

Students after successful completion of the course will be able to:

1. Identify various facilities required to set up a basic Instrumentation Laboratory.
2. Acquire a critical knowledge of various Electrical Instruments used in the Laboratory.
3. Demonstrate skills of using instruments like CRO, Function Generator, Multimeter etc. through hands on experience.
4. Understand the Principle and operation of different display devices used in the display systems and different transducers
5. Comprehend the applications of various biomedical instruments in daily life like B.P. meter, ECG, Pulse oximeter etc. and know the handling procedures with safety and security.

### **UNIT-I Introduction to Instruments (9 Hrs)**

#### a) Basic of measurements:

Instruments accuracy, precision, sensitivity, resolution, range, errors in measurement, Classification of Instruments, Analog instruments & Digital Instruments, Construction and working of an Analog Multimeter and Digital Multimeter (Block diagram approach), DC Voltmeter and AC Voltmeter, Sensitivity,  $3\frac{1}{2}$  display and  $4\frac{1}{2}$  display Digital Multimeter, Sources of errors in the Measurement of resistance, voltage and current, Specifications of Multimeter and their significance.

#### b) Balancing and damping Moving iron instruments & PMMC instruments.

### **UNIT-II Oscilloscope (9Hrs)** a) Cathode ray oscilloscope – Principle and block diagram of CRO -

Cathode Ray Tube – functioning – various controls

#### b) Applications CRO: Measurement of voltage (dc and ac ), frequency & time period, Different types of oscilloscopes and their uses, Digital storage Oscilloscope

### **UNIT-III Transducers and Bridges (9 Hrs)**

#### a) Linear Variable Differential Transformer (LVDT), Resistive, Capacitive & Inductive transducers, Piezo electric transducer.

#### b) DC Bridge -Wheatstone's bridge, AC Bridges - Measurement of Inductance and Capacitance – Maxwell's bridge, Schering Bridge, Measurement of frequency – Wien's bridge.

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### **UNIT-IV ADC and DAC & Display Instruments (9Hrs)**

#### a) A/D & D/A converters - Binary ladder, A/D converters –successive approximation type. b) Introduction to Display devices, LED Displays, Seven Segment Displays, Construction and operation (Display of numbers), Types of SSDs (Common Anode & Common Cathode type), Limitations of SSDs, Liquid Crystal Displays, Principle and working, Applications of LCD modules.

### **UNIT-V Amplifiers, Oscillators & Biomedical Instruments (9 Hrs)**

#### a) Amplifiers – Classification of amplifiers, Coupling amplifiers – RC Coupled amplifier – frequency response characteristics (no derivation), Feedback in Electronic circuits – Positive and Negative feedback, expressions for gains, advantages of negative feedback, Barkhausen criteria, RC phase shift

oscillator.

- b) Basic operating principles and uses of (i) ECG machine (ii) Radiography (iii) Ultrasound scanning (iv) Ventilator (v) Pulse oximeter.

#### **REFERENCE BOOKS:**

1. Electronic Instrumentation by H.S.Kalsi ,TMH Publishers
2. Electronic Instrument Hand Book by Clyde F. Coombs ,McGraw Hill
3. Introduction to Biomedical Instrumentation byMandeep Singh, PHI Learning.
4. Electronic Instrumentation – WD Cooper
5. Electrical and Electronic Instrumentation – AK Sawhany
6. A text book in electrical technology by B.L.Thereja (S.Chand&Co)
7. *Biomedical Instrumentation* and Measurements by Leslie *Cromwell* ,*Prentice Hall India*.
8. Electronic Measurements and Instrumentation by Kishor, K Lal, Pearson, New Delhi
9. Electrical and Electronic Measurements by Sahan, A.K., Dhanpat Rai, New Delhi
10. Electronic Instruments and Measurement Techniques by Cooper, W.D. Halfrick, A.B., PHI Learning, New Delhi
11. Web sources suggested by the teacher concerned and the college librarian including reading material.

#### **SEMESTER-V**

#### **COURSE 6: ELECTRONIC INSTRUMENTATION**

Practical Credits: 1 2 hrs/week

#### **COURSE OBJECTIVE:**

The objective of the practical course on Electronic Instrumentation is to provide students with hands-on experience in using electronic instruments for measurement, data acquisition, and control applications. The course aims to develop students' practical skills in operating, calibrating, and troubleshooting electronic instruments commonly used in scientific, engineering, and industrial settings.

#### **LEARNING OUTCOMES:**

1. Familiarize students with a range of electronic instruments, including multimeters,

- oscilloscopes, signal generators, and data acquisition systems.
2. Learn the basic operation, functions, and features of each instrument.
  3. Gain hands-on experience in connecting, configuring, and using different instruments for various measurement tasks.
  4. Develop proficiency in performing common electrical measurements, such as voltage, current, resistance, frequency, and temperature measurements.
  5. Learn specialized measurement techniques, including impedance measurements, time and frequency measurements, and power measurements.
  6. Gain practical experience in selecting appropriate measurement techniques and instruments for specific applications.

## **PRACTICAL SYLLABUS**

1. Familiarization of digital multimeter and its usage in the measurements of (i) resistance (ii) current, (iii) AC & DC voltages
  2. Measure the AC and DC voltages, frequency using a CRO and compare the values measured with other instruments like Digital multimeter.
  3. Formation of Sine, Square wave signals on the CRO using Function Generator and measure their frequencies. Compare the measured values with actual values.
  4. Display the numbers from 0 to 9 on a single Seven Segment Display module by applying voltages.
  5. Displacement transducer-LVDT
  6. A.C - Impedance and Power Factor.
  7. Maxwell's Bridge – Determination of Inductance.
  8. Measurement of body temperature using a digital thermometer and list out the error and corrections. 9. Measurement of Blood Pressure of a person using a B.P. meter and record your values and analyze them.
  10. Display the letters **a** to **h** on a single Seven Segment Display module by applying voltages.
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11. Get acquainted with an available ECG machine and study the ECG pattern to understand the meaning of various peaks
  12. Observe and understand the operation of a Digital Pulseoxymeter and measure the pulse rate of different people and understand the working of the meter.

### **VI. Lab References:**

1. Electronic Measurement and Instrumentation by J.P. Navani. ,S Chand & Co Ltd
2. Principles of Electronic Instrumentation by A De Sa, Elsevier Science Publ.

3. Electronic Measurements and Instrumentation by S.P.Bihari, YogitaKumari, Dr. Vinay Kakka, Vayu Education of India .
- 4.Laboratory Manual For Introductory Electronics Experiments by Maheshwari, New Age International (P) Ltd., Publishers.
- 5.Electricity-Electronics Fundamentals: A Text-lab Manual by Paul B. Zbar ,Joseph Sloop, & Joseph G. Sloop , McGraw-Hill Education.
- 6.Web sources suggested by the teacher concerned.

**SEMESTER-V**  
**COURSE 6: ELECTRONIC INSTRUMENTATION**  
**STUDENT ACTIVITIES**

**Co-Curricular Activities**

- (a) Mandatory:***(Training of students by teacher in field related skills: (lab:10 + field:05) 1.*  
**For Teacher:** Training of students by the teacher in the in the laboratory/field for notless than 15 hours on the field techniques/skills of understanding the operation, Maintenance and utility of various electrical and electronic instruments both in the Laboratory as well as in

daily life.

**For Student:** Students shall (individually) visit a local electrical and electronics shop or small firm to familiarize with the various electrical and electronic instruments available in the market and also to understand their functionality, principle of operation and applications as well as the troubleshooting of these instruments. (Or) Student shall visit a diagnostic centre and observe the ECG machine and the ECG pattern (Or) Student shall visit a diagnostic centre and observe the CT scan and MRI scan. (Or) Student shall visit a mobile smart phone repair shop and observe the different components on the PCB (Motherboard), different ICs (chips) used in the motherboard and trouble shooting of touch screen in smart phones.

Observations shall be recorded in a hand-written Fieldwork/Project work not exceeding 10 pages in the given format to be submitted to the teacher.

2. Max marks for Fieldwork/Project work: 05.

3. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

4. Unit tests (IE)

#### **(b) Suggested Co-Curricular Activities**

1. Training of students by related industrial / technical experts.

2. Assignments (including technical assignments like identifying different measuring instruments and tools and their handling, operational techniques with safety and security.

3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).

4. Making your own stethoscope at home.

5. Making seven segment display at home.

6. Preparation of videos on tools and techniques in various branches of instrumentation. 7.

Collection of material/figures/photos related to products of Measuring Instruments, Display Modules and Biomedical Instruments and arrange them in a systematic way in a file.

8. Visits to Instrumentation Laboratories of local Universities or Industries like Cement, Chemical or Sugar Plants etc. or any nearby research organizations, private firms, etc. 9.

Invited lectures and presentations on related topics by Technical / industrial experts

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