Department Of Physics

Course Name: Core Course - 01
Course Code: PHSACOR01T & PHSACOR01P
Topic Name: Mathematical Physics - I

Course Outcome: Upon successful completion of this course

- students will gain a better understanding of Calculus of a real variable and subsequently the Calculus of more than one variable.
- students will learn to solve first order differential equations.

students will learn Vector Calculus and related fundamental theorems.

In the practical component

- Python language is introduced to the students.
- students will learn to write basic Python codes and to draw simple graphs using Qtiplot.
- students will learn the implement logical and loop structure in programming.
- students will learn how to define functions in Python.
- students will learn to solve algebraic and transcendental equations by Bisection and Newton- Raphson method.
- students will learn to handle quadratic equations with complex roots.

Course Name: Core Course - 02
Course Code: PHSACOR02T & PHSACOR02P
Topic Name: Mechanics
Course Outcome: Upon successful completion of this course

- students will learn about Gravitation and its impact on the dynamic Universe.
- students will understand about elastic properties of matter and its application and how to measure different types of elastic constant.
- students will learn about Fluid motion, Oscillations etc.
- students will acquire basic knowledge about Special Theory of Relativity.
- students will understand different techniques for measuring different physical properties like (i) flexure method (ii) Searle's method (iii) Poiseuille's method etc
- students will know the uses of different apparatus like (i) Ttorsional Pendulum (ii) Sextant (iii) Bar Pendulum (iv) Kater's Pendulum
- students will know how to make systematic experimental observation, data collection, recording of data and other basic laboratory practices in this course.
- students will know the technique of plotting the graphs and will able to determine the different parameters from the graph.
- Students will able to estimate the errors in experimental data.

Course Name: Core Course - 03
Course Code: PHSACOR03T & PHSACOR03P
Topic Name: Electricity & Magnetism

Course Outcome: Upon successful completion of this course

- students will learn how to find the electric and magnetic field under certain special conditions.
- students will have an understanding of electrostatic potential and vector potential being important mathematical construct in computing corresponding fields.
- students will learn electro-magnetic induction along with the theory of simple electrical circuits.
- Students will able to know about various electrical components, power supply, multimeter and various other measuring instruments like (i)Potentiometer (ii) Carey Foster's Bridge (iii) Anderson's bridge (iv) Galvanometer etc
- students will able to perform experiments on various topics of electricity and magnetism associated with the course.
- Students will know about precautions to be taken during performing an experiment and will be able to identify different sources of error.

Course Name: Core Course - 04
Course Code: PHSACOR04T & PHSACOR04P
Topic Name: Waves and Optics

Course Outcome: Upon successful completion of this course

- students will understand the fundamental principles of wave motion.
- students will able to understand Huygen's wave theory.
- students will able to understand various optical phenomena, for example interference, diffraction etc.
- Students will able to analyze and solve problems involving wave propagation.
- students will know about different instruments/parts like (i) Spectrometer (ii) EDF Prism (iii) Sodium source and Sodium Vapour Lamp, Mercury Vapour Lamp (iv) Diffraction Grating (v)wedge-shaped Film etc
- students will able to determine the frequency of an electric tuning fork by Melde's experiment.
- students will understand about different experimental set up like (i) Fresnel Biprism (ii) Newton's Rings (iii) Michelson's interferometer etc.

Course Name: Core Course - 05
Course Code: PHSACOR05T & PHSACOR05P
Topic Name: Mathematical Physics - II

Course Outcome: Upon successful completion of this course

- students will learn the expansion of a function in Fourier series.
- students will learn a special class of second order differential equation yielding special functions.
- students will learn calculus of variation and subsequently Classical Mechanics.
- students will get a first exposure to some physically important partial differential equations using separation of variables.

In the practical component (implemented in Python language)

- students will learn how to use numpy to simplify program code.
- students will learn matplotlib, a very useful module to draw graphs and plots in 2 and 3 dimensions.
- students will learn certain sorting algorithm and how to calculate different statistic out of a data set.
- students will learn numerical method for interpolation, differentiation and integration and the solution of first order differential equation using Euler method.

Course Name: Core Course - 06
Course Code: PHSACOR06T & PHSACOR06P
Topic Name: Thermal Physics

Course Outcome: Upon successful completion of this course

- students will understand the fundamental principles of thermodynamics and laws of thermodynamics.
- students will understand the concepts of entropy, various thermodynamic potentials and their applications in various systems.
- students will able to understand the microscopic behavior of the systems to explain pressure, transport phenomena, viscosity, diffusion etc.
- Students will to interpret and visualize thermodynamic concepts: Understand the physical significance of thermodynamic quantities (e.g., temperature, entropy)
- students will get the idea of measuring various physical parameters related to the thermal properties of matter.
- students will able to verify Stefan’s law.
- Students will to determine the Coefficient of Thermal Conductivity of a bad conductor by

Lee and Charlton's disc method.

- students will able to determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT) using constant current source.

- students will able to perform experiments on various topics associated with the course.

Course Name: Core Course - 07
Course Code: PHSACOR07T
Topic Name: Digital Systems and Applications
60 Lectures 4 Credits

Course Outcome:

Here's a structured course outcome for each section of your electronics course, which spans several key areas from basic electronic components to complex computer organization. This breakdown should help in clearly defining what students are expected to learn from each part of the course.

1. Course Outcome for "Introduction to Electronic Components and Measuring Devices" (4 Lectures)

Objective: Provide students with foundational knowledge of electronic components and measuring devices, focusing on their functions, characteristics, and applications with an emphasis on Cathode-Ray Oscilloscope (CRO).

Outcomes:

- Understand basic electronic components such as resistors, capacitors, and transistors, and their roles in circuits.

Learn the operational fundamentals and applications of the CRO including waveform analysis and electrical measurements (voltage, current, frequency, phase).

Analyse block diagrams of CROs, focusing on key components like the electron gun, deflection system, and time base.

Apply knowledge of CRO to measure and interpret electronic signals.

2. Course Outcome for "Integrated Circuits" (5 Lectures)

Objective: Explore the technology, advantages, and types of integrated circuits (ICs), including their classification and scale of integration.

Outcomes:

- Differentiate between active and passive components, and discrete components.

Understand the concepts of wafer and chip fabrication.

Comprehend the scale of integration from SSI to VLSI and the respective applications.

Classify ICs into linear and digital categories and provide examples of each.

3. Course Outcome for "Digital Circuits" (16 Lectures)

Objective: Delve into the fundamentals and complexities of digital circuits, covering binary numbers, logic gates, and Boolean algebra.

Outcomes:

- Differentiate between analog and digital circuits.

Master conversions between decimal, binary, BCD, octal, and hexadecimal systems.

Apply De Morgan’s Theorems and Boolean Laws to simplify logic circuits.

Design and analyze logic circuits using different simplification methods including Karnaugh Maps.

Understand the function and application of XOR and XNOR gates, particularly in parity checking.

4. Course Outcome for "Arithmetic Circuits" (5 Lectures)

Objective: Study the fundamental arithmetic operations performed by digital circuits, focusing on their design and implementation.

Outcomes:

- Understand and design simple arithmetic circuits like binary adders and subtractors.

Develop half and full adders and subtractors.

Construct complex arithmetic circuits like 4-bit binary adder/subtractors.

5. Additional Course Outcomes:

- **Data Processing Circuits** (5 Lectures): Gain a basic understanding of multiplexers, demultiplexers, decoders, and encoders.

Sequential Circuits (6 Lectures): Learn about various flip-flops and their applications in designing sequential logic circuits.

Timers (4 Lectures): Understand the IC 555 timer and its applications in creating astable and monostable multivibrators.

Registers (4 Lectures): Master the different types of shift registers and their applications in data handling and processing.

Counters (4 Lectures): Understand different types of counters and their applications in digital circuits.

Computer Organization (7 Lectures): Gain insights into the architecture and organization of computers, including memory, I/O devices, and interfacing.

General Learning Outcomes:

By the end of this course, students will:

- Have a comprehensive understanding of both theoretical and practical aspects of electronics and digital circuits.

Be capable of designing and troubleshooting basic to moderately complex electronic circuits.

Be prepared for further studies or careers in electronics, digital design, and related fields.

These outcomes should provide a clear guide for both teaching staff and students on what knowledge and skills are expected to be developed throughout the course.

Course Name: Core Course - 07
Course Code: P H S A C O R 0 7 P
Topic Name: Digital Systems and Applications Lab
60 Class Hours 4 Credits

For a course focused on practical applications of electronic principles and devices, clear course outcomes that define specific skills and competencies students are expected to gain are essential. Below is a structured breakdown of the course outcomes based on the practical labs and tasks outlined:

Course Outcomes

Outcome 1:

- a) Efficiently use a Cathode-Ray Oscilloscope (CRO) to:

(i) Measure voltage levels in different parts of electronic circuits.

(ii) Determine the time period of periodic waveforms, enabling frequency calculation.

b) Use a multimeter to test the functionality and characteristics of diodes and transistors.

Outcome 2:

- a) Design and implement a transistor-based switch (NOT gate), understanding the role of transistors in logic inversion.

b) Utilize NAND gates to create and verify the operation of AND, OR, NOT, and XOR logic gates, demonstrating the versatility of NAND gates in digital circuit design.

Outcome 3:

- Analyze a given truth table to derive the corresponding logic equation, simplify it, and then design and implement the circuit using appropriate logic gate ICs.

Outcome 4:

- Construct and test different types of adders:

Design a Half Adder.

Design a Full Adder.

Design and implement a 4-bit binary Adder, integrating multiple Full Adders.

Outcome 5:

- Develop Flip-Flop circuits using NAND gates, specifically:

RS Flip-Flop

D-type Flip-Flop

JK Flip-Flop

Outcome 6:

- Design and build an astable multivibrator using the 555 Timer IC to specifications, demonstrating the ability to generate continuous oscillating outputs.

Outcome 7:

Design and construct a monostable multivibrator using the 555 Timer IC, to generate a single pulse of adjustable duration based on given specifications.

Outcome 8:

Implement arithmetic circuits using ICs:

Construct a Half Subtractor.

Construct a Full Subtractor.

Construct an Adder-Subtractor combination using a Full Adder IC.

Outcome 9:

Build and test a JK Master-Slave Flip-Flop circuit using Flip-Flop ICs, understanding its operation and the solution to the "race condition".

Outcome 10:

Develop a 4-bit counter using D-type or JK Flip-Flop ICs and analyze the timing diagram to understand the sequence and timing of operations.

Outcome 11:

Construct a 4-bit Shift Register using:

Serial-in and Serial-out configuration.

Serial-in and Parallel-out configuration.

Parallel-in and Serial-out configuration.

Parallel-in and Parallel-out configuration.

General Learning Outcomes:

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

Apply theoretical concepts in practical scenarios, enhancing understanding of digital and analog circuitry.

Design, build, and troubleshoot basic to moderately complex electronic circuits.

Use a variety of electronic measuring and testing tools effectively.

Analyse and interpret electronic circuit behaviour through experimental data.

This structure gives a clear indication of what students are expected to learn and accomplish, directly aligning practical activities with learning goals, thereby enhancing both the teaching and learning experience in the course.

Course Name: Core Course - 08
Course Code: PHSACOR08T & PHSACOR08P
Topic Name: Mathematical Physics - III

Course Outcome: Upon successful completion of this course

- students will learn the theory of functions of a single complex variable. This approach turns out to be of importance in studying advanced subjects like Quantum Field Theory, two-dimensional Conformal Field Theory etc.
- students will learn one type of integral transform, viz., the Fourier Transform which is essential to study Quantum Mechanics. It is used to determine Green function of some differential operators having profound physical significance, viz., Laplacian etc.
- students will learn to tackle boundary value problems occurring in electrostatic, wave mechanics, theory of heat conduction etc.
- students will have a clear understanding of how to deal with various matrices representing abstract linear operators.

In the practical component (implemented in Python language)

- students will learn matrix manipulation viz. Diagonalization, triangulation, computation of determinant, inverse etc. by elementary row operations.
- students will learn different numerical techniques, viz., Gauss elimination method, Gauss-Jordan method and Gauss-Seidal iterative method for approximate solutions of a system of linear equations.
- students will learn to solve heat equation, Laplace equation, Poisson equation and wave equation as boundary value problems by discretizing derivatives.

Course Name: Core Course - 09
Course Code: PHSACOR09T & PHSACOR09P
Topic Name: Elements of Modern Physics

Course Outcome: Upon successful completion of this course

- students will get the idea of relativistic dynamics, that is study of dynamics under relativistic view point. They will also know the 4-vectors and their applications
- students will know how the quantum theory has been emerged and why. The students will get the essence how ultraviolet catastrophe was elegantly removed by the famous hypothesis of Planck. The particle and wave-dual nature inherent in quantum theory is

the most important as well as interesting part towards understanding the properties of small particles.

- students will get the idea of LASER and its applications.
- students will also be able to get the basic knowledge in nuclear and particle physics. This is important to understand the fundamental forces existing in nature and also the properties of atomic nucleus and the existing particles in the universe.
- Students will learn about Nuclear structure and various models.
- students will learn about the nuclear radiation and nuclear reactors.
- students will understand about the basic properties of nuclear reaction.
- students will know about different instruments like (i) Spectrometer, (ii) photo detector etc.
- students will understand about different experimental set up like (i) Millikan oil drop apparatus, (ii) wavelength of laser source using diffraction of single slit etc.

Course Name: Core Course - 10
Course Code: P H S A C O R 10 T
Topic Name: Analog Systems and Applications
60 Lecture   4 Credits

Course Outcome:

Here are the course outcomes for each topic:

History of the Development of Electronics (3 Lectures):

Understand the historical progression of electronics from valve circuits to modern semiconductor devices.

Analyze the advantages of semiconductor devices over valve circuits in modern electronic systems.

Semiconductor Diodes (7 Lectures):

Explain the characteristics of P and N type semiconductors and their energy level diagrams.

Understand the fabrication of PN junction diodes and the formation of the depletion region.

Analyze the static and dynamic resistance of diodes and their current flow mechanisms under forward and reverse bias.

Derive equations for barrier potential, barrier width, and current for step junction diodes.

Two-terminal Devices and their Applications (7 Lectures):

Describe the operation of rectifier diodes in half-wave, full-wave, center-tapped, and bridge configurations.

Calculate ripple factor and rectification efficiency for different rectifier circuits.

Understand the principle and structure of LEDs, photodiodes, and solar cells.

Explain the working principle of Zener diodes and their application in voltage regulation.

Bipolar Junction Transistors (8 Lectures):

Understand the construction and operation of n-p-n and p-n-p transistors.

Analyze the characteristics of common base (CB), common emitter (CE), and common collector (CC) configurations.

Explain the physical mechanism of current flow in transistors and derive relations between current gains α and β.

Analyze transistor circuits using load line analysis and determine operating points in active, cutoff, and saturation regions.

Field Effect Transistors (3 Lectures):

Explain the basic principle of operation of junction field-effect transistors (JFETs).

Describe JFET parameters and characteristics of common source (CS) configurations.

Amplifiers (8 Lectures):

Understand transistor biasing and stabilization circuits.

Analyze single-stage common emitter (CE) amplifier circuits using hybrid model and determine input/output impedance, gains, and stability.

Classify amplifiers into Class A, B, and C based on their operation.

Coupled Amplifier (3 Lectures):

Understand the configuration and frequency response of two-stage RC-coupled amplifiers.

Feedback in Amplifiers (4 Lectures):

Explain the concept of feedback and its effects on amplifier parameters such as impedance, gain, stability, distortion, and noise.

Sinusoidal Oscillators (4 Lectures):

Apply Barkhausen's criterion to determine conditions for self-sustained oscillations.

Understand the operation and frequency determination of RC phase shift, Hartley, and Colpitts oscillators.

Operational Amplifiers (4 Lectures):

Describe the characteristics of ideal and practical operational amplifiers (Op-Amps).

Analyze open-loop and closed-loop gain, frequency response, common mode rejection ratio (CMRR), and slew rate.

Applications of Op-Amps (7 Lectures):

Explain various linear and non-linear applications of operational amplifiers, including amplifiers, adders, subtractors, integrators, differentiators, comparators, and oscillators.

Conversion (2 Lectures):

Describe resistive network conversion techniques such as weighted and R-2R ladder networks.

Understand the principles of A/D conversion, particularly successive approximation, and analyze accuracy and resolution.

Course Name: Core Course - 10
Course Code: P H S A C O R 10 T
Topic Name: Analog Systems and Applications
60 Lecture 4 Credits

Course Outcome:

Here are the course outcomes for each topic:

History of the Development of Electronics (3 Lectures):

Understand the historical progression of electronics from valve circuits to modern semiconductor devices.

Analyze the advantages of semiconductor devices over valve circuits in modern electronic systems.

Semiconductor Diodes (7 Lectures):

Explain the characteristics of P and N type semiconductors and their energy level diagrams.

Understand the fabrication of PN junction diodes and the formation of the depletion region.

Analyze the static and dynamic resistance of diodes and their current flow mechanisms under forward and reverse bias.

Derive equations for barrier potential, barrier width, and current for step junction diodes.

Two-terminal Devices and their Applications (7 Lectures):

Describe the operation of rectifier diodes in half-wave, full-wave, center-tapped, and bridge configurations.

Calculate ripple factor and rectification efficiency for different rectifier circuits.

Understand the principle and structure of LEDs, photodiodes, and solar cells.

Explain the working principle of Zener diodes and their application in voltage regulation.

Bipolar Junction Transistors (8 Lectures):

Understand the construction and operation of n-p-n and p-n-p transistors.

Analyze the characteristics of common base (CB), common emitter (CE), and common collector (CC) configurations.

Explain the physical mechanism of current flow in transistors and derive relations between current gains α and β.

Analyze transistor circuits using load line analysis and determine operating points in active, cutoff, and saturation regions.

Field Effect Transistors (3 Lectures):

Explain the basic principle of operation of junction field-effect transistors (JFETs).

Describe JFET parameters and characteristics of common source (CS) configurations.

Amplifiers (8 Lectures):

Understand transistor biasing and stabilization circuits.

Analyze single-stage common emitter (CE) amplifier circuits using hybrid model and determine input/output impedance, gains, and stability.

Classify amplifiers into Class A, B, and C based on their operation.

Coupled Amplifier (3 Lectures):

Understand the configuration and frequency response of two-stage RC-coupled amplifiers.

Feedback in Amplifiers (4 Lectures):

Explain the concept of feedback and its effects on amplifier parameters such as impedance, gain, stability, distortion, and noise.

Sinusoidal Oscillators (4 Lectures):

Apply Barkhausen's criterion to determine conditions for self-sustained oscillations.

Understand the operation and frequency determination of RC phase shift, Hartley, and Colpitts oscillators.

Operational Amplifiers (4 Lectures):

Describe the characteristics of ideal and practical operational amplifiers (Op-Amps).

Analyze open-loop and closed-loop gain, frequency response, common mode rejection ratio (CMRR), and slew rate.

Applications of Op-Amps (7 Lectures):

Explain various linear and non-linear applications of operational amplifiers, including amplifiers, adders, subtractors, integrators, differentiators, comparators, and oscillators.

Conversion (2 Lectures):

Describe resistive network conversion techniques such as weighted and R-2R ladder networks.

Understand the principles of A/D conversion, particularly successive approximation, and analyze accuracy and resolution.

Course Name: Core Course - 10
Course Code: P H S A C O R 10 P
Topic Name: Analog Systems and Applications Lab
60 Class Hours 2 Credits

Course Outcome:

Here are the course outcomes corresponding to each topic:

To study V-I characteristics of PN junction diode and Light Emitting Diode (LED) (using both current and voltage source):

Understand the behavior of PN junction diodes and LEDs under different biasing conditions.

Analyze the V-I characteristics of diodes using both current and voltage sources.

To study the V-I characteristics of a Zener diode and its use as a voltage regulator:

Understand the breakdown behavior of Zener diodes and their characteristics.

Analyze the V-I characteristics of Zener diodes and their use as voltage regulators.

Study of V-I & power curves of Solar Cells and find maximum power point and efficiency:

Understand the operation of solar cells and their V-I characteristics.

Analyze the power curves of solar cells to find the maximum power point and **efficiency.**

To study the characteristics of a Bipolar Junction Transistor (BJT) in CE configuration:

Understand the common emitter (CE) configuration of BJTs.

Analyze the characteristics of BJTs in CE configuration including input and output characteristics.

To study the frequency response of voltage gain of an RC-coupled transistor amplifier:

Understand the frequency response characteristics of RC-coupled transistor amplifiers.

Analyze the voltage gain variation with**a) To investigate the use of an op-amp as an Integrator. b) To investigate the use of an op-amp as a Differentiator:**

Understand the principles and applications of op-amp integrators and differentiators.

Design and analyze integrator and differentiator circuits using operational amplifiers.

To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias:

Understand the principles of voltage divider biasing in CE transistor amplifiers.

a) To investigate the use of an op-amp as an Integrator. b) To investigate the use of an op-amp as a Differentiator:

Understand the principles and applications of op-amp integrators and differentiators.

Design and analyze integrator and differentiator circuits using operational amplifiers.

To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias:

Understand the principles of voltage divider biasing in CE transistor amplifiers.

Design and analyze CE transistor amplifier circuits for a specified gain using voltage divider biasing.

To study the various biasing configurations of BJT for normal class A operation:

Understand different biasing configurations such as base bias, collector bias, and emitter bias for BJT amplifiers.

Analyze the characteristics and stability of BJT amplifiers operating in class A mode under different biasing conditions.

To design a Phase Shift Oscillator of given specification using Op-Amp:

Understand the principle of operation of phase shift oscillators.

Design and analyze phase shift oscillator circuits using operational amplifiers to meet specified specifications.

To study the Colpitt's Oscillator:

Understand the principle of operation of the Colpitt's oscillator.

Analyze the characteristics and frequency stability of the Colpitt's oscillator circuit.

To design a digital-to-analog converter (DAC) of given specifications:

Understand the principles of digital-to-analog conversion.

Design and analyze DAC circuits to meet specified resolution and accuracy requirements.

To study the analog-to-digital converter (ADC) IC:

Understand the principles of analog-to-digital conversion.

Analyze the characteristics and operation of ADC integrated circuits.

To design a precision Differential amplifier of given I/O specification using Op-Amp:

Understand the principles and applications of precision differential amplifiers.

Design and analyze precision differential amplifier circuits using operational amplifiers to meet **specified input/output requirements.**

To design a circuit to simulate the solution of a 1st/2nd order differential equation:

Understand the principles of analog computing.

Design and analyze analog circuits to simulate the solutions of first and second-order differential equations.

To design inverting amplifier using Op-amp (741/351) and study its frequency response:

Understand the principles of inverting amplifier configuration.

Design and analyze inverting amplifier circuits using operational amplifiers, and study their frequency response.

To design non-inverting amplifier using Op-amp (741/351) & study its frequency response:

Understand the principles of non-inverting amplifier configuration.

Design and analyze non-inverting amplifier circuits using operational amplifiers, and study their frequency response.

To study the zero-crossing detector and comparator:

Understand the principle of operation of zero-crossing detectors and comparators.

Analyze the characteristics and applications of zero-crossing detectors and comparators.

Using Schmitt trigger and associated circuit (with OPAMP) generate different waveforms:

Understand the operation and characteristics of Schmitt triggers.

Design and analyze Schmitt trigger circuits to generate different waveforms based on input signal characteristics.

Design and analyze CE transistor amplifier circuits for a specified gain using voltage divider biasing.

To study the various biasing configurations of BJT for normal class A operation:

Understand different biasing configurations such as base bias, collector bias, and emitter bias for BJT amplifiers.

Analyze the characteristics and stability of BJT amplifiers operating in class A mode under different biasing conditions.

To design a Phase Shift Oscillator of given specification using Op-Amp:

Understand the principle of operation of phase shift oscillators.

Design and analyze phase shift oscillator circuits using operational amplifiers to meet specified specifications.

To study the Colpitt's Oscillator:

Understand the principle of operation of the Colpitt's oscillator.

Analyze the characteristics and frequency stability of the Colpitt's oscillator circuit.

To design a digital-to-analog converter (DAC) of given specifications:

Understand the principles of digital-to-analog conversion.

Design and analyze DAC circuits to meet specified resolution and accuracy requirements.

To study the analog-to-digital converter (ADC) IC:

Understand the principles of analog-to-digital conversion.

Analyze the characteristics and operation of ADC integrated circuits.

To design a precision Differential amplifier of given I/O specification using Op-Amp:

Understand the principles and applications of precision differential amplifiers.

Design and analyze precision differential amplifier circuits using operational amplifiers to meet **specified input/output requirements.**

To design a circuit to simulate the solution of a 1st/2nd order differential equation:

Understand the principles of analog computing.

Design and analyze analog circuits to simulate the solutions of first and second-order differential equations.

To design inverting amplifier using Op-amp (741/351) and study its frequency response:

Understand the principles of inverting amplifier configuration.

Design and analyze inverting amplifier circuits using operational amplifiers, and study their frequency response.

To design non-inverting amplifier using Op-amp (741/351) & study its frequency response:

Understand the principles of non-inverting amplifier configuration.

Design and analyze non-inverting amplifier circuits using operational amplifiers, and study their frequency response.

To study the zero-crossing detector and comparator:

Understand the principle of operation of zero-crossing detectors and comparators.

Analyze the characteristics and applications of zero-crossing detectors and comparators.

Using Schmitt trigger and associated circuit (with OPAMP) generate different waveforms:

Understand the operation and characteristics of Schmitt triggers.

Design and analyze Schmitt trigger circuits to generate different waveforms based on input signal characteristics.

frequency in RC-coupled amplifiers.

To design inverting, non-inverting, and buffer amplifiers using Op-amp (741/351) for DC voltage:

Understand the principles of inverting, non-inverting, and buffer amplifiers using operational amplifiers.

Design and analyze these amplifier circuits for DC voltage applications.

To design a Wien bridge oscillator for a given frequency using an Op-Amp:

Understand the principle of operation of the Wien bridge oscillator.

Design and analyze the Wien bridge oscillator circuit using an operational amplifier for a specified frequency.

To add DC voltages using Op-amp in inverting and non-inverting mode:

Understand the principles of adding DC voltages using operational amplifiers in both inverting and non-inverting configurations.

Design and analyze circuits for adding DC voltages.

a) To investigate the use of an op-amp as an Integrator. b) To investigate the use of an op-amp as a Differentiator:

Understand the principles and applications of op-amp integrators and differentiators.

Design and analyze integrator and differentiator circuits using operational amplifiers.

To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias:

Understand the principles of voltage divider biasing in CE transistor amplifiers.

Design and analyze CE transistor amplifier circuits for a specified gain using voltage divider biasing.

To study the various biasing configurations of BJT for normal class A operation:

Understand different biasing configurations such as base bias, collector bias, and emitter bias for BJT amplifiers.

Analyze the characteristics and stability of BJT amplifiers operating in class A mode under different biasing conditions.

To design a Phase Shift Oscillator of given specification using Op-Amp:

Understand the principle of operation of phase shift oscillators.

Design and analyze phase shift oscillator circuits using operational amplifiers to meet specified specifications.

To study the Colpitt’s Oscillator:

Understand the principle of operation of the Colpitt's oscillator.

Analyze the characteristics and frequency stability of the Colpitt's oscillator circuit.

To design a digital-to-analog converter (DAC) of given specifications:

Understand the principles of digital-to-analog conversion.

Design and analyze DAC circuits to meet specified resolution and accuracy requirements.

To study the analog-to-digital converter (ADC) IC:

Understand the principles of analog-to-digital conversion.

Analyze the characteristics and operation of ADC integrated circuits.

To design a precision Differential amplifier of given I/O specification using Op-Amp:

Understand the principles and applications of precision differential amplifiers.

Design and analyze precision differential amplifier circuits using operational amplifiers to meet **specified input/output requirements.**

To design a circuit to simulate the solution of a 1st/2nd order differential equation:

Understand the principles of analog computing.

Design and analyze analog circuits to simulate the solutions of first and second-order differential equations.

To design inverting amplifier using Op-amp (741/351) and study its frequency response:

Understand the principles of inverting amplifier configuration.

Design and analyze inverting amplifier circuits using operational amplifiers, and study their frequency response.

To design non-inverting amplifier using Op-amp (741/351) & study its frequency response:

Understand the principles of non-inverting amplifier configuration.

Design and analyze non-inverting amplifier circuits using operational amplifiers, and study their frequency response.

To study the zero-crossing detector and comparator:

Understand the principle of operation of zero-crossing detectors and comparators.

Analyze the characteristics and applications of zero-crossing detectors and comparators.

Using Schmitt trigger and associated circuit (with OPAMP) generate different waveforms:

Understand the operation and characteristics of Schmitt triggers.

Design and analyze Schmitt trigger circuits to generate different waveforms based on input signal characteristics.

Course Name: Core Course - 11
Course Code: PHSACOR11T & PHSACOR11P
Topic Name: Quantum Mechanics & Applications

Course Outcome: Upon successful completion of this course

- students will get acquainted with the axiomatic structure of Quantum Mechanics.
- students will learn how to compute discrete energy levels for certain quantum mechanical systems admitting bound state solutions and the associated normalized eigen functions.
- students will learn how to compute the reflection and transmission coefficients in the theory of scattering by certain potentials. As an important application of this, they learn the quantum origin of radioactive disintegration.
- students will learn how to tackle systems in higher (two and three) dimensions with the introduction of angular momentum operator and thereby study the exact solution of hydrogen atom problem.
- students will learn how to apply the quantum theory to Atomic and Molecular Physics, Nano-Physics etc. to predict the behaviour of a wide variety of systems.

In the practical component (implemented in Python language)

- students will learn to solve graphically transcendental equations while determining the bound state energy levels of a finite potential well.
- students will learn a numerical technique to discretize derivatives and thereby solve Schroedinger equation (which is a differential equation) after converting it to a system of algebraic equations. This is known as Finite Difference Method.
- students will learn another popular numerical technique to solve Schroedinger equation in an iterative way, known as the 'Shooting Method'.
- students will learn how to numerically estimate the energy levels and the s-wave solution of the hydrogen atom.
- students will learn how to numerically estimate the ground state of the Yukawa potential, an harmonic oscillator and the Morse potential (used to model the vibrational modes of a diatomic molecule).

Course Name: Core Course - 12
Course Code: P H S A C O R 12 T
Topic Name: Solid State Physics
60 Lectures 4 Credits

Course Outcome:

Here are the proposed course outcomes for each section of the course:

Crystal Structure (12 Lectures):

Understand the distinction between amorphous and crystalline materials.

Ability to describe lattice translation vectors and lattice with a basis.

Proficiency in determining unit cells and Miller indices.

Comprehend reciprocal lattice and its significance.

Identify different types of lattices and their characteristics.

Apply Brillouin zones concept to understand the behavior of crystals.

Explain the principles of X-ray diffraction by crystals, including Laue's condition and Bragg's Law.

Analyze the concept of structure factor and its role in crystallography.

Elementary Lattice Dynamics (10 Lectures):

Describe lattice vibrations and phonons in solids.

Differentiate between linear monoatomic and diatomic chains.

Explain the qualitative description of the phonon spectrum in solids.

Understand Dulong and Petit's Law and its limitations.

Discuss Einstein's theories of specific heat of solids and their constraints.

Magnetic Properties of Matter (8 Lectures):

Classify materials based on their magnetic properties.

Explain the Classical Langevin Theory and Quantum Mechanical Treatment of magnetism.

Apply Curie’s law and Weiss’s Theory of Ferromagnetism.

Analyze the B-H Curve, Hysteresis, and Energy Loss in magnetic materials.

Dielectric Properties of Materials (8 Lectures):

Understand polarization and its effects.

Describe the concept of electric susceptibility and polarizability.

Apply the Clausius-Mosotti Equation and understand its implications.

Discuss the Classical Theory of Electric Polarizability.

Analyze the phenomenon of normal and anomalous dispersion.

Explain the Langevin-Debye equation and the concept of complex dielectric constant.

Ferroelectric Properties of Materials (6 Lectures):

Understand structural phase transition and classification of crystals.

Describe various effects like piezoelectric, pyroelectric, and ferroelectric.

Apply Curie-Weiss Law and analyze ferroelectric domains and hysteresis loop.

Drude’s Theory (6 Lectures):

Explain the behavior of free electron gas in metals.

Discuss concepts such as effective mass, drift current, mobility, and conductivity.

Understand the Hall effect in metals and its applications.

Analyze thermal conductivity and limitations of Drude’s theory.

Elementary Band Theory (10 Lectures):

Describe the Kronig-Penney model and understand band gap.

Classify materials as conductors, semiconductors (P and N type), and insulators.

Analyze conductivity of semiconductors, mobility, and Hall Effect.

Discuss the measurement of conductivity using the 4-probe method and Hall coefficient.

Superconductivity (6 Lectures):

Interpret experimental results related to superconductivity.

Understand critical temperature and critical magnetic field.

Explain the Meissner effect and differentiate between Type I and Type II superconductors.

Apply London’s Equation and understand Penetration Depth.

Discuss the isotope effect on superconductivity.

These outcomes are designed to ensure students have a comprehensive understanding of each topic covered in the course and are able to apply the concepts to solve problems and analyze real-world phenomena.

Course Name: Core Course - 12

Course Code: P H S A C O R 12 P
Topic Name: Solid State Physics Lab
60 Class Hours 2 Credits

Course Outcome:

Here are the course outcomes corresponding to each of the specified topics:

To determine the Coupling Coefficient of a Piezoelectric crystal:

Understand the principles of piezoelectricity.

Perform experimental techniques to measure the coupling coefficient of a piezoelectric crystal.

Analyze the results to determine the effectiveness of the crystal for piezoelectric applications.

To measure the Dielectric Constant of a dielectric Material with frequency:

Understand the concept of dielectric constant and its dependence on frequency.

Utilize experimental methods to measure the dielectric constant of materials across different frequencies.

Analyze the data to understand the frequency-dependent behavior of dielectric materials.

To study the characteristics of a Ferroelectric Crystal:

Identify the distinctive characteristics of ferroelectric crystals.

Perform experiments to study the polarization-electric field hysteresis loop and domain structure of ferroelectric crystals.

Analyze the results to understand the ferroelectric behavior and domain dynamics.

To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis:

Understand the principles of magnetic hysteresis and BH curves.

Conduct experiments to draw the BH curve of iron using a solenoid.

Calculate the energy loss from the hysteresis loop and analyze the magnetic behavior of iron.

To measure the resistivity of a semiconductor (Ge) with temperature by reverse bias characteristics of Ge diode (room temperature to 80 oC) and to determine its band gap:

Perform experiments to measure the resistivity of germanium semiconductor at various temperatures using reverse bias characteristics.

Analyze the data to determine the temperature dependence of resistivity and calculate the band gap of germanium.

To determine the Hall coefficient of a semiconductor sample:

Understand the Hall effect and its applications in determining semiconductor properties.

Conduct experiments to measure the Hall coefficient of a semiconductor sample.

Analyze the results to understand the charge carrier concentration and mobility in the semiconductor.

To study the temperature coefficient of a semiconductor (NTC thermistor):

Perform experiments to measure the temperature coefficient of a semiconductor using an NTC thermistor.

Analyze the data to understand the temperature dependence of the semiconductor's resistance.

Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method):

Understand the principles of paramagnetism and susceptibility.

Perform experiments using the Quinck's tube method to measure the susceptibility of a paramagnetic solution.

Analyze the results to determine the magnetic properties of the solution.

To measure the Magnetic susceptibility of Solids:

Conduct experiments to measure the magnetic susceptibility of solid materials.

Utilize appropriate experimental techniques such as Gouy method or Faraday method.

Analyze the data to understand the magnetic behavior of the solid materials.

To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR):

Understand the principles of surface plasmon resonance (SPR) and its applications.

Perform experiments to determine the complex dielectric constant and plasma frequency of a metal using SPR.

Analyze the SPR curves to extract the desired parameters.

To determine the refractive index of a dielectric layer using SPR:

Perform experiments using SPR to determine the refractive index of a dielectric layer.

Analyze the SPR curves to extract the refractive index information.

Understand the relationship between SPR and the optical properties of the dielectric layer.

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

Course Outcome: Upon successful completion of this course

- students will learn abouut Maxwell’s equations, gauge transformations,Poynting,s theorem, moentum density & field energy density.
- Students will unstarstand about the Electromagnetic wave propagation in Bounded & Unbounded media.
- students will learn about the Polarization of EM waves.
- students will know about Wave guides & Optical Fibres -concepts and applications.
- students will understand about Optical communication and Wave propagation along with Transmission theory.
- students will able to verify the law of Malus for plane polarized light.
- students will understand about different experimental set up like (i) Polarimeter, (ii) Babinet’s compensator (iii) Dipole antenna etc.

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

Course Outcome: Upon successful completion of this course

- students will understand the fundamental principles of statistical mechanics: (i) Microstates, macrostates and the concept of entropy (ii) probability distributions (e.g., Maxwell- Boltzmann, Fermi-Dirac, Bose-Einstein)
- students will able to understand statistical properties of matter and connections with thermodynamics.
- students will understand the behaviour of a thermodynamic system in the quantum regime occurring at low temperature and high density.

In the practical component (implemented in Python language)

- students will learn how to compute the partition function and the grand partition function for a thermodynamic system. Computation of them is central in all of Statistical Mechanics.
- students will learn how to generate the plot showing the temperature variation of specific heat predicted by different models.

Course Name: Discipline Specific Elective - 1
Course Code: PHSADSE01T & PHSADSE01P
Topic Name: Advanced Mathematical Physics - I

Course Outcome: Upon successful completion of this course

- students will have their first exposure to Abstract Algebra in the form of linear Vector Space, the knowledge of which is essential to learn Quantum Mechanics.

students will learn a very useful integral transform, viz. The Laplace transform needed to solve a wider class of Partial Differential Equations.

students will learn the basics of tensor formulation and its omnipresence in physical theories.

In the practical component (implemented in Python language)

- students will learn how to estimate quantum mechanical ground state of a quartic potential, the corresponding Schrodinger equation of which is not amenable to exact treatment, with the help of a numerical method, viz., the variational principle.
- students will learn how to graphically estimate energy levels by numerically operating the Hamiltonian on its stationary states.
- students will learn how to draw phase space trajectories

➢ students will have an understanding of special functions as the eigenfunctions of a class of hermitian operators known as the Sturm-Liouville operators.

Course Name: Discipline Specific Elective-2
Course Code: PHSADSE03T
Topic Name: Nuclear and Particle Physics

Course Outcome: Upon the completion of course

- students will understand the fundamental of nuclear physics : (i) Nuclear structure and properties (e.g., binding energy, spin, parity etc.) (ii) Nuclear reactions
- students will understand fundamental of particle physics: (i) Elementary particles and their interactions
- students will lea

Course Name: Discipline Specific Elective - 3
Course Code: PHSADSE04T
Topic Name: Advanced Mathematical Physics - II

Course Outcome: Upon successful completion of this course

➢ students will have their exposure to Abstract Algebra in the form of Group Theory, a major stepping stone to learn recent developments in Theoretical Physics.
➢ Students will learn about the Nuclear models (e.g., Liquid drop model, Fermi gas model, shell model)
➢ students will understand the systematic classification of Partial Differential Equations governing the physical world.
➢ students will learn about Particle Accelerators (e.g., Linear accelerator, Cyclotron, Synchrotrons)

Course Name:Discipline Specific Elective-4
Course Code: PHSADSE06P
Topic Name: Communication Electronics Lab
60 Class Hours 2 Credits

Here are the course outcomes for the specified topics:
<u>Designing an Amplitude Modulator using Transistor:</u>
Understand the principles of amplitude modulation (AM).
Design and implement an amplitude modulator circuit using transistors.

Analyze the performance of the designed modulator in terms of modulation index and output characteristics.

Studying Envelope Detector for Demodulation of AM Signal:

Understand the concept of envelope detection in demodulating AM signals.

Study the operation and characteristics of envelope detector circuits.

Analyze the demodulated output and its fidelity compared to the original modulating signal.

Studying FM Generator and Detector Circuit:

Understand the principles of frequency modulation (FM).

Study the circuits for generating and detecting FM signals.

Analyze the frequency deviation, modulation index, and bandwidth characteristics of FM signals.

Studying AM Transmitter and Receiver:

Understand the design and operation of amplitude modulation (AM) transmitters and receivers.

Analyze the performance parameters such as power efficiency, signal-to-noise ratio, and bandwidth in AM transmission and reception.

Studying FM Transmitter and Receiver:

Understand the design and operation of frequency modulation (FM) transmitters and receivers.

Analyze the performance parameters such as frequency deviation, signal-to-noise ratio, and frequency response in FM transmission and reception.

Studying Time Division Multiplexing (TDM):

Understand the concept of time-division multiplexing (TDM).

Study the design and operation of TDM systems for multiplexing multiple signals onto a single transmission medium.

Analyze the time slots allocation and synchronization techniques in TDM.

Studying Pulse Amplitude Modulation (PAM):

Understand the principles of pulse amplitude modulation (PAM).

Study the generation and demodulation techniques for PAM signals.

Analyze the performance in terms of signal-to-noise ratio and bandwidth efficiency.

Studying Pulse Width Modulation (PWM):

Understand the principles of pulse width modulation (PWM).

Study the generation and demodulation techniques for PWM signals.

Analyze the performance in terms of distortion, noise, and efficiency.

Studying Pulse Position Modulation (PPM):

Understand the principles of pulse position modulation (PPM).

Study the generation and demodulation techniques for PPM signals.

Analyze the performance in terms of timing accuracy and bandwidth efficiency.

Studying ASK, PSK, and FSK Modulators:

Understand the principles of amplitude shift keying (ASK), phase shift keying (PSK), and frequency shift keying (FSK).

Study the design and operation of modulators for ASK, PSK, and FSK signals.

Analyze the performance in terms of modulation index, spectral efficiency, and noise immunity.

Course Code: PHSADSE045T

Topic Name: Astronomy and Astrophysics

Course Outcome: Upon successful completion of this course

- students will have their exposure to astronomical scales.
- students will understand the astronomical techniques.

- students will learn about the milky way, galaxies, large scale structure and expanding universe.

Course Code: PHSADSE06P
Topic Name: Communication Electronics Lab
60 Class Hours 2 Credits

Here are the course outcomes for the specified topics:

<u>Designing an Amplitude Modulator using Transistor:</u>
Understand the principles of amplitude modulation (AM).
Design and implement an amplitude modulator circuit using transistors.
Analyze the performance of the designed modulator in terms of modulation index and output characteristics.

<u>Studying Envelope Detector for Demodulation of AM Signal:</u>
Understand the concept of envelope detection in demodulating AM signals.
Study the operation and characteristics of envelope detector circuits.
Analyze the demodulated output and its fidelity compared to the original modulating signal.

<u>Studying FM Generator and Detector Circuit:</u>
Understand the principles of frequency modulation (FM).
Study the circuits for generating and detecting FM signals.
Analyze the frequency deviation, modulation index, and bandwidth characteristics of FM signals.

<u>Studying AM Transmitter and Receiver:</u>
Understand the design and operation of amplitude modulation (AM) transmitters and receivers.
Analyze the performance parameters such as power efficiency, signal-to-noise ratio, and bandwidth in AM transmission and reception.

<u>Studying FM Transmitter and Receiver:</u>
Understand the design and operation of frequency modulation (FM) transmitters and receivers.
Analyze the performance parameters such as frequency deviation, signal-to-noise ratio, and frequency response in FM transmission and reception.

<u>Studying Time Division Multiplexing (TDM):</u>
Understand the concept of time-division multiplexing (TDM).
Study the design and operation of TDM systems for multiplexing multiple signals onto a single transmission medium.
Analyze the time slots allocation and synchronization techniques in TDM.

<u>Studying Pulse Amplitude Modulation (PAM):</u>
Understand the principles of pulse amplitude modulation (PAM).
Study the generation and demodulation techniques for PAM signals.
Analyze the performance in terms of signal-to-noise ratio and bandwidth efficiency.

<u>Studying Pulse Width Modulation (PWM):</u>
Understand the principles of pulse width modulation (PWM).
Study the generation and demodulation techniques for PWM signals.
Analyze the performance in terms of distortion, noise, and efficiency.

<u>Studying Pulse Position Modulation (PPM):</u>
Understand the principles of pulse position modulation (PPM).
Study the generation and demodulation techniques for PPM signals.
Analyze the performance in terms of timing accuracy and bandwidth efficiency.

<u>Studying ASK, PSK, and FSK Modulators:</u>

Understand the principles of amplitude shift keying (ASK), phase shift keying (PSK), and frequency shift keying (FSK).
Study the design and operation of modulators for ASK, PSK, and FSK signals.
Analyze the performance in terms of modulation index, spectral efficiency, and noise immunity.

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

Course Outcome: Upon successful completion of this course

- students will get hands-on skill in different instruments.
- students will understand the basics of CRO, construction of CRT, Electron gun, electrostatic focusing and acceleration, screen phosphor, visual persistence & chemical composition. Time base operation, synchronization.
- students will able to use CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes)
- students will learn the principle and working of digital meters, comparison of analog and digital instruments, working principles of digital voltmeter.
- students will able to use this knowledge in their future careers.

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

Course Outcome: Upon successfulcompletion of this course

- students will understand applications of some fundamental Linux commands.
- students will understand LaTeX word processor, preparing a basic LaTeX file, document, preparing an input file for LaTeX, compiling LaTeX file, LaTeX tags for creating different environments, defining LaTeX commands and environments, changing the type style, equation representation: (formulae and equations), figures and other floating bodies, generating table of contents, bibliography and citation, different fonts, picture environment and colors etc.
- students will learn graphical analysis and its limitations, importance of visualization of computational and computational data, basic gnu plot commands: simple plots, plotting data from a file, saving and exporting etc
- students will understand basic of F90 programming.
- students will learn about GNUPLOT in 1D and 2D.