MANAV RACHNA UNIVERSITY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF PHYSICS

PROGRAM STRUCTURE

&

DETAILED SYLLABUS

M.Sc. Physics

BATCH: 2018-2020

MANAV RACHNA UNIVERSITY									
DEPARTMENT OF PHYSICS									
M.Sc. Physics (PHP01)									
SEMESTER-1									
SUBJECT CODES	**SUBJECT NAME**	**OFFERING DEPARTMENT**	**COURSE NATURE (Hard/Soft/NTCC)**	**COURSE TYPE (Core/ Elective etc)**	**L**	**T**	**P**	**O**	**NO. OF CREDITS**
PHH502	Mathematical Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH503	Classical Mechanics	Physics	HARD	CORE	4	0	0	**0**	4
PHH504	Quantum Mechanics-I	Physics	HARD	CORE	4	0	0	**0**	4
PHH505	Electronic Devices	Physics	HARD	CORE	4	0	0	**0**	4
PHS503	Introduction to Research	Physics	HARD	CORE	1	0	2	**0**	2
PHH506	Laboratory work	Physics	PRACTICAL	CORE	0	0	12	**0**	6
	TOTAL (L-T-P-/CREDITS)				**17**	**0**	**14**	**0**	**24**
SEMESTER – 2									
SUBJECT CODES	**SUBJECT NAME**	**OFFERING DEPARTMENT**	***COURSE NATURE (Hard/Soft/ NTCC)**	**COURSE TYPE (Core/ Elective etc)**	**L**	**T**	**P**	**O**	**NO. OF CREDITS**
PHH508	Quantum Mechanics-II	Physics	HARD	CORE	4	0	0	**0**	4

PHH509	Statistical Mechanics	Physics	HARD	CORE	4	0	0	**0**	4
PHH510	Electrodynamics and Plasma Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH511	Atomic and Molecular Physics	Physics	HARD	CORE	4	0	0	**0**	4
MES515	Research paper writing	Physics	HARD	CORE	1	0	2	**0**	2
PHH512	Laboratory work	Physics	HARD	CORE	0	0	12	**0**	6
PHO121	Post 2nd sem Summer Training	Physics	HARD	CORE	0	0	0	**0**	3
	TOTAL (L-T-P-/CREDITS)				**17**	**0**	**14**	**0**	**27**
SEMESTER – 3									
SUBJECT CODES	**SUBJECT NAME**	**OFFERING DEPARTMENT**	**COURSE NATURE (Hard/Soft/ NTCC)**	**COURSE TYPE (Core/ Elective etc)**	**L**	**T**	**P**	**O**	**NO. OF CREDITS**
PHH613	Solid State Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH614	Nuclear and Particle Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH615	Condensed Matter Physics	Physics	HARD	CORE	4	0	0	**0**	4

PHH616	Fundamental Atmospheric Physics	Physics	HARD		4	0	0	**0**	4
PHH617	Fabrication and Characterization Techniques	Physics	HARD	Elective (any one)	4	0	0	**0**	
PHN619	Seminar	Physics	NTCC (Non-teaching credit course)	CORE	0	0	0	**0**	2
PHH618	Laboratory work	Physics	PRACTICAL	CORE	0	0	12	**0**	6
	TOTAL (L-T-P-/CREDITS)				**16**	**0**	**12**	**0**	**24**
SEMESTER – 4									
SUBJECT CODES	**SUBJECT NAME**	**OFFERING DEPARTMENT**	**COURSE NATURE (Hard/Soft/ NTCC)**	**COURSE TYPE (Core/ Elective etc)**	**L**	**T**	**P**	**O**	**NO. OF CREDITS**
PHH619	Computational Method and Programming	Physics	HARD	CORE	2	0	2	0	4
PHH620	Advanced atmospheric Physics	Physics	HARD	ELECTIVE (any one)	4	0	0	0	4
PHH621	Condensed Matter II	Physics	HARD		4	0	0	0	
PHN623	Project work	Physics	HARD	CORE	0	0	12	0	6

PHN624	Seminar	Physics	NTCC (Non-teaching credit	CORE	0	0	0	0	2
	TOTAL (L-T-P-O/CREDITS)				**6**	**0**	**2**	**0**	**16**

Total Credits Scheme

S. No.	Semester	Contact Hours	Credits
1	**I**	**25**	**24**
2	**II**	**31**	**27**
3	**III**	**32**	**24**
4	**IV**	**24**	**16**
Total		**112**	**91**

PROGRAMME BOOKLET

M.Sc. Physics (PHP01)
(Batch: 2018-2020)

Department of Physics
Faculty of Applied Sciences
Manav Rachna University

MANAV RACHNA UNIVERSITY

Vision

To educate students in frontier areas of knowledge enabling them to take up challenges as ethical and responsible global citizens

Mission

- To impart outcome based holistic education
- To disseminate education in frontier areas
- To produce globally competitive, ethical and socially responsible human resources
- To produce human resources sensitive to issues of Environment and Sustainable Development
- To develop Environment and Sustainable development as a thrust area of research and development.

Quality Policy

To continuously learn from the best practices, study role models and develop transparent procedures for empowerment of stakeholders.

Strategic Objectives

- To facilitate, enhance & promote innovation in curriculum design and delivery and have Outcome-oriented Learning Culture.
- To promote Research Environment and Management Practices.
- To enhance the quality of the student learning experience.
- To provide Resources and Infrastructure for Academic Excellence.

DEPARTMENT OF PHYSICS

Vision

- To educate the students in frontier areas of Physics enabling them to take challenges to solve the problem of the society.

Mission

- To inculcate outcome based holistic education in frontier areas of Physics.
- To develop competent physicists who address future issues of the society.
- To conduct interdisciplinary research in thrust areas
- To produce good quality human resources sensitive to environmental and sustainable development issues.
- To produce globally competitive, ethical and socially responsible young minds

M.Sc Physics

Programme Outcomes (POs)

- Read, understand and interpret physical information – verbal, mathematical and graphical. Perform experiments and interpret the results of observation including an assessment of experimental uncertainties.
- Demonstrate a rigorous understanding of the core theories & principles of physics, which includes mechanics, electromagnetism, thermodynamics, & statistical and quantum mechanics.
- Learn the concepts as quantum mechanics, relativity, introduced at degree level in order to understand nature at atomic levels.
- Provide knowledge about material properties and its application for developing technology to ease the problems related to the society.
- Understand the set of physical laws, describing the motion of bodies, under the influence of system of forces.
- Understand the relationship between particles & atom, as well as their creation & decay. Relate the structure of atoms & subatomic particles and evaluate their problems. Understand physical properties of molecule the chemical bonds between atom as well as molecular dynamics.
- Analyze the applications of mathematics to the problems in physics & develop suitable mathematical method for such application & for formulation of physical theories.
- Learn the structure of solid materials & their different physical properties along with metallurgy, cryogenics, electronics, & material science.
- Understand the fundamental theory of nature at small scale & levels of atom & sub-atomic particles.
- The graduate has skills in planning and carrying out advanced physics experiments and is able to solve scientific problems by applying a combination of theory, numerical simulation, and experiments.
- Demonstrate engagement with current research and developments in the subject

MANAV RACHNA UNIVERSITY
DEPARTMENT OF PHYSICS
M.Sc (PHP01)

SEMESTER-1

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	NO. OF CREDITS
PHH502	Mathematical Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH503	Classical Mechanics	Physics	HARD	CORE	4	0	0	**0**	4
PHH504	Quantum Mechanics-I	Physics	HARD	CORE	4	0	0	**0**	4
PHH505	Electronic Devices	Physics	HARD	CORE	4	0	0	**0**	4
PHS503	Introduction to Research	Physics	HARD	CORE	1	0	2	**0**	2
PHH506	Laboratory work	Physics	PRACTICAL	CORE	0	0	12	**0**	6
	TOTAL (L-T-P-/CREDITS)				**17**	**0**	**14**	**0**	**24**

SEMESTER – 2

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	NO. OF CREDITS
PHH508	Quantum Mechanics-II	Physics	HARD	CORE	4	0	0	**0**	4
PHH509	Statistical Mechanics	Physics	HARD	CORE	4	0	0	**0**	4
PHH510	Electrodynamics	Physics	HARD	CORE	4	0	0	**0**	4

	and Plasma Physics								
PHH511	Atomic and Molecular Physics	Physics	HARD	CORE	4	0	0	**0**	4
MES515	Research paper writing	Physics	HARD	CORE	1	0	2	**0**	2
PHH512	Laboratory work	Physics	HARD	CORE	0	0	12	**0**	6
PHO121	Post 2nd sem Summer Training	Physics	HARD	CORE	0	0	0	**0**	3
	TOTAL (L-T-P-/CREDITS)				**17**	**0**	**14**	**0**	**27**

SEMESTER – 3									
SUBJECT CODES	**SUBJECT NAME**	**OFFERING DEPARTMENT**	**COURSE NATURE (Hard/Soft/ NTCC)**	**COURSE TYPE (Core/ Elective etc)**	**L**	**T**	**P**	**O**	**NO. OF CREDITS**
PHH613	Solid State Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH614	Nuclear and Particle Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH615	Condensed Matter Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH616	Fundamental Atmospheric Physics	Physics	HARD	Elective (any one)	4	0	0	**0**	4
PHH617	Fabrication and Characterization Techniques	Physics	HARD		4	0	0	**0**	
PHN619	Seminar	Physics	NTCC (Non-teaching credit course)	CORE	0	0	0	**0**	2
PHH618	Laboratory work	Physics	PRACTICAL	CORE	0	0	12	**0**	6
	TOTAL (L-T-P-/CREDITS)				**16**	**0**	**12**	**0**	**24**

SEMESTER – 4									
SUBJECT CODES	**SUBJECT NAME**	**OFFERING DEPARTMENT**	**COURSE NATURE (Hard/Soft/ NTCC)**	**COURSE TYPE (Core/ Elective etc)**	**L**	**T**	**P**	**O**	**NO. OF CREDITS**
PHH619	Computational Method and Programming	Physics	HARD	CORE	2	0	2	0	4
PHH620	Advanced atmospheric Physics	Physics	HARD	ELECTIVE (any one)	4	0	0	0	4
PHH621	Condensed Matter II	Physics	HARD		4	0	0	0	
PHN623	Project work	Physics	HARD	CORE	0	0	12	0	6
PHN624	Seminar	Physics	NTCC (Non-teaching credit course)	CORE	0	0	0	0	2
	TOTAL (L-T-P-O/CREDITS)				**6**	**0**	**2**	**0**	**16**

Total Credits Scheme

S. No.	**Semester**	**Contact Hours**	**Credits**
1	**I**	**25**	**24**
2	**II**	**31**	**27**
3	**III**	**32**	**24**
4	**IV**	**24**	**16**
Total		**112**	**91**

M.Sc. Physics- PHP01
Semester-I

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	NO. OF CREDITS
PHH502	Mathematical Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH503	Classical Mechanics	Physics	HARD	CORE	4	0	0	**0**	4
PHH504	Quantum Mechanics-I	Physics	HARD	CORE	4	0	0	**0**	4
PHH505	Electronic Devices	Physics	HARD	CORE	4	0	0	**0**	4
PHS503	Introduction to Research	Physics	HARD	CORE	1	0	2	**0**	2
PHH506	Laboratory work	Physics	PRACTICAL	CORE	0	0	12	**0**	6
	TOTAL (L-T-P-/CREDITS)				**17**	**0**	**14**	**0**	**24**

Detailed Syllabus

SEMESTER 1

Course Title/Code	**Mathematical Physics / PHH502**
Course Type	**CORE**
L-T-P Structure	**4-0-0**
Credits	**4**
Course Objective	To study matrix algebra and special functions which are applied to physics problems
Prerequisites (if any)	**Nil**

Learning Outcomes: Student will be able to

- Find Eigen values and Eigen vectors using matrix algebra
- Solve differential equations of special functions
- find Fourier transforms, Laplace Transforms and Inverse LT for various functions applied to physics theory

SECTION – A

Vector Spaces and Matrices; Linear independence: Bases; Dimensionality; inner product; Linear transformations; Matrices; inverse; Orthogonal and unitary matrices; independent elements of a matrix; Eigenvalues and eigenvectors; Diagonalization; Complete orthonormal sets of functions.

SECTION - B

Differential Equations and Special Functions; Second order linear ODEs with variable coefficients;

SECTION-C

Solution by series expansion; Legendre, Bessel, Hermite and Lagaurre equations; Physical applications; Generating functions; recursion relations.

SECTION - D

Integral Transforms, Laplace transform; First and second shifting theorems; Inverse LT by partial fractions; LT of derivative and integral of a function; Fourier series; FS or arbitrary period; Half-wave expansions; Partial sums; Fourier integral and transforms; FT of delta function

Text and Reference Books

1. Mathematical Methods for Physics, by G Arfken
2. Matrices and Tensors for Physicists, by A W Joshi
3. Mathematics for Physicists, by Mary L Boas
4. Mathematics for Physicists, by Pipes

Course Title/Code	Classical Mechanics / PHH503
Course Type	CORE
L-T-P Structure	4-0-0
Credits	4
Course Objective	To study mechanics in Lagrang's formulation and Hamilton –Jacobi Equation .
Prerequisites (if any)	Nil

Learning Outcomes: Students will have the Ability to:

1. Solve problems in many particle system and apply conservation laws
2. Solve problems using Lagrange's equations
3. Apply Hamilton-Jacobi equations

SECTION – A

Preliminaries; Newtonian mechanics of one and many particle systems; conservation laws, work-energy theorem; open systems (with variable mass). Constraints; their classification; D'Alembert's principle' generalized coordinates.

SECTION- B

Lagrange's equations; gyroscopic forces; dissipative systems; Jacobi integral; gauge invariance; generalized coordinates and momenta; integrals of motion; symmetries of space and time with conservation laws; Invariance under Galilean transformations. Rotating frames; inertial forces; terrestrial and astronomical applications of coriolis force.

SECTION- C

Central force; definition and characteristics; Two-body problem; closure and stability of circular orbits; general analysis of orbits, Kepler's Laws and equation; artificial satellites; Rutherford scattering.

SECTION- D

Principle of least action; derivation of equations of motion; variation and end points; Hamiltonian formulation, Hamilton's principle and characteristic functions; Hamilton-Jacobi equation.

Canonical transformation; generating functions; Properties; group property; examples; infinitesimal generators; Poisson bracket; Poisson theorems; angular momentum PBs; small oscillations; normal modes and coordinates.

Text and Reference Books

1. Classical Mechanics, by NC Rana and PS Joag (Tata cGraw-Hill,)
2. Classical Mechanics, by H Goldstein
3. Mechanics, by A Sommerfeld (Academic Press)
4. Introduction to Dynamics, by Perceival and D Richards Cambridge Univ. Press. 1982).

Course Title/Code	Quantum Mechanics I / PHH504
Course Type	**CORE**
L-T-P Structure	**4-0-0**
Credits	**4**
Course Objective	To study Quantum Mechanical formulation and solve simple problems .
Prerequisites (if any)	**Nil**

Learning Outcomes:
Students will have the ability to:

1. Solve one dimensional QM problems using time Independent Schrodinger Equation
2. Solve central force problem of Hydrogen atom
3. Solve degenerate and non degenerate cases using Perturbation Theory

SECTION – A

Basic review of quantum mechanics, Revision; Inadequacy of classical mechanics; Schrodinger equation; Continuity equation; Ehrenfest theorem; Admissible wave functions; Stationary states. One-dimensional problems, wells and barriers; Harmonic oscillator by Schrodinger equation and by operator method.

SECTION - B

Uncertainty relation of *x* and *p*, States with minimum uncertainty product; General formalism of wave mechanics; Commutation relations; Representation of states and dynamical variables; Completeness of Eigen functions;

SECTION - C

Dirac delta function; bra and ket notation; Matrix representation of an operator; Unitary transformation. Angular momentum in QM; Central force problem: Solution of Schrodinger equation for spherically symmetric potentials; Hydrogen atom.

SECTION - D

Time-independent perturbation theory; Non-degenerate and degenerate cases; Applications such as Stark effect.

Text and Reference Books

1. Quantum Mechanics by Schiff
2. Quantum Mechanics by J.J Sakurai
3. Quantum Mechanics by Mathews and Venjatesan

Course Title/Code	Electronic Devices / PHH505
Course Type	CORE
L-T-P Structure	4-0-0
Credits	4
Course Objective	To study different type of electronic devices, circuits and apply them to practical problems
Prerequisites (if any)	Nil

Learning Outcomes:
Students will have the Ability to:

1. Apply different types of diodes and transistors
2. Use various Photonic Devices and conditions for lasing
3. Study various memory devices

SECTION – A

Basics of semiconductor electronics

Semiconductors: intrinsic and extrinsic semiconductors, charge densities in p and n type semiconductors,conduction by charge drift and diffusion, the pn-junction, energy level diagrams of pn-junction under forward and reverse bias conditions, derivation of pn-diode equation, Zener and avalanche breakdowns, clipping and clamping circuits; The bipolar junction transistor: Basic working principle, configurations and characteristics, voltage breakdowns, JFET: Basic working principle, configurations and characteristics the Ebers-Moll's model; Network theorems: node theorem, mesh theorem, Millman's theorem, Thevenin's theorem, Norton's theorem, superposition theorem.

SECTION - B

Amplifier models, feedback and biasing

Two port network analysis: active circuit models, gain in decibels, equivalent circuit for BJT, the transconductance model for BJT, analysis of CE, CB, and CC amplifiers; An amplifier with feedback, effect of negative feedback on gain and its stability, distortions, input and output impedances of amplifiers, Analysis of amplifiers with voltage series, voltage shunt, current series and current shunt negative feedbacks; Location of quiescent (Q) point, biasing circuits for amplifiers: fixed bias, emitter feedback bias & voltage feedback bias, bias sources for integrated circuits, Circuits for stabilization of Q-Point.

SECTION – C

Frequency response of amplifiers

Introduction, the amplifier pass band, mid range response of CE cascade, the high frequency equivalent circuit (Miller effect), the high frequencies response, the frequency response of RC and transformer coupled CE amplifiers, gain-frequency plots of amplifier response, bandwidth of cascaded amplifiers, bandwidth criterion for the transistor, the gain-bandwidth product, composite amplifier designs, bootstrapping in amplifiers, noise in amplifiers, noise figure.

SECTION – D

Power amplifiers and regulators

Power amplifiers: class A large signal amplifiers, second and higher order harmonic distortions, the transformer coupled power amplifier, impedance matching, efficiency, push-pull amplifiers, class-B amplifiers, complementary stages, cross over distortions, class-AB operation, heat sinks; Electronic voltage regulators: basic introduction, Zener diode voltage regulator, single BJT shunt and series regulators.

Reference Books:

1.Electronic fundamentals and applications (5^{th} ed.) by J. D. Ryder
2.Integrated Electronics by J. Millman and C. C. Halkias
3.Network analysis by Van Valkenburg
4. Electronic devices and circuits by Y. N. Bapat
5. Pulse, digital and switching waveforms by J. Millman and H. Taub
6.Millman’s Electronic Devices & Circuits by J. Millman, C. C. Halkias

Course Title/Code	Introduction to Research / PHS503
Course Type	CORE
L-T-P Structure	1-0-2
Credits	2
Course Objective	To understand and adopt the ethical practice that are to be followed in the research activities
Prerequisites (if any)	Nil

Learning outcomes:

1. The student shall be able to describe research and its impact.
2. The student shall be able to identify broad area of research, analyze, the processes and procedures to carryout research.
3. The student shall be able to use different tools for literature survey
4. The student is able choose specific area of research and supervisor/mentor is finalized
5. To understand and adopt the ethical practice that are to be followed in the research activities
6. To work in groups with guidance

Section A

Identification of Broad Area of research

Capturing the current research trends, Insight about scientific research performed by renowned experts in the related field(case studies), Do's and Don'ts pertaining to research, Identification of thrust area of research for deciding broad area, Framing the research questions and hypothesis, Identification of the research gap based on feasibility of problem, Exploration of in-house and commercially available facilities related to broad area

Section B

Understanding the tools for Literature Survey

Finding research papers related to a topic, Understanding the different aspects of Literature search Usage of different sources like Google scholar, WoS, SCI/ SCIE, PubMed, Scopus, ABDC, EBSCO etc. , Search for online journals relevant to research area, Indexing of Journals , Usage of scholarly networking sites like Research Gate, Mendeley, Academia.edu etc. Demo sessions on the usage of above mentioned sources

Section C

Review of research papers pertaining to broad area and specific area of research

Selection of relevant papers, Finding specific research problem from broad area of research, Literature survey and justification of specific research problem, Experimentation and data cleaning and verification, Understanding and selection of the research domain Seeking information through published work w.r.t the problem Reading & categorizing the downloaded/referred papers and structuring of the idea Model design about framing the research questions

Section D

Report Writing and Presentation skill Development

Report making on the surveyed literature to cater the basic idea of the research papers , Compiling and analyzing the published results to justify and understand the proposed ideas ,Usage of MS-PowerPoint and other technical resources for the presentation, Development of presentation skills and group addressing Scientific/technical writing and ethical practice, project report

Text and Reference Books

1. Introduction to Research Methods 4th Edition: A Practical Guide for Anyone Undertaking a Research Project by **Catherine Dawson**

Course Title/Code	Laboratory work / PHH506
Course Type	CORE
L-T-P Structure	0-0-12
Credits	6
Course Objective	To practice application of electronic components in power supply and other devices
Prerequisites (if any)	Nil

Learning Outcomes:
Students will have the Ability to:

- Apply diodes and transistors in Power supply and amplifiers
- Half life of a radioactive nucleus
- Measure specific charge e/m

List of Practical:

- To study the frequency response of low-pass, high-pass and band-pass filters.
- To study the rectifier circuits and to measure the ripple factors of C, L and π-section filters.
- Also study the stabilization characteristics of a voltage regulator consisting of IC- 741.
- To generate and find the frequency of saw-tooth waves using UJT.
- To draw frequency response characteristics of a RC-coupled single stage BJT amplifier in all the three configurations.
- To design circuits for OR, AND, NOT, NAND and NOR logic gates and verify their truth tables.
- To measure (a) phase difference, (b) deflection sensitivity and (c) frequency of an unknown ac signal using CRO.
- To study the astable multivibrator.
- To study the clipping and clamping circuits.
- To study the differentiating and integrating circuits.
- To determine various parameters of a pn-junction diode.
- To study the modulation and demodulation circuits.

Semester-II

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	*COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	NO. OF CREDITS
PHH508	Quantum Mechanics-II	Physics	HARD	CORE	4	0	0	**0**	4
PHH509	Statistical Mechanics	Physics	HARD	CORE	4	0	0	**0**	4
PHH510	Electrodynamics and Plasma Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH511	Atomic and Molecular Physics	Physics	HARD	CORE	4	0	0	**0**	4
MES515	Research paper writing	Physics	HARD	CORE	1	0	2	**0**	2
PHH512	Laboratory work	Physics	HARD	CORE	0	0	12	**0**	6
PHO121	Summer Training	Physics	HARD	CORE	0	0	0	**0**	3
	TOTAL (L-T-P-/CREDITS)				**17**	**0**	**14**	**0**	**27**

Detailed Syllabus

Course Title/Code	Quantum Mechanics ll / PHH508
Course Type	CORE
L-T-P Structure	4-0-0
Credits	4
Course Objective	To develop familiarity with the physical concepts and facility with the mathematical methods of quantum mechanics
Prerequisites (if any)	Nil

Learning Outcomes:
Students will have the Ability to:
1) Use quantum mechanics in real physical situations
2.) Obtain approximate solutions

SECTION –A

Variational method; WKB approximation; Time dependent perturbation theory; Harmonic perturbat ion; Fermi's golden rule; Adiabatic and sudden approximations.

SECTION - B

Collision in 3-D and scattering; Laboratory and centre of mass reference frames; Scattering amplitude; differential scattering cross section and total scattering cross section; Scattering by spherically symmetric potentials; Partial waves and phase shifts;

SECTION- C

Scattering by a perfectly rigid sphere and by square well potential; Complex potential and absorption. Identical particles; Symmetric and antisymmetric wave functions; Collision of identical particles; Spin angular momentum; Spin functions for a many-electron system.

SECTION- D

Semiclassical theory of radiation; Transition probability for absorption and induced emission; Electric dipole and forbidden transitions; Selection rules.

Text and Reference Books

1. L I Schiff, Quantum Mechanics (McGraw-Hill)
2. S. Gasiorowicz, Quantum Physics (Wiley)
3. B Craseman and J D Powell, Quantum Mechanics (Addison Wesley)
4. A P Messiah, Quantum Mechanics
4. J J Sakurai. Modern Quantum Mechanics
5. P. M. Mathews, K. Venkatesan- A Textbook of quantum mechanics (McGraw-Hill)

Course Title/Code	Statistical Mechanics/ PHH509
Course Type	**CORE**
L-T-P Structure	**4-0-0**
Credits	**4**
Course Objective	To develop familiarity with the physical concepts and facility with the mathematical methods of Statistical mechanics
Prerequisites (if any)	**Nil**

Learning Outcomes:
Students will have the Ability to:

1. explore the physical behaviour of a variety of statistical systems
2. demonstrate practical importance of the course

SECTION- A

Foundations of statistical mechanics; specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox. Microcanonical ensemble, phase space, trajectories and density of states, Liouville's theorem,

SECTION - B

Canonical and grand canonical ensembles; partition function, calculation of statistical quantities, Energy and density fluctuations. Density matrix, statistics of ensembles, statistics of indistinguishable particles, Maxwell- Boltzman statistics,

SECTION - C

Fermi-Dirac and Bose Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation. Cluster expansion for a classical gas, Virial equation of state, ising model, mean-field theories of the ising model in three, two and one dimensions Exact solutions in one dimension.

SECTION - D

Landau theory of phase transition, critical indices, scale transformation and dimensional analysis. Correlation of space-time dependent fluctuations, fluctuations and transport phenomena, Brownian motion, Langevin theory, fluctuation dissipation theorem. The Fokker-Planck equation.

Text and Reference Books

1.Statistical and Thermal Physics, by F Reif
2.Statistical Mechanics, by K Huang(John Wiley & Sons)
3.Statistical Mechanics, R K Pathria
4.Statistical Mechanics, R. Kubo
5.Statistical Physics, Landau and Lifshitz

Course Title/Code	Electrodynamics and Plasma Physics / PHH510
Course Type	CORE
L-T-P Structure	4-0-0
Credits	4
Course Objective	To learn Tensor formalism for EM wave and properties of Plasma
Prerequisites (if any)	Nil

Learning Outcomes:
Students will have the Ability to:

- Demonstrate an understanding of the use of scalar and vector potentials and of gauge invariance
- Know and use methods of solution of Poisson/Laplace equation
- Know and use principles of Lorentz covariant formalism and tensor analysis
- Demonstrate the compatibility of electrodynamics in special theory of relativity
- Gather basic understanding of Plasma state essential for higher studies.

SECTION - A

Review of Four-Vector and Lorentz Transformation in Four-Dimensional Space, Electromagnetic Field Tensor in Four Dimensions and Maxwell's Equations, Dual Field Tensor, Wave Equation for Vector and Scalar Potential and Solution Retarded Potential and Lienard-Wiechert Potential, Electric and Magnetic fields due to a Uniformly Moving Charge and an Accelerated Charge,

SECTION - B

Linear and Circular Acceleration and Angular Distribution of Power Radiated, Bremsstrahlung, Synchrotron Radiation and Cerenkov Radiation, Reaction Force of Radiation. 2. Motion of charged Particles in Electromagnetic Field: Uniform E and B Fields, Non uniform Fields, Diffusion Across Magnetic Fields, Time Varying E and B Fields, Adiabatic Invariants: First, Second Third Adiabatic invariants.

SECTION - C

Elementary Concepts: Derivation of moment Equations from Boltzmann Equation, Plasma Oscillations, Debye Shielding, Plasma Parameters, Magneto plasma, Plasma Confinement.
Hydrodynamical Description of Plasma: Fundamental equations. Hydromagnetic Waves: Magnetosonic and Alfven Waves.

SECTION - D

Wave Phenomena in Magneto plasma: Polarization, Phase Velocity, Group Velocity, Cutoffs, Resonance for Electromagnetic Wave Propagating Parallel and Perpendicular to the Magnetic Field, Propagation at Finite Angle and CMA Diagram, Appleton - Hartee Formula and Propagation through ionosphere and Magnetosphere: Helicon, Whistler, Faraday Rotation.

Text and Reference Books

1.Panofsky & Phillips: Classical Electricity and Magnetism
2. Bittencourt: Fundamentals of Plasma Physics (Springer)
3. Chen: Plasma Physics
4. Jackson: Classical Electrodynamics

Course Title/Code	Atomic and Molecular Physics / PHH511
Course Type	CORE
L-T-P Structure	4-0-0
Credits	4
Course Objective	Illustrate the fundamental aspects of atomic and molecular physics using quantum mechanics at different levels to understand the structure and dynamics of both atoms and molecules

Learning Outcomes:
Students will have the Ability to:

1. Carry out experimental and theoretical studies on atoms and molecules, with focus on the structure and dynamics of atoms and molecules
2. Account for theoretical models, terminology and working methods used in atomic and molecular physics.

SECTION - A

Quantum states of one electron atoms-Atomic orbitals-Hydrogen spectrum-Pauli's principle-Spectra of alkali elements-Spin orbit interaction and fine structure in alkali Spectra-Equivalent and non-equivalent electrons-Normal and anomalous Zeeman effect- Paschen Back effect

SECTION - B

Stark effect-Two electron systems-interaction energy in LS and JJ Coupling-Hyperfine structure (qualitative)-Line broadening mechanisms (general ideas) Types of molecules-Diatomic linear symmetric top, asymmetric top and spherical top molecules

SECTION - C

Rotational spectra of diatomic molecules as a rigid rotor-Energy level and spectra of non rigid rotor-intensity of rotational lines-Stark modulated microwave spectrometer (qualitative)

SECTION - D

Vibrational energy of diatomic molecule-Diatomic molecule as a simple harmonic oscillator- Energy levels and spectrum-Morse potential energy curve-Molecules as vibrating rotator- Vibration spectrum of diatomic molecule-PQR branches IR spectrometer (qualitative), Raman effect.

Text and Reference Books

1. Introduction to Atomic spectra—H.E.White(T)
2. Fundamentals of molecular spectroscopy—C.B.Banwell (T)
3. Spectroscopy Vol I, ll & Ill—Walker & Straughen
4. Introduction to Molecular spectroscopy—GMBarrow
5. Spectra of diatomic molecules—Herzberg
6. Molecular spectroscopy—Jeanne L McHale
7. Molecular spectroscopy—JMBrown
8. Spectra of atoms and molecules—P.F.Bemath
9. Modern spectroscopy—J.M.Holias

Course Title/Code	Research Paper writing / MES515
Course Type	CORE
L-T-P Structure	1-0-2
Credits	2
Course Objective	To acquaint the researcher with the tools of research by exposing them to the mechanics of writing a research report/ research paper/ thesis/ dissertation.
Prerequisites (if any)	Nil

Learning outcomes :
Upon completion of this course, the students should be able to:

- Know what formats, designs, structure and styles to use to best get their ideas, concepts and messages across in a way that is clear and unambiguous.
- Be capable of recognising and correcting many common errors that currently occur within written communication in the technical field.
- Produce different types of Technical Reports for various purposes
- Use clear and powerful language to target and persuade readers for positive results
- Produce documents of a high professional standard.

SECTION A

Research Paper:- Definition, Quality of a good Research Paper, Report Paper and Thesis Paper; Details of a Research Paper – Steps and Schedule.
Choosing a Topic:- Brainstorming, Consulting Experts, Considering Parameters, Narrowing the Research Topic.
Thesis:- Definition and function, Outline, Thesis Statement

SECTION B

Doing Research:- Finding Information, Sources of Information; Online Resources, Search Engines, Databases, Newsgroups, Internet Sites; Library – Books, Research Papers, Periodicals, Magazines and Journals,, Interviews, Surveys, Government Documents, Pamphlets, Special Collections; Evaluating Sources
Taking Notes:- Reading, Notes Taking Methods, Guidelines and Summarizing

SECTION C

Rough Draft :- Transforming Notes into Rough Draft Creating Outlines, Types of Outlines; Basics of Research Paper Style ; Words, Sentences, Punctuation ; Writing Introduction; Using Notes, Quotations, Graphics etc.

Revising Rough Drafts:- Principles, Revising Opening Paragraph, Sentences, Words and Rules for Writers, Plagiarism and how to avoid it, Plagiarism Detection Programs.

SECTION D

Documentation :- MLA System of Documentation ; Parenthetical Documentation, Format for Work Cited, Using Footnotes and Endnotes to Document Sources and add Observations and Comments – Guidelines and Format ; APA System of Documentation, Traditional System of Documentation (CMS).

Presentation of Research Paper:- Title Page, Table of Contents, Forward and Preface, Abstract, Presentation Footnote. Finished Form of Paper – Revising, Editing, Proofreading, Peer Review Checklist, Submitting Electronically. Model Research Papers

Reference Books:

1) Gibaldi, Joseph. MLA Handbook for Writers of Research Papers. 7th ed. New Delhi: East-West Press, 2009
2) Kothari, C.R. Research Methodology: Methods and Techniques. New Delhi: New Age International Ltd, 1985.
3) Rahim, F. Abdul. Thesis Writing: A Manual for Researchers. New Delhi: New Age International Pvt Ltd, 1996.
4) Laurie Rozakis, Schaum's Quick Guide to Writing Great Research Papers, M/cGraw- Hill 2007.
5) Anthony C. Winkler / Jo Ray McCuen –Metherel, Writing the Research Paper. Wadsworth Cengage Learning. 2008

<u>Work to be done:</u>

Report writing consisting of about 1,000 words, on any subject of the student's choice in the field of research in Mechanical Engineering.

Prepare atleast two Research Papers in IEEE & Science Direct Format. Your **research paper** must be 3 pages **minimum** plus reference page, typed (approx. 250 words per page) on a technical topic of the student's choice dealing the field of research in Mechanical.

Seminar presentation, on Report Writing and Research Papers

Course Title/Code	Laboratory work / PHH512
Course Type	CORE
L-T-P Structure	0-0-12
Credits	6
Course Objective	To apply basics of science and engineering concepts to verify and learn experimental set up

Learning outcomes:

- Analyse of clipping, clamping, modulation and demodulation in circuits. Application of CRO, differentiation and integration of various circuits, Study and apply.

PRACTICALS LIST:

1. Experiment on FET and MOSFET characterization and application as an amplifier.
2. Experiment on Uni-Junction Transistor and its application.
3. Digital I: Basic Logic Gates, TTL, NAND and NOR.
4. Digital ll: Combinational Logic.
5. Flip-Flops.
6. Operational Amplifier (741).
7. Differential Amplifier.
8. Measurement of resistivity of a semiconductor by four probe method at different temperatures and Determination of band gap.
9. Determination of Lande's factor of DPPH using Electron-Spin resonance (E.S.R.) Spectrometer.
10. Measurement of Hall coefficient of given semicoundutor: Identification of type of semiconductor and estimation of charge carrier concentration.
11. To study the fluorescence spectrum of DCM dye and to determine the quantum yield of fluorescence maxima and full width at half maxima for this dye using monochromator.
12. To study Faraday effect using He-Ne Laser.

Course Title/Code	Summer Training / PHO121
Course Type	**CORE**
L-T-P Structure	**0-0-0**
Credits	**3**
Course Objective	To apply basics of science and engineering concepts to verify and learn experimental set up

Semester III

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	NO. OF CREDITS
PHH613	Solid State Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH614	Nuclear and Particle Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH615	Condensed Matter Physics	Physics	HARD	CORE	4	0	0	**0**	4
PHH616	Fundamental Atmospheric Physics	Physics	HARD	Elective (any one)	4	0	0	**0**	4
PHH617	Fabrication and Characterization Techniques	Physics	HARD		4	0	0	**0**	
PHN619	Seminar	Physics	NTCC (Non-teaching credit course)	CORE	0	0	0	**0**	2
PHH618	Laboratory work	Physics	PRACTICAL	CORE	0	0	12	**0**	6
	TOTAL (L-T-P-/CREDITS)				**16**	**0**	**12**	**0**	**24**

Detailed syllabus

Course Title/Code	Solid State Physics / PHH613
Course Type	CORE
L-T-P Structure	4-0-0
Credits	4
Course Objective	To study and analyze different types of crystal structure.
Prerequisites (if any)	Nil

Learning Outcomes:

Students will have the Ability to:

1) Analyze the XRD pattern and determine the crystal structure of a material.

2) Measure the electrical, magnetic and dielectric properties of materials.

SECTION - A

Crystal Physics and Defects in Crystals Crystalline solids, unit cells and direct lattice, two and three dimensional Bravais lattices, Miller Indices, closed packed structures, Interaction of X-rays with matter, absorption of X-rays. Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods,

SECTION - B

Crystal structure factor and intensity of diffraction maxima. Extinctions due to lattice centering. Point defects, line defects and planer (stacking) faults. The role of dislocations in plastic deformation and crystal growth. The observation of imperfections in crystals, X—ray and electron microscopic techniques.

SECTION – C

Electronic Properties of Solids, Electrons in a periodic lattice: Bloch theorem, band theory, classification of solids, effective mass. Tight-binding, cellular and pseudopotential methods. Fermi surface, de Hass von Alfen effect, cyclotron resonance, magneto-resistance, quantum Hall effect.

SECTION – D

Superconductivity: critical temperature, persistent current, Meissner effect. Weiss theory of ferromagnetism. Heisenberg model and molecular field theory. Spin waves and magnons. Curie-Weiss law for susceptibility, Ferri- and antiferro-magnetic order . Domains and Bloch-wall energy. BCS theory.

Text and Reference Books

1. Verma and Srivastava: Crystallography for Solid State Physics
2. Azaroff : introduction to Solids
3. Omar : Elementary Solid State Physics
4. Aschroft & Mermin: Solid State Physics
5. Kittel: Solid State Physics
6. Chaikin and Lubensky: Principles of Condensed Matter Physics

Course Title/Code	Nuclear and Particle Physics / PHH614
Course Type	CORE
L-T-P Structure	4-0-0
Credits	4
Course Objective	Provide the students with an understanding of basic radiation interaction and detection techniques for nuclear physics, radioactive decays, nuclear reactions and elementary particle physics
Prerequisites (if any)	Nil

Learning Outcomes:
Students will have the Ability to:

- Describe the basic interaction mechanisms for charged particles and electromagnetic radiation relevant for radiation detectors and explain their importance for detecting various types of ionizing radiation at different energies.
- Describe the basic features involved in alpha and beta decays, nuclear forces and various kinds of nuclear reactions besides the fundamentals of elementary particle physics.

SECTION - A

Nuclear Interactions and Nuclear Reactions
Nucleon - nucleon interaction - Exchange forces and tensor forces - Meson theory of nuclear forces - Nucleon - nucleon scattering - Effective range theory - Spin dependence of nuclear forces - Charge independence and charge symmetry of nuclear forces - lsospin formalism - Yukawa interaction. Direct and compound nuclear reaction mechanisms - Cross sections in terms of partial wave amplitudes - Compound nucleus - Scattering matrix - Reciprocity theorem - Breit - Wigner one - level formula - Resonance scattering.

SECTION - B

Nuclear Models
Liquid drop model - Bohr - Wheeler theory of fission - Experimental evidence for shell effects - Shell model - Spin - Orbit coupling - Magic numbers – Angular momenta and parities of nuclear ground states - Qualitative discussion and estimates of transition rates - Magnetic moments and Schmidt lines - Collective model of Bohr and Mottelson.

SECTION - C

Nuclear Decay
Beta decay - Fermi theory of beta decay - Shape of the beta spectrum - Total decay rate- Anguiar momentum and parity selection rules - Comparative half - lives - Allowed and forbidden transitions - Selection rules - Parity violation - Two-component theory of neutrino decay - Detection and properties of neutrino - Gamma decay - Multipole transitions in nuclei – Angular momentum and parity selection rules - Internal conversion - Nuclear isomerism.

SECTION - D

Elementary Particle Physics
Types of interaction between elementary particles - Hadrons and leptons — Symmetry and conservation laws - Elementary' ideas of CP and CPT invariance - Classification of hadrons -

Lie algebra, SU(2) - SU(3) multiplets - Quark model - Gell - Mann - Okubo mass formula for octet and decuplet hadrons - Charm, bottom and top quarks.

Text and Reference Books

1. A. Bohr and ER Mottelson, Nuclear Structure, Vol. 1 (1969) and Vol.2, Benjamin, Reading, A, 1975.
2. Kenneth S.Kiane, introductory Nuclear Physics,Wiiey, New York,1988.
3. Ghoshal, Atomic and Nuclear Physics Vol. 2.
4. P. H. Perkins, introduction to High Energy Physics, Addison-Wesley, London, 1982.
5. Shirokov Yudin, Nuclear Physics Vol. I & 2, Mir Publishers, Moscow, 1982.
6. D. Griffiths, introduction to Elementary Particles, Harper and Row, New York, 1987.

Course Title/Code	**Condensed Matter Physics / PHH615**
Course Type	**CORE**
L-T-P Structure	**4-0-0**
Credits	**4**
Course Objective	Give the competence to handle complex problems and independently take part in interdisciplinary work and identify needs for and structure of own learning.
Prerequisites (if any)	**Nil**

Learning Outcomes:

- Deduce Bloch's theorem from the Schrödinger equation for electrons in a periodic potential.
- Perform band structure calculations for simple systems in the weak potential- and in the Linear Combination of Atomic Orbitals approximations
- Describe the relation between electron band-structure and crystal symmetry.
- Explain the effective electron mass and apply it to describe electron dynamics in semiconductors.
- Describe the effect of doping on the electronic properties of semiconductors
- Describe the characteristics of liquids
- Explain structural order and disorder in soft materials
- Perform simple calculations of the material properties of soft systems.

SECTION – A

Lattice Dynamics and Optical Properties of Solids lnteratomic forces and lattice dynamics of simple metals, ionic and covalent crystals. Optical phonons and dielectric constants. Inelastic neutron scattering. Mossbauer effect. Debye-Waller factor.

SECTION - B

Anharmonicity, thermal expansion and thermal conductivity. Interaction of electrons and phonons with photons. Direct and indirect transitions. Absorption in insulators, Polaritons, one phonon absorption, optical properties of metals, skin effect and anomalous skin effect.

SECTION - C

Electron-Phonon Interaction, Interaction of electrons with acoustic and optical phonons, polarons. Superconductivity: manifestations of energy gap. Cooper pairing due to phonons, BCS theory of superconductivity,

SECTION - D

Ginzsburg-Landau theory and application to Josephson effect: d-c Josephson effect, a-c Josephson effect, macroscopic quantum interference, Vortices and type II superconductors, high temperature superconductivity (elementary).

Text and Reference Books

1.Madelung: Introduction to Solid State Theory
2. Callaway: Quantum Theory of Solid State
3. Huang: Theoretical Solid State Physics
4. Kittel: Quantum Theory of Solids

Course Title/Code	Fundamental Atmospheric Physics/ PHH616
Course Type	ELECTIVE
L-T-P Structure	4-0-0
Credits	4
Course Objective	Understanding of advanced atmospheric thermodynamic and dynamic concepts; they have the ability to apply these independently and lead others in an operational or research
Prerequisites (if any)	Nil

Learning Outcomes:

1. Explain the physical laws governing the structure and evolution of atmospheric phenomena spanning a broad range of spatial and temporal scales.
2. Apply mathematical tools to study atmospheric processes.
3. Explain the principles behind, and use of, meteorological instrumentation.
4. Describe, analyze and create graphical depictions of meteorological information.
5. Demonstrate critical and analytical skills to interpret and predict weather systems using weather products (model results, maps, satellite imagery, etc.).
6. Present and communicate weather analyses and forecasts in a team or individually.

Section A

ESSENTIALS OF ATMOSPHERIC PHYSICS

Structure of the atmosphere: troposhere, stratopshere, mesosphere, thermosphere; Composition of air. Greenhouse effect and enhanced greenhouse effect. Transport of matter, energy and momentum in nature. Stratification and stability of atmosphere. Laws of motion, hydrostatic equilibrium. Elements of weather and climate of India

Section B

SOLAR AND TERRESTRIAL RADIATION

Physics of radiation. Interaction of light with matter. Rayleigh- and Mie- scattering. Laws of radiation (Kirchoffs law, Planck's law,Beer's law, Wien's displacement law, etc.). Solar and terrestrial spectra. UV radiation. Ozone depletion problem. IR absorption energy balance of the earth atmosphere system.

Section C

ATMOSPHERIC POLLUTION AND DEGRADATION

Elementry fluid dynamics. Diffusion. Turbulence and turbulent diffusion. Factors governing air, water and noise pollution Air and water quality standards. Waste disposal. Heat island dffect. Land and see breeze. Puffs and plumes. Gaseous and particulate matters. Wet and dry deposition
Residence time and reaction rates of pollutants, sulphur compounds, nitrogen compounds, carbon compounds, organic compounds, aerosols, toxic gases and radio active particles trace gases.

Section D

GLOBAL AND REGIONAL CLIMATE

Elements of weather and climate. Stability and vertical motion of air. Horizontal motion of air and water. General circulation & climate. Pressure gradient forces. Viscous forces. Inertia. Reynolds number. Energy balance-a zero- dimensional Greenhouse model. Global climate models.

Reference and Text Books:

1. Meteorology for Scientists & Engineers: Ronald B. Still, Brooks/ Cole Cengage Learning 1995.
2. Environmental Physics : Edbert B and Reink V Groundelle, John Wiley
3. The Physics of Atmosphere : J.T. Hougtion, Cambridge Univ. Press, 1977.
4. Atmospheric Science: John M. Wallace & Peter V. Hobbs, Academic Press (2006)
5. Meteorology for Scientists and Engineers: Ronald B. Stull, Brocks/Cole Cengage Learning (1995)
6. The Lightning Discharge: Martin A. Uman, Academic Press (1987)

Course Title/Code	Fabrication and Characterization Techniques/ PHH617
Course Type	**ELECTIVE**
L-T-P Structure	**4-0-0**
Credits	**4**
Course Objective	To study and analyze different types of crystal structure.
Prerequisites (if any)	**Nil**

Learning Outcomes:

Students will have the Ability to:

1) Analyze the XRD pattern and determine the crystal structure of a material.
2) Prepare thin films using different methods.
3.) Understand different characterization techniques

SECTION- A

Introduction to Band theory: Bloch Theorem, Kronig-Penney Model, Brillouin Zones, Effective Mass of Electrons and holes, nearly free electron model, Pseudopotential method, classifications of materials on the basis of band theory.

SECTION - B

Introduction to bulk and thin films, different methods (solid state reaction, rapid two stage solid state reactions, pulse laser deposition, thermal evaporation, RF sputtering etc.) of bulk and film preparation, nucleation and methods of crystal growth.

SECTION - C

Introduction to soft condensed matter, sol-gel technique (preparation and characterizations of bulk, nanomaterials and thin films).

SECTION - D

Characterization techniques (Powder XRD, FT-Raman, UV-Vis., HRXRD, SEM, TEM, electrical etc.), Size effect on transport properties.

Course Title/Code	Laboratory Work/ PHH618
Course Type	**CORE**
L-T-P Structure	**0-0-12**
Credits	**6**
Course Objective	To practice application of electronic components in power supply and other devices
Prerequisites (if any)	**Nil**

Learning Outcomes:
Students will have the Ability to:

- Study and examine the different rectifier circuits, amplifier circuits.
- Students will implement theory concepts in practical lab to perform practicals.

Practical list:

1. Pulse Amplitude Modulation/Demodulation
2. Pulse position/Pulse width Modulation/Demodulation
3. FSK Modulation Demodulation using Timer/PLL
4. Microwave characterization and Measurement
5. PLL circuits and applications
6. Fibre Optics communication
7. Design of Active filters
8. BCD to Seven segment display
9. A/D and D/A conversion
10. Addition, substraction, multiplication & division using 8085/8086
11. Wave form generation and storage oscilloscope
12. Frequency, Voltage, Temperature measurements
13. Motor Speed control, Temperature control using 8086.
14. Trouble shooting using signature analyzer.
15. Assembler language programming on PC.
16. Study of line spectra on photographed plates/films and calculation of plate factor.

Course Title/Code	**Seminar / PHN619**
Course Type	**CORE**
L-T-P Structure	**0-0-0**
Credits	**2**
Course Objective	To acquaint the researcher with the tools of research by exposing them to the mechanics of writing a research report/ research paper
Prerequisites (if any)	**Nil**

Semester-IV

SUBJECT CODES	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (Hard/Soft/ NTCC)	COURSE TYPE (Core/ Elective etc)	L	T	P	O	CREDITS
PHH619	Computational Method and Programming	Physics	HARD	CORE	2	0	2	0	4
PHH620	Advanced atmospheric Physics	Physics	HARD	ELECTIVE (any one)	4	0	0	0	4
PHH621	Condensed Matter II	Physics	HARD		4	0	0	0	
PHN623	PROJECT WORK	Physics	HARD	CORE	0	0	12	0	6
PHN624	Seminar	Physics	NTCC (Non-teaching credit course)	CORE	0	0	0	0	2
	TOTAL (L-T-P-O/CREDITS)				**6**	**0**	**2**	**0**	**16**

DETAILED SYLLABUS

Course Title/Code	Computational Method and Programming / PHH619
Course Type	**CORE**
L-T-P Structure	**2-0-2**
Credits	**4**
Course Objective	To familiarize the students with different programming language in serial and parallel mode with applications
Prerequisites (if any)	**Nil**

Learning Outcomes:
Students will have the Ability to:
1. Write code in C, C++ and Fortran.
2. Compile and run the code in unix and windows environment
3. To run the code in parallel mode.
4. To write code for advanced level problem.

SECTION – A

Overview of computer organization, hardware, software, scientific programming in FORTRAN and/or C, C++

SECTION - B

Sorting, interpolation, extrapolation, regression, numerical integration, quadrature, random number generation, linear algebra and matrix manipulations, inversion, diagonalization, eigenvectors and eigenvalues, integration of initial-value problems, Euler, Runge-Kutta, and Verlet schemes, root searching, optimization, fast Fourier transforms.

SECTION - C

Monte Carlo methods, molecular dynamics, simulation methods for the Ising model and atomic fluids, simulation methods for quantum-mechanical problems, time-dependent Schrödinger equation, discussion of selected problems in percolation, cellular automata, nonlinear dynamics, traffic problems, diffusion-limited aggregation, celestial mechanics, etc.

SECTION - D

Introduction to parallel computation

Reference and Text Books:

1. Sastry: Introductory Methods of Numerical Analysis
2. Rajaraman: Numerical Analysis
3. Rajaraman: Fortran Programming
4. Vetterming: Teukolsky, Press and Flannery: Numerical Recipes

Course Title/Code	**Advanced atmospheric Physics / PHH620**
Course Type	**Elective**
L-T-P Structure	**4-0-0**
Credits	**4**
Course Objective	To bring students to an understanding of the basic processes involved in weather and to understand the major components of the earth-biosphere-atmosphere system and their interactions
Prerequisites (if any)	**Nil**

Learning Outcomes:

1. Demonstrate expert knowledge of the weather and climate of the Tropics
2. Apply basic atmospheric thermodynamic principles such as potential temperature, equivalent potential temperature, vapor pressure, mixing ratio and the first and second laws of thermodynamics to understand weather and climate issues
3.Create sophisticated computer programs and/or utilize those available on the web
4. Work independently with an observational dataset or numerical simulation

SECTION – A

ATMOSPHERIC THERMODYNAMICS

Gas laws: virtual temperature. Hydrostatic equation: geopotential, scale height, constant pressure surfaces, reduction of pressure to sea level. First law of thermodynamics: joule's law, specific heats & enthalpy. Adiabatic processes: air parcel & dry adiabaic lapse rate, potential temperature, thermodynamic diagrams. Water vapour in air: moisture parameters, Pseudoadiabatic processes & saturated adiabatic lapse rate, equivalent and wet bulb potential temperatures, normand's rule, ascent decent effect. Static Stability: unsaturated & saturated air, conditional & convective stability. Second law of thermodynamics: Carnot cycle, entropy, Clausius Clapeyron equation.

SECTION – B

CLOUD FORMATION & MICROPHYSICS OF CLOUD

Theory of nucleation of water vapour & cloud condensation nuclei. Microstructure of warm clouds. Cloud liquid water content & entrainment. Growth of cloud droplets in warm clouds: by condensation, by collection, by collission-coalescence. Microphysics of cold clouds: nucleation, growth & concentration of ice particles, formation of precipitation in cold clouds. Artificial modification of clouds & precipitation: modification of warm & cold clouds, inadvertent modification.

SECTION - C

ATMOSPHERIC DYNAMICS

Kinamatics of large scale horizontal flow: elementary properties, vorticity & divergence, defotmations, streamlines & trajectories. Dynamics of horizontal flow: apparent & real forces, equation of motion, geostrophic & thermal wind, vertical motion & planetary rotation vorticity conservation, potential vorticity. Primitive equations: vertical coordinate,hydrostatic balance, energy equation, vertical motion field, solution & application of primitive equations

SECTION – D

ATMOSPHERIC ELECTRICITY & LIGHTNING

Fair weather atmospheric electric fields and currents Mechanisms of cloud electrification: precipititation powdered & connective mechanisms, electrochemical charge separation, charge structure of the clouds, thundercloud electric fields, Lightning initiation in a thundercloud, Cloud to ground and intracoud lightning, Positive lightning, Llightning superbolts, Lightning fields: electric & magnetic fields, ratiations from lightning, application of the lightning electric field measurements. Lightning sprites.

Reference and Text Books:

1. Atmospheric Science: John M. Wallace & Peter V. Hobbs, Academic Press (2006)
2. Meteorology for Scientists and Engineers: Ronald B. Stull, Brocks/Cole Cengage Learning (1995)
3. The Lightning Discharge: Martin A. Uman, Academic Press (1987)
4. Dynamic Meteorology : Holton, J.R., 3rd edition ,Academic PressN.Yf. (1992).
5. The Physics of Monsoons : R.N. Keshvamurthy ans M. Shanker Rao, Allied Publishers, 1992
6. Numerical Weather Prediction : G.J. Haltiner and R.T.Villians, John Wiley and Sons, 1980

Course Title/Code	Condensed Matter II / PHH621
Course Type	**Elective**
L-T-P Structure	**4-0-0**
Credits	**4**
Course Objective	To provide a firm foundation of the theoretical tools for the electronic structure of the materials.
Prerequisites (if any)	**Nil**

Learning Outcomes:
Students will have the Ability to:
1) Use quantum mechanics for calculating electronic structure of the materials
2.) Analyze and visualize the electronic structure of the materials

SECTION - A

The Huckel method, Huckel theory and the LCAO approximation, Self-consistent field theory, Koopmans'Theorem.

SECTION - B

The Basis Set approximation, Slater and Gaussian type Orbitals, The Hartree equation, The Fock equation, Restricted and Unrestricted Hartree-Fock approximation.

SECTION - C

Correlation energy, Electron density, Description of quantum states and the Dirac notation, Density operators, Hartree-Fock theory in density-matrix form.

SECTION - D

The Hohenberg-Kohn theorems, The Kohn-Sham method: Basic principles, Local Density methods, Gradient corrected methods, Hybrid methods.

Text and Reference Books

1-Understanding Molecular simulation by Daan Frenkel, Academic Press.
2-Computer simulation of Liquid by M.P.Allen, Clarendon press, Oxford.
3-Density Functional Theory of atoms and molecules by Robert G. Parr and Weitao Yang, Oxford University Press.

Course Title/Code	Project work / PHN623
Course Type	**Core**
L-T-P Structure	**0-0-12**
Credits	**6**
Course Objective	Understand and adopt the ethical practice that is to be followed in the research activities. Work in groups with guidance.
Prerequisites (if any)	**Nil**

Learning Outcomes:

- Students will be able to apply characterization and analysis tools in different areas of Physics meeting research goals.

Course Title/Code	Seminar / PHN624
Course Type	**CORE**
L-T-P Structure	**0-0-0**
Credits	**2**
Course Objective	To acquaint the researcher with the tools of research by exposing them to the mechanics of writing a research report/ research paper
Prerequisites (if any)	**Nil**

Learning Outcomes:

- Students will be able to explore and demonstrate his/her research project related tasks.