PD 197: Physics Lab –I **(L0-T0-P3-CH6-CR3)**

Course Outcomes:

CO1: The students will be able to use the different components and equipment in physics practical.

CO2: The students will also able to work effectively and safely in the laboratory environment independently and as well as in teams.

Course Contents:

1. Laboratory related components:
   a. Laboratory safety measures; handling of chemical; electrical and electronics items and instruments; handling of laser and laser related instruments and experiments; handling of radioactive samples and related instruments; general safety measures etc.
2. Familiarization with equipment and components:
   a. Familiarization of different Electrical and Electronics components and hence identification & determination of values of unknown components
   b. Familiarization of different optical and hence show different optical behavior & pattern by using different optical components and optical sources (white light, laser, sodium light etc.)
   c. Familiarization of Microsoft excel, Origin and other software for data analysis
   d. Soldering and de-soldering of components in a circuit board.
3. Use of equipment:
   a. Multimeter and its uses
   b. Function generator and its uses
   c. CRO and its use to measure the wavelength, frequency, amplitude etc. of a given electrical signal.
4. Study the variation of time period with distance between center of gravity and center of suspension for a bar pendulum and,
   a. determine
      a) radius of gyration of the bar about its axis through its center of gravity and perpendicular to its length and,
      b) value of g
5. Determine the moment of a given magnet and horizontal component of Earth's magnetic field using magnetometers
6. Determine g through Kater's Pendulum
7. Find the refractive index of a given prism with the help of a spectrometer.
8. To determine the surface tension of the given liquid (water/CC14) by capillary tube method.
9. To measure the focal length of a given lens using (a) Bessel's method and (b)Magnification method.
10. To study elastic and inelastic collisions using suspended spherical balls of different materials.
11. Determination of Young's modulus of the given wire by torsional oscillation (Searl's method)

PD 198: Physics Lab -II **(L0-T0-P3-CH6-CR3)**

Course Outcomes:

CO1: The students will have a good foundation in the fundamentals related to the experiments included in this course and their advanced applications.

Course Content:

(a) Design LCR series and parallel circuits and to measure resonant frequencies.
(b) To prove Thevenin's and Norton's theorem.
(c) Determine the force between two current carrying conductors.
(d) Study the I-V characteristics of a Diode.
(e) Study of Lissajous Figure of two different waves using CRO and find out the unknown frequency of anelectrical signal.
(f) To determine the thickness of thin film using interferometric method.
(g) Determine the mechanical/ Electrical equivalent of heat by Joule's Calorimeter.
(h) Determine the coefficient of linear expansion of the given metal sample by optical lever method.
(i) Determine of the co-efficient of viscosity of water by Poiseulle's method.
(j) Determine the wavelength of the given source of light using Fresnels' Biprism.
(k) Measurement of frequency of an unknown tuning fork using a sonometer.

To determine the coefficient of self-inductance of a coil by Rayleigh's D.C. Bridge method

PD 297: Physics Lab-III **(L0-T0-P4-CH8-CR4)**

Course Outcomes:

CO1: The students will be able to learn practically the interference and diffraction, thermocouple, Wheatstone bridge principles and Op-Amp.

CO2: The students will get motivated to develop small experiments related to these techniques and develop their physical understanding.

Course Content:

1. To observe the rotation of the plane of polarization of monochromatic light by a given solution and to determine the specific rotation of sugar solution using a Polarimeter.
2. Determine the wavelength (λ) of the given monochromatic light by using Lloyd's mirror.
3. To measure thermo e.m.f. of a thermocouple as a function of temperature and find inversion temperature.
4. To measure the radius of curvature of a given concave mirror and to measure the refractive index of a liquid by this method.
5. To measure the inductance of a given inductor using Anderson bridge.
6. To measure the capacitance of a capacitor by de-Sauty method and to find permittivity of air.
7. To study Op-Amp. characteristics:
    a. To get data for different input bias current,
    b. To measure and null the output offset voltage.
8. Determine the efficiency of the given solar cell for different intensity and different frequency of light sources.
9. Measure the elasticity of the given sample by Newton's ring method.

PD 298: Physics Lab-IV **(L0-T0-P4-CH8-CR4)**

Course Outcomes:

CO1: The students will be able to learn practically the experiments using laser, optical fibre etc..

CO2: The students will also learn how to use the optical bench.

CO3: The students will get motivated to develop small experiments related to these techniques and develop their physical understanding.

Course Content:

1. To determine the resistivity of the given semiconductor sample by Four Probe method.
2. To determine the susceptibility of the given sample by Quince tube method.
3. To determine the Planck constant using different wavelength of light using Planck constant kit.
4. To study interference and diffraction with a laser beam at a single slit, double slit, three slits and four slits, and measure the slit separations.
5. To measure the spot size of a beam from a He-Ne laser and a diode laser and to calculate the M parameter.
6. To study the p-n junction characteristics and obtain output voltage at different frequencies.
7. To study connector losses in optical fibers:
    a. loss due to diameter mis-match,
    b. loss due to lateral off-set,
    c. loss due to angular misalignment
8. To measure the refractive index of a sample with a Michelson interferometer.
9. Determination of the focal length and hence the power of a convex lens by displacement method on an optical bench.
10. To find out the velocity of ultrasonic waves in a medium using ultrasonic interferometer.

PD 220: Renewable Energy **(L2-T1-P0-CH3-CR3)**

Course Outcomes:

CO1: The Students will have a good understanding of various small and large scale renewable energy sources.

CO2: The students will be able to learn to harness electricity utilizing these renewable energy sources.

Course Content:

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Electromagnetic and Piezoelectric Energy Harvesting, Energy storage and conversion devices: fuel cells, batteries, supercapacitors.

Environmental issues and Renewable sources of energy, sustainability.

Text Books:

1. H. P. Garg and Jai Praksh, *Solar Energy Fundamentals and Applications*, TMH, 2000.
2. J. Twidell and T. Weir, *Renewable Energy Resources*, E & F N Spon, 1986.
3. G. Boyle, (Ed.), *Renewable Energy, Power for a Sustainable Future*, The Open University/Oxford University Press, 1996.
4. R. O. Hayre, S. W. Cha, W. Colella and F. B. Prinz, *Fuel Cell Fundamentals*, Wiley, 2008.
5. B. E. Logan, *Microbial Fuel Cells*, Wiley, 2007.
6. G.D Rai, *Non-conventional energy sources*, Khanna Publishers, New Delhi, 2011.
7. M P Agarwal, *Solar energy*, S Chand and Co. Ltd., 1983.
8. Suhas P Sukhative, *Solar energy: principles of thermal collection and storage,* Tata McGraw - Hill Publishing Company Ltd, 3rd Ed. 2008.

Reference Books:

1. A. Luque and S. Hegedus (Eds.), *Hand book of Photovoltaic Science and Engineering*, 2nd Edn., John Wiley, 2011.

2. P Jayakumar, *Solar Energy: Resource Assessment Handbook, 2009.*
3. P. Takahashi and A. Trenka, *Ocean Thermal Energy Conversion*, John Wiley, 1994.
4. C. Y. Wereko-Brobby and E. B. Hagan, *Biomass Conversion and Technology*, John Wiley, 1997.
5. J. F. Walker and N. Jenkins, *Wind Energy Technology*, John Wiley and Sons, 1997.
6. D. D. Hall and R. P. Grover, *Biomass Regenerable Energy*, John Wiley, 1987.
7. T. Jiandong, Z. Naibo, W. Xianhaun, H. Jing, and D. Huishen, *Mini Hydropower*, John Wiley, 1996.

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PD 399: Physics Lab-V **(L0-T0-P4-CH8-CR4)**

Course Outcomes:

CO1: The students will be able to understand the theory related to the experiment and their application in their future course of time.

CO2: The students will acquire motivation to develop small experiments related to these techniques and develop their physical understanding.

Course Content:

1. To find out the magneto-resistance of the semiconductor sample as a function of magnetic field and to plot the graph between magnetic field vs. potential developed using magneto-resistance set-up.
2. To plot the gain – bandwidth relation for a negative feedback amplifier using IC 741.
3. To find out the Curie temperature of the given ferromagnetic material ($BaTiO_3$) using Curie temperature kit.
4. To study Malus' law of polarization.
5. To measure optical nonlinearity using z-scan method.
6. To find out the value of Boltzmann constant using Boltzmann Constant kit.
7. To find out the Rydberg constant by observing the Balmer series of Hydrogen using spectrophotometer.
8. To study diffraction at a circular aperture and find the resolving power of a given lens used as an objective of a telescope.
9. a. Develop a clipping and a clamping circuit and determine the output voltage with different DC bias voltage applied.
   b. Design and develop a full wave and a half wave rectifier circuits and find out the ripple factor of the circuits.
10. To study the temperature dependence of Hall coefficient of a semiconductor sample using Hall effect set-up.

PD 317: Basic Computation Techniques **(L2-T1-P0-CH3-CR3) Course**

Outcomes:

CO1: The students will be skilled in C language programming and develop algorithms and programs to tackle physics problems.

Course Content:

Introduction to computers.
Programming using FORTRAN; programming using C and C++

Simple programming examples from calculus; solution of simple algebraic equations, solution of simple differential equations.
Examples of least squares curve fitting, matrix eigenvalue problems. **Text Books:**

5. Gottfried**,** B. S**.,** *Schaum's outline of theory and problems of programming with C***,** (McGraw-Hill Professional, 1996).
6. Mayo, W. E. and Cwiakala, M., *Schaum's Outline of Programming With Fortran 77*, Schaum's Outline series, (McGraw-Hill, 1995).
7. Scheid, F., *Schaum's outline of theory and problems of numerical analysis*, 2nd edition, Schaum's outline series, (McGraw-Hill, 1989).

Suggested Readings:

5. Kanetkar, Y., *Let us C,* (BPB *Publications,* 2012).
6. Mathews, J. H., *Numerical Methods for Mathematics, Science and Engineering*, (Prentice Hall).
7. Narsingh Deo, *System Simulation with Digital Computers*, (Prentice Hall, 1979).

PD 300: Project cum Physics Lab-VI **(L0-T0-P4-CH8-CR4)**

Course Outcomes:

CO1: After completion of this course students will be able to design and carry out scientific experiments. Students will be able to learn how to report their results in the form of a report.

PD 314: Measurement Physics **(L2-T1-P0-CH3-CR3)** **Course Outcomes:**

CO1: The students will be able to interpret data (both theoretical and experimental) and subsequently learn how the important parameters can be derived from a given set of results.

CO2: The students will be able to understand the operational principle of these components while using them for experimental investigations.

CO3: The students will learn the physics of different electronic instrumentations and the ways to improve the signal quality from any electronic circuit.

Course Content:

Data interpretation and analysis, precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and nonlinear curve fitting, chi-square test, Measurement of energy and time using electronic signals from the detectors and associated instrumentation, signal processing; multi-channel analyser, Time of flight technique, coincidence measurements, true-to-chance ratio.

Transducers (temperature, pressure/vacuum, magnetic field, vibration, optical), measurement and control, ionization chamber, proportional counter, GM counters, spark chambers, cloud chamber, semiconductor detectors for charged particles and γ-ray detectors, scintillation counters, photodiodes and charge coupled device (CCD) and CMoS cameras for detection of electromagnetic radiation.

Production of low temperature below 1K, adiabatic demagnetisation and magnetic refrigerator, special properties of liquid helium, temperature below 10^{-6}K, nuclear demagnetisation, measurement of low temperatures.

Op-amp based, instrumentation amp, feedback, filtering and noise reduction, shielding and grounding, Fourier transforms, lock-in detector, box-car integrator, modulation techniques.

Text Books:

12. Sayer, M. and Mansingh, A., *Measurement, Instrumentation and Experiment Design in Physics and Engineering*, (Prentice-Hall India, 2000).
13. Nakra, B. C. and Chaudhry, K. K., *Instrumentation Measurement and Analysis* (Tata McGraw-Hill, 1985).

Reference Books:

3. Knoll, G. F., *Radiation, Detection and Measurement*, 3rd edition, (John Wiley & Sons, 2000).
4. Jones, B. E., *Instrumentation measurement and feedback* (Tata McGraw-Hill, 1978).

PD 400: Physics Laboratory-VII **(L0-T0-P4-CH8-CR4)** **Course Outcomes:**

CO1: The students will be able to connect characteristics properties of the theoretical models.

CO2: The students are expected to get familiarized with various experimental tools and characterization techniques of different experiments in physics.

Course Content:

1. To design and fabricate a phase shift oscillator for the given frequency and to study the output using OpAmp. 741/ 324 / 325.
2. Determination of thermal conductivity of a substance by Lee's method.
3. Scintillation counter:
   Find out the resolution and the FWHM of the given Scintillation counter
   Find out the gamma ray energy of the given radioactive sources
4. Determination of the Young's modulus of a beam by four-point bending.
5. To determine the velocity of sound in (a) dry air, and (b) rods by Kundt's tube method
6. Calculate the difference in wavelength between atomic transition lines and Zeeman lines using Zeeman effect set-up. (SES instruments Pvt. Ltd).
7. To study Talbot imaging and to obtain Talbot distances with moiré interferometry and to measure the focal length of a lens.
8. Determination of the boiling point of a liquid by platinum resistance thermometer and metre-bridge.
9. To measure the diameter of a thin wire using (a) interference, and (b) diffraction and compare the results.
10. To measure the dielectric constant and loss using microwave bench.

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