DUM DUM MOTIJHEEL COLLEGE

UNDERGRADUATE DEPARTMENT OF PHYSICS

B.Sc. Physics (Hons) CBCS Syllabus

With effect from 2018-19

Programme Specific Outcomes

- Upon concluding the undergraduate Physics program, students will acquire fundamental knowledge of the subject along with a comprehensive understanding of the functioning of various scientific and engineering instruments. This acquired knowledge will prove beneficial in their future professional endeavors. Physics, being inherently analytical, aims to cultivate a mindset that questions and comprehends concepts based on logic rather than accepting information without rationale.
- PSO 1: The impact extends to the everyday experiences of individuals, where one gains insights into the fundamental principles governing the properties of matter and the interconnections between various principles. This understanding is facilitated through the study of mathematical and analytical physics. Students delve into essential aspects such as mechanics, general properties of matter, sound, optics, and more, revealing the foundational characteristics of matter.
- PSO 2: This motivates students to conduct experiments in areas like mechanics, general properties of matter, optics, electronics, etc., and subsequently compare the obtained values with theoretical predictions.
- PSO 3: The structure of this course is crafted to enable students to engage in diverse laboratory experiments corresponding to each theoretical concept. This approach aids in establishing a solid understanding of the subject and serves as a source of motivation for students to delve into experimental physics.
- PSO 4: Students are encouraged to explore specialized topics in Physics, including astrophysics, nuclear and particle physics, communication electronics, etc. Additionally, they are motivated to prepare themselves for competitive examinations.

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Course Outcome or Learning Outcome

Three year B.A. /B.Sc. degree course

Under CBCS semester system

HONOURS COURSE IN PHYSICS

With effect from the session: 2018 – 2019

Course Name: **Core Course-1**
Course Code: **PHSACOR01T & PHSACOR01P**
Topic Name: **Mathematical Physics and LAB**

Course Outcome: Upon successful completion of this course, students will acquire the following:

1. A comprehensive understanding of Calculus, facilitating the clear analysis and estimation of infinitesimal dynamic variations in both Space and Time domains.
2. Proficiency in Vector Calculus, enabling the comprehension of direction-specific variations in 1D, 2D, and 3D Space within a time-dependent coordinate system.
3. Familiarity with Probability, providing insights into the statistical behavior of extensive databases.
4. Enrichment in specific Mathematical tools for investigating and comprehending issues in Physical, Chemical, and Biological domains, along with theoretical concepts.
5. Proficiency in the fundamentals of Python programming, a universally accepted open-source language.
6. Knowledge of the open-source advanced operating system Linux.
7. Competence in operating Gnuplot for graphical analysis, aiding students in visually interpreting various problems.
8. Application of diverse computational techniques in theoretical and experimental physics across different branches.

Course Name: **Core Course-2**
Course Code: **PHSACOR02T & PHSACOR02P**
Topic Name: **Mechanics and LAB**

Course Outcome: Upon successful completion of this course, students will be able to:

1. Acquire knowledge about Gravitation and its influence on the dynamic Universe.
2. Gain insights into the elastic properties of matter and its practical applications in construction, including the bending of beams and measurement of various elastic constants.
3. Comprehend the relativity of motion and rest, with an understanding that the speed of light is the ultimate velocity in the universe.
4. Explore the movement of fluids and the application of conservation theorems in this context.
5. Engage in hands-on experiences within the classical mechanical domain, reinforcing theoretical learning.
6. Cultivate fundamental skills for future laboratory experiments.
7. Familiarize themselves with various techniques for measuring physical properties, such as the flexure method, Searle's method, and Poiseuille's method.
8. Understand the utility of different apparatus, including the Torsional Pendulum, Sextant, Bar Pendulum, and Kater's Pendulum.
9. Master the art of systematic experimental observation, data collection, recording, and other essential laboratory practices. Additionally, develop proficiency in graph plotting techniques and the determination of different parameters from graphs.
10. Learn to estimate errors in experimental data

Course Name: Core Course-3
Course Code: PHSACOR03T & PHSACOR03P
Topic Name: Electricity and Magnetism and LAB

Course Outcome: Upon successful completion of this course, students will attain knowledge in the following areas:

1. Understanding Electrostatics, Gauss Law, and Capacitance concepts, including their application to Capacitors.
2. Exploration of Dielectric Properties of Materials and the concept of Polarization in various media, along with practical applications.
3. Comprehension of the existence and generation of Magnetic Fields and Forces, Concepts of Magnetic Dipole formation, Amperes Circuital Law, and its applications.
4. Study of Magnetic properties of matter, covering Magnetization, Magnetic susceptibility, permeability, Ferromagnetism, and the development of the Hysteresis phenomenon.
5. Examination of Electromagnetic Induction, Lenz's Law, and the Reciprocity theorem.
6. Analysis of Electrical circuits, their types, and applications. Development of Network theorems and their practical uses, providing insights into the design and fabrication of motors, dynamos, etc., at both large and small scales.
7. Familiarity with various electrical components, power supply, multimeter, and various other measuring instruments such as the Potentiometer, Carey Foster's Bridge, Anderson's Bridge, Galvanometer, etc.
8. Hands-on experimentation on various topics related to electricity and magnetism covered in the course.
9. Understanding precautions to be taken during experiments and the ability to identify different sources of error.

Course Name: Core Course-4
Course Code: PHSACOR04T & PHSACOR04P
Topic Name: Wave and Optics and LAB

Course Outcome: (1) I conducted online classes due to the prevailing pandemic situation.
(2) Topics covered in the condensed course included Huygen's wave theory-based Interference and Diffraction phenomena, excluding most of Fresnel's theory.
(3) Students were provided with e-study materials and web resources, in addition to regular online classes.
(4) The students demonstrated a solid grasp of the course content, evident from their responses in the final online examination scripts and their interactions on WhatsApp, both during and outside of scheduled online class sessions.
(5) Students undertook additional work by solving nonlinear equations of diffractions through graphical analysis and Python computer programming, a commendable effort.
(6) Familiarity with various instruments/parts such as (i) Spectrometer (ii) EDF Prism (iii) Sodium source and Sodium Vapour Lamp, Mercury Vapour Lamp (iv) Diffraction Grating (v) wedge-shaped Film, etc.
(7) Understanding different experimental setups like (i) Fresnel Biprism (ii) Newton's Rings (iii) Michelson's interferometer, etc.

Course Name: Core Course-5
Course Code: PHSACOR05T & PHSACOR05P
Topic Name: Mathematical methods II and LAB

Course Outcome: Upon successful completion of this course, students will have the ability to:

1. Engage in mathematical modeling and subsequently solve various physical problems.
2. Cultivate proficiency in diverse mathematical domains.
3. Grasp advanced topics in mathematical physics, including Fourier series, special functions, special integrals, integral transforms, partial differential equations, and probability. These topics are crucial for delving into the theoretical aspects of various branches of physics.
4. Acquire knowledge about various numerical analysis techniques, such as the utilization of arrays, numerical solutions for matrix algebra problems, numerical integration, interpolation, differential equation solutions, and curve fitting.

Course Name: Core Course-6
Course Code: PHSACOR06T & PHSACOR06P
Topic Name: Thermal Physics and LAB

Course Outcome: (1) Examining the first law of thermodynamics offers students insights into the equivalence between work and energy, fostering a fundamental comprehension of the mechanisms at play in thermal engines.
(2) The concept of entropy provides a grasp of the inherent directionality within natural processes.
(3) The fundamental principles of thermodynamics act as a pathway for understanding the macroscopic thermal characteristics of a system.
(4) The study of kinetic theory equips students with a foundational understanding of developing microscopic theories related to the thermal properties of matter. This knowledge proves valuable for students involved in researching applications of kinetic theory, particularly in fields like economics and social science.
(5) Through participation in the laboratory course, students acquire knowledge about measuring diverse physical parameters associated with the thermal properties of matter.
(6) Specific practical exercises incorporate electronic circuits for the measurement of thermal parameters, offering students a distinctive opportunity to observe the creation of prototype machines.

Course Name: Core Course-7
Course Code: PHSACOR07T & PHSACOR07P
Topic Name: Digital Systems and Applications and LAB

Course Outcome: Upon successful completion of this course, students will have the ability to:

1. Comprehend the process of constructing Integrated Circuits (ICs) and gain knowledge about the historical development of IC formation.
2. Understand various number systems and Boolean Algebra. Additionally, students will be capable of simplifying digital circuits using Boolean expression simplification methods.
3. Grasp the design and functionality of different combinational digital circuits, including Adders, Subtractors, Multiplexers, De-Multiplexers, Encoders, and Decoders.
4. Construct application-oriented digital circuits using Karnaugh Map simplification based on specific requirements.
5. Differentiate between synchronous and asynchronous counters, understanding their formation techniques.
6. Recognize the utility of shift registers as random sequence generators.
7. Familiarize themselves with various discrete components and accessories such as resistances, breadboards, ICs, voltmeters, multimeters, and DC power supplies.
8. Identify the pin diagrams of various TTL ICs (e.g., 7400, 7404, 7408, 7410, 7411, 7432, 7473, 7476, 7483, 7486, etc.) and create circuits on a breadboard.

Course Name: Core Course-8
Course Code: PHSACOR08T & PHSACOR08P
Topic Name: Mathematical Physics III and LAB

Course Outcome: (1) The complex variable course empowers students to apply its principles across diverse fields such as electrical network theory and quantum mechanics. An essential component of the course, contour integration, facilitates the assessment of improper integrals commonly encountered in physics problems.
(2) The exploration of integral transforms allows students to understand the correlation between the physical properties of a system in a specific space and its reciprocal space.
(3) Proficiency in techniques for solving boundary value problems proves highly advantageous in addressing physical challenges related to electrostatics, wave mechanics, heat conduction, and more.
(4) The study of matrices provides a fundamental grasp of linear operators, with versatile applications in theoretical physics.
(5) This coursework covers a variety of numerical methods essential for students to acquire proficiency in fundamental numerical techniques.
(6) Numerical methods play a crucial role in offering a practical visualization of specific mathematical techniques discussed in the corresponding theory paper.
(7) This coursework enhances students' capacity to write computer codes.
(8) The discussed numerical techniques are invaluable for undertaking advanced research endeavours.

Course Name: **Core Course-9**
Course Code: **PHSACOR09T & PHSACOR09P**
Topic Name: **Elements of Modern Physics and LAB**

Course Outcome:

Upon successful completion of the course, students will acquire the following abilities:

1. Comprehend the principles of relativistic dynamics, exploring the dynamics from a relativistic perspective, and gaining proficiency in the application of 4-vectors.
2. Understand the evolution and significance of quantum theory, including the resolution of the ultraviolet catastrophe through Planck's hypothesis. Gain insight into the dual nature of particles and waves inherent in quantum theory.
3. Grasp the concept of LASER and its applications, recognizing its emergence as a crucial technology influenced by quantum theory.
4. Attain foundational knowledge in nuclear and particle physics, enabling an understanding of the fundamental forces in nature, the properties of atomic nuclei (constituents of atoms), and the various particles in the universe.
5. Acquire knowledge about nuclear radiation and detectors, understanding the different types of radiation (α, β, and γ rays) and the appropriate detectors for radiation containment. This knowledge holds practical significance in the field of medical physics.
6. Gain insights into nuclear reactions, acquiring knowledge on harnessing nuclear energy as a sustainable and environmentally friendly energy source.
7. Develop an understanding of particle physics, essential for comprehending the standard model and the unification of forces.

Course Name: **Core Course-10**
Course Code: **PHSACOR10T & PHSACOR10P**
Topic Name: **Analog Systems and Applications and LAB**

Course Outcome:

Upon successful completion of this course, B.Sc (Honours) Physics students should be able to:

1. Grasp the fundamental principles of semiconductor physics and comprehend its practical applications.
2. Gain understanding in the operation, characteristics, and diverse applications of various components such as diodes, transistors, field-effect transistors, operational amplifiers (OPAMP), and oscillators.
3. Comprehend the working principles of amplifiers, feedback amplifiers, and oscillators. Students will be capable of distinguishing between different amplifier types and selecting an appropriate amplifier for specific applications.
4. Identify various circuit components, including resistors, capacitors, inductors, diodes, transistors, and operational amplifier integrated circuits (ICs) such as the 741.
5. Construct different analog circuits on a breadboard.
6. Acquire knowledge about essential equipment such as the Cathode Ray Oscilloscope (CRO), Function Generator, and Regulated Power Supply.
7. Gain practical experience in handling different Trainer Kits, including those for Diode Experiments, BJT & FET Characteristics study, CE-Amplifier Experiments, and OP-AMP Experiments.
8. Develop the skills to create diverse circuits on a breadboard, empowering students to design circuits for unknown hardware applications.

Course Name: **Core Course-11**

Course Code: **PHSACOR11T & PHSACOR11P**

Topic Name: **Quantum Mechanics and its Applications and LAB**

Course Outcome:

Upon successful completion of this course, students are anticipated to acquire knowledge in the following areas:

1. Fundamental concepts of Quantum Mechanics (QM), including the formalism of Hamiltonian, the importance of Hermitian operators, development of wave-function, Eigen values, and practical applications of uncertainty principles.
2. Understanding of Time-Dependent and Time-Independent Schrodinger Equation, Quantum Mechanical Scattering, and Tunnelling in 1D Step Potential, Rectangular Potential barrier, and the Tunnelling effect in Alpha Decay. Introduction to Scanning Tunnelling Microscopes (STM) is also covered.
3. Knowledge of the existence of Bound states in arbitrary Potentials and the Quantum Theory of Hydrogen-like atoms, Helium ions, etc.
4. Application of Quantization rules in Atomic Physics, with a focus on the Zeeman Effect, attracting students interested in Quantum Mechanical Phenomena and Systems in Physics, Chemistry, and Nano-materials.
5. Inclusion of lessons on Quantum Mechanics-related numerical practicals, covering topics beyond the Undergraduate core course theory syllabus.
6. Learning how to transform a time-independent Schrodinger equation involving dimensionless variables, employing two methods: (a) shooting method, (b) direct matrix method. The former involves iterative numerical solutions using RUNGE KUTTA methods, while the latter employs diagonalization as a single-shot method.
7. Independent coding using the Python programming language, excluding the diagonalization procedure.
8. Output interpretation involving probability distribution and eigenvalues, demonstrating proficiency in applying proper boundary conditions specific to various quantum mechanical problems.
9. Solving advanced problems like the isotropic anharmonic oscillator and Quantum Morse oscillator, extending beyond their Undergraduate syllabus.
10. Preparation and submission of an electronic Lab Notebook (e-LNB) at the term end, demonstrating a high standard of work.
11. Equipping students with the capability to numerically solve Schrodinger equations, enabling exploration of more complex problems in higher physics during their future studies.

Course Name: Core Course-12
Course Code: PHSACOR12T & PHSACOR12P
Topic Name: Solid State Physics and LAB

Course Outcome:

Upon successful completion of this course, students will achieve the following:

1. Gain knowledge about the classification of solid materials into amorphous and crystalline structures, understanding how the properties of matter are influenced by both structure and electronic configuration. Additionally, comprehend the study of matter structure using X-ray techniques.
2. Understand how lattice oscillations impact the properties of matter.
3. Acquire knowledge about magnetic properties, various types of magnetic behaviors, and dielectric properties of matter. Familiarity with Drude's theory, including the conduction of electrons through matter and concepts such as drift velocity.
4. Explore the development of band theory and its successful explanation of various properties of matter.
5. Learn about the recently emerged material property known as superconductivity and its practical applications.
6. Develop an understanding of electric current carried by charges, distinguishing between negative and positive charges. Proficiency in determining the type of carriers (negative or positive) through Hall voltage measurements.
7. Gain insights into the widespread use of magnetism in daily life and industries, understanding the different types of magnets with various properties. Learn to assess the characteristics of a particular magnet through B-H experiments, which reveal how magnetic field strength (B) and magnetic field intensity (H) vary within the magnet, along with energy loss.
8. Recognize the extensive use of semiconductors in various industries and technologies. Understand that semiconductor properties are primarily dependent on the band gap between the valence and conduction bands. Develop the ability to estimate the band gap by measuring voltage with temperature.

Course Name: Core Course-13
Course Code: PHSACOR13T & PHSACOR13P
Topic Name: Electromagnetic Theory and LAB

Course Outcome:

Upon successful completion of this course, students will acquire knowledge in the following areas:

1. Understanding Maxwell's Equations and their characteristics in free space and various media, including the application of Poynting Theorem and vectors, as well as exploring energy density and field energy density.
2. Studying the propagation of Electromagnetic (EM) waves in both bounded and unbounded media, along with gaining insights into the polarization of EM waves.
3. Exploring the concepts and applications of waveguides and optical fibers, providing students with a comprehensive understanding of Optical Communication, Wave Propagation, and Transmission Theory.

Course Name: **Core Course-14**
Course Code: **PHSACOR14T & PHSACOR14P**
Topic Name: **Statistical Mechanics and LAB**

Course Outcome:

(1) Statistical mechanics offers a method to comprehend microscopic aspects of physical systems while establishing connections with their macroscopic properties.
(2) Quantum statistical mechanics aids students in grasping the behavior of systems at low temperatures.
(3) The fundamental framework of statistical mechanics equips students to apply it across a broad spectrum of physical systems.
(4) Proficiency in statistical physics significantly benefits students engaging in research across advanced physics branches such as condensed matter physics and particle physics.
(5) Through this computational lab course, students gain a distinctive opportunity to experiment with various statistical mechanics methods.
(6) The course introduces fundamental concepts for conducting numerical research related to statistical physics.
(7) Participation in this course enhances the students' capability to write numerical codes.

Course Name: **Discipline Specific Elective-1**

Course Code: **PHSADSE02T**

Topic Name: **Advanced Dynamics**

Course Outcome:

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

1. Comprehend the dynamics and derivation of Lagrange's equations.
2. Solve dynamics problems involving both time-dependent and time-independent constraints.
3. Gain an understanding of the dynamics of rigid bodies and fluid dynamics.
4. Grasp the concepts of phase space, autonomous and non-autonomous systems.
5. Analyze the behavior of one-dimensional autonomous systems, two-dimensional dynamical systems, etc.
6. Understand the notion of limit cycles, discrete-time dynamical systems, iterative maps, and logistic maps.
7. Evaluate the impact of parameter dependence on steady, periodic, and chaotic states.
8. Acquire knowledge about the concept of chaos and Lyapunov exponents.

Course Name: **Discipline Specific Elective-2**

Course Code: Topic Name: PHSADSE03T, Nuclear and Particle Physics

Course Outcome: Upon concluding the course, students will be capable of:

1. Understanding the fundamental principles of nuclear and particle physics.
2. Gaining expertise in advanced nuclear and particle physics concepts.
3. Applying the principles of nuclear and particle physics for the sustainable development of the nation.

Course Name: **Discipline Specific Elective-3**

Course Code: **PHSADSE04T**

Topic Name: **Advanced mathematical physics**

Course Outcome:

Upon successfully finishing the course, students will have the capability to:

1. Resolve various problems that incorporate modern mathematics, statistics, and calculus.
2. Develop a substantial amount of knowledge and skill in formulating scientific laws across interdisciplinary subjects.

Course Name: **Discipline Specific Elective-4**

Course Code: **PHSADSE06T & PHSADSE06P**

Topic Name: **Communication Electronics and LAB**

Course Outcome:

Upon completing this course, students will have the ability to:

1. Comprehend the practical applications of modern communication systems, both analog and digital.
2. Gain knowledge about various modulation techniques such as AM, FM, PM, FSK, PSK, ASK, BPSK, etc., providing a foundation for advanced studies.
3. Understand the techniques involved in satellite communication.
4. Build and analyze modulator and demodulator circuits, and demonstrate proficiency in calculating various parameters of modulated waves.
5. Grasp the principles and practical implementation of transmitter circuits.

Course Name: **Skill Enhancement Course-1**
Course Code: **PHSSSEC01M**
Topic Name: **Basic Instrumentation Skills**

Course Outcome:

Upon completion of the course, students will have the capability to:

(1) Develop practical skills in using various instruments crucial for physical measurements.
(2) Apply the acquired knowledge in their future professional endeavors.
(3) Gain a comprehensive understanding of cathode ray oscilloscope (CRO), including the basics of its operation, construction of cathode ray tubes (CRTs), electron gun functionality, electrostatic focusing and acceleration, and a brief discussion on screen phosphor.
(4) Comprehend the principles and operations of digital meters, make comparisons between analog and digital instruments, and understand the functioning of digital voltmeters.
(5) Understand the operation of a digital multimeter, enabling them to measure current, voltage, frequency, and other parameters using this instrument.

Course Name: **Skill Enhancement Course-2**
Course Code: **PHSSSEC02M**
Topic Name: **Computational Physics**

Course Outcome:

Upon completion of the course, students will be able to:

1. Grasp the practical applications of fundamental Linux commands.
2. Acquire proficiency in using the LaTeX word processor, including creating basic LaTeX files and documents, preparing input files, compiling LaTeX files, utilizing LaTeX tags for different environments, defining commands and environments, modifying type styles, representing equations and formulas, handling figures and floating bodies, generating tables of contents, bibliography, and citations, exploring various fonts, using the picture environment, and incorporating colors.
3. Understand graphical analysis, recognizing its limitations, and recognizing the significance of visualizing computational and computational data. Gain competence in basic gnuplot commands, such as creating simple plots, plotting data from a file, saving, and exporting.
4. Familiarize themselves with essential Linux commands commonly needed in various contexts.
5. Participate in a course on F90 programming, mastering the ability to write elementary codes. Students independently conducted programming related to the course and compiled their work into an e-Notebook for evaluation.
6. Apply F90 programming knowledge to elementary projects such as the numerical solution of central force orbits, projectile motion, and simple harmonic motion.
7. Successfully complete an online examination at the end of the term, presenting their project work codes, and achieving good results.
8. Learn and apply GNUPLOT in 1D and 2D data visualization.
9. Demonstrate a solid understanding of the course, showcasing the ability to apply F90 programming skills in future endeavors.

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Course Outcome or Learning Outcome
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GENERAL COURSE IN PHYSICS
With effect from the session: 2018 – 2019

Course Name: **Generic Elective/Department Specific Core Course-1**
Course Code: **PHSHGEC01T & PHSHGEC01P / PHSGCOR01T & PHSGCOR01P**
Topic Name: **Mechanics and LAB**

Course Outcome:

Upon successful completion of this course, students will be able to learn about:

1. Operations involving vectors.
2. Fundamental laws of mechanics, including Newton's laws, conservation of momentum, and energy.
3. Laws governing the motion of particles, including celestial bodies like Earth and the Sun, under the influence of gravity.
4. The dynamics of fluids, including understanding streamline and turbulent motion.
5. Concepts related to frames of reference, the absence of absolute rest, and the acknowledgment that the velocity of light is the highest in the universe, as per the special theory of relativity.
6. Application of slide calipers and screw gauges, enabling students to measure dimensions such as length, breadth, width of a bar, diameter of a cylinder, and diameter of a wire.
7. Use of a stopwatch to determine the time period of a body, as well as the application of a telescope in experiments like determining Young's experiment.
8. Determination of the moment of inertia of a regular body using another auxiliary body and a cradle suspended by a metallic wire.
9. Understanding how to determine Young's Modulus through the flexure method, and the determination of the Modulus of Rigidity of a wire using a torsional pendulum.

Course Name: **Generic Elective/Department Specific Core Course-2**
Course Code: **PHSHGEC02T & PHSHGEC02P / PHSGCOR02T & PHSGCOR02P**
Topic Name: **Electricity and Magnetism and LAB**

Course Outcome:

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

1. Comprehend the electrostatic field, electric flux, Gauss's theorem, and its applications in electrostatics. Understand the electric potential due to an electric dipole, capacitance of an isolated spherical conductor, parallel plate condenser, and polarization.
2. Understand Biot-Savart's law, its applications, Ampere's circuital law, and magnetic properties of materials.
3. Grasp Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, and the energy stored in a magnetic field.
4. Understand Thevenin's, Norton's, maximum power transfer, superposition theorems, and the basics of Anderson's bridge.
5. Understand Maxwell's equations, Poynting's vector, electromagnetic wave (EM) propagation through a vacuum, transverse nature of EM waves, and polarization.
6. Gain knowledge about measuring resistance, capacitance, current, and voltages using a multimeter. Understand the series/parallel connections of ammeters/voltmeters and their applications for measuring currents/voltages.
7. In the laboratory, be able to determine an unknown low resistance using Carey Foster's bridge.
8. Verify Thevenin's, Norton's, superposition, and maximum power transfer theorems.
9. Study the response curve of a series LCR circuit, determining its resonant frequency, impedance at resonance, quality factor Q, and bandwidth.
10. Study the characteristics of a series RC circuit.

Course Name: **Generic Elective/Department Specific Core Course-3**
Course Code: **PHSHGEC03T & PHSHGEC03P / PHSGCOR03T & PHSGCOR03P**
Topic Name: **Thermal Physics Statistical Mechanics and LAB**

Course Outcome:

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

1. Grasp various thermodynamic processes, apply the first and second laws of thermodynamics, understand system entropy, and comprehend the Carnot cycle.
2. Understand Maxwell's law of velocity distribution, apply it to determine average, root mean square (r.m.s.), and most probable velocities, and explore various transport phenomena such as viscosity, conduction, and diffusion.
3. Understand black body radiation, including Planck's law, Wien's distribution law, Rayleigh-Jeans law, Stefan-Boltzmann law, and Wien's displacement law.
4. Comprehend the fundamentals of Statistical Mechanics, including concepts like phase space, macrostate, microstate, entropy, and thermodynamic probability. Gain basic knowledge of Fermi-Dirac and Bose-Einstein statistics.
5. Understand the practical use of a traveling microscope for measuring disc width in experiments related to the coefficient of thermal conductivity. Acquire skills in using a thermometer for temperature measurement.
6. Verify Stefan's law using a torch bulb.
7. Determine the coefficient of thermal conductivity of a poor conductor through the Lee and Charlton's disc method. Additionally, understand Newton's law of cooling in this experiment.
8. Study the variation of thermo-electromotive force (thermo-emf) of a thermocouple with the temperature difference at its two junctions.

Course Name: **Generic Elective/Department Specific Core Course-4**
Course Code: **PHSHGEC04T & PHSHGEC04P / PHSGCOR04T & PHSGCOR04P**
Topic Name: **Waves and Optics and LAB**

Course Outcome:

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

1. Comprehend the superposition of collinear and perpendicular harmonic oscillations, including the understanding of Lissajous figures with equal and unequal frequencies. Gain knowledge about transverse waves on a string, traveling and standing waves on a string, forced vibrations, resonance, intensity, loudness of sound, musical notes, and reverberation.
2. Understand the properties of surface tension and viscosity of liquids.
3. Grasp the Huygens principle and the interference of light, covering aspects such as Fresnel's biprism, phase change on reflection (Stokes' treatment), interference in thin films, and Newton's rings.
4. Understand the diffraction of light, including half-period zones, zone plate, single and double slits, and plane transmission grating. Gain knowledge about the polarization of light, covering the transverse nature of light waves, production and analysis of plane-polarized light, circular and elliptical polarization.
5. Understand the basics and applications of Michelson's interferometer, including the determination of wavelength and wavelength difference.
6. Understand the basics of a spectrometer and microscope, along with their application for optical measurements. Acquire knowledge about the use of prisms and the measurement of prism angles. Become familiar with Schuster's focusing for the measurement of the minimum deviation for different colors.
7. Determine the frequency of an electric tuning fork through Melde's experiment and verify the λ^2–T law.
8. Determine the refractive index of the material of a prism using a sodium source. Also, determine the dispersive power and Cauchy constants of the prism material using a mercury source.
9. Form Newton's rings and, consequently, determine the wavelength of sodium light.

Course Name: **Department Specific Elective-1**
Course Code: PHSGDSE01T & PHSGDSE01P
Topic Name: **Digital, Analog Circuits and Instrumentation and LAB**

Course Outcome:

Upon successfully completing this course, students will possess the ability to:

1. Comprehend binary-to-decimal and vice-versa conversions, as well as perform operations such as addition, subtraction, multiplication, and division with binary numbers. Understand logic gates like OR, AND, NOT, NOR, NAND, XOR, XNOR, and apply De Morgan's theorems. Additionally, grasp the concepts of half and full adders/subtractors.
2. Understand the biasing of p-n diodes, their operational mechanisms, and applications. Gain insights into the operations and uses of LEDs, photodiodes, and solar cells. Comprehend the characteristics of transistors under various biasing conditions (CB, CE, and CC), and their applications in different amplifier implementations (A, B, AB, and C).
3. Understand the characteristics of operational amplifiers (OPAMPs) and their applications in inverting and non-inverting amplifiers, adders, subtractors, differentiators, integrators, and oscillators.
4. Grasp the applications of Cathode Ray Oscilloscopes (CRO) and different rectifiers such as half-wave, full-wave, and bridge rectifiers.
5. Recognize the pin configurations of OPAMPs, as well as logic gates including OR, AND, NOT, NAND, NOR, XOR, and XNOR gates.
6.
7. Verify and design logic gates (AND, OR, NOT, XOR) using NAND gates. Minimize given logic circuits, design them, and create corresponding truth tables. Additionally, verify De Morgan's theorems by implementing circuits with different Integrated Circuits (ICs).
8. Verify the outputs of half adders/subtractors and full adders/subtractors, preparing respective truth tables.

Course Name: **Department Specific Elective-2**
Course Code: **PHSGDSE03T & PHSGDSE03P**
Topic Name: **Solid State Physics and LAB**

Course Outcome:

Upon successful completion of this course, students will achieve the following:

1. Differentiate between crystal and amorphous solid materials, understanding their distinctions in terms of structure, electrical properties, optical characteristics, and more.
2. Gain knowledge that all atoms or molecules within materials are continually oscillating, even if the bulk matter may appear at rest.
3. Acquire an understanding of the magnetic properties of materials, the various types of magnetic behaviors, and their practical applications.
4. Explore how, following the limitations of the free electron theory in explaining observed properties, the band theory effectively elucidates major properties of matter, facilitating the classification of materials into conductors, semiconductors, and insulators.
5. Learn about emerging materials with zero resistivity, presenting promising possibilities for various applications.
6. Comprehend the fundamentals and biasing of p-n junction diodes, along with understanding their characteristics.
7. Understand the variation of semiconductor resistivity with temperature. Students will be able to design necessary circuit arrangements to measure the resistivity of a Germanium semiconductor with temperature (under reverse bias), thereby determining its band gap.
8. Develop the ability to design requisite circuit arrangements for studying the temperature coefficient of a semiconductor (NTC thermistor).