P.G. DEPARTMENT OF PHYSICS
(SEMESTER PATTERN)
CHOICE BASED CREDIT SYSTEM (CBCS)

TWO YEARS FULL TIME PROGRAMME
COURSE OF STUDIES R-20

GIET UNIVERSITY, GUNUPUR
ODISHA

All the precautions have been taken to print the course curriculum accurate. However, mistakes if any will be corrected as and when noticed. The university reserves the right to include/exclude any content at any point of time during the progression of the course.

M. Sc PHYSICS

Schedule for Instruction and Examination
(Proposed Scheme for Academic year 2020-2021)

I SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PHPC	101	Mathematical Methods in Physics	3	1	0	4
2	PHPC	102	Classical Mechanics	4	0	0	4
3	PHPC	103	Computer Programming and Numerical Analysis	3	1	0	4
4	PHPC	104	Quantum Mechanics-I	4	0	0	4
PRACTICAL / SESSIONAL							
5	PHPC	105	Computer programming in Physics (Laboratory)	0	0	6	4
6	PHPC	106	Seminar & Project-I	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PHPC	201	Classical Electrodynamics	3	1	0	4
2	PHPC	202	Basic Nuclear physics	4	0	0	4
3	PHPC	203	Basic Solid State Physics	4	0	0	4
4	PHPC	204	Quantum Mechanics-II	3	1	0	4
PRACTICAL / SESSIONAL							
5	PHPC	205	Optics (Laboratory)	0	0	6	4
6	PHPC	206	Seminar & Project-II	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

BoS Members:1. Dr. Tapan. Ku Patnaik 2. Dr. Sukanta Kumar Tripathy
3. Dr. S. K. Singh 4 Dr. Dillip Ku. Pattanayak 5. Dr. Biswajit Dalai
6. Mrs. Bijayalaxmi Kuanar 7. Mrs. Bijayalaxmi Sahu

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Date:03/06/2020





III SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PHPC	301	Relativistic Quantum Mechanics & Field theory	4	0	0	4
2	PHPE	302	Electronics	3	1	0	4
		303	General Theory of Relativity				
3	PHPE	304	Condensed Matter & Materials Physics-1	3	1	0	4
		305	Nuclear Science-1(NP)				
4	PHCBOE	306	Optical Fiber & Optoelectronics	4	0	0	4
		307	Environmental Physics				
PRACTICAL / SESSIONAL							
5	PHPC	308	Modern Physics, (laboratory)	0	0	6	4
6	PHPC	309	Summer Internship / Seminar & Project-III	0	0	2	2
TOTAL				**14**	**2**	**10**	**22**

IV SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PHPC	401	Elementary Particle Physics	3	1	0	4
2	PHPE	402	Condensed Matter & Materials Physics-2	4	0	0	4
		403	Nuclear Science-2				
3	PHOE	404	Ethics and IPR	4	0	0	4
PRACTICAL / SESSIONAL							
3	PHPE	405	Condensed Matter & Materials Physics, (Laboratory)	0	0	6	4
		406	Nuclear science, (laboratory)				
4	PHPC	407	Major Research Project / Dissertation	0	0	10	8
5	VAC	408	Value added course / MOOCS	-	-	-	-
TOTAL				**11**	**1**	**16**	**24**

PC---Professional Courses, PE---Professional Elective , CBOE---Choice Based Open Elective, OE--- Open Elective, EC---Elective Courses, VAC —Value Added Course, L---- Lectures, T---Tutorial, P--Practical

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SCHEME OF INSTRUCTION SUMMARY

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER				TOTAL CREDITS	%
		I (550 marks)	II (550 marks)	III (550 marks)	IV (600 marks)	Total (2250 marks)	
1	Professional Core (PC)	20	20	8	4	52	58
2	Professional Elective (PE)	-	-	8	8	16	18
3	Open Electives (OE)	-	-	4	4	8	9
4	Project Work, Seminar and/or Internship in Industry or elsewhere	2	2	2	8	14	15
5	Value added Courses/MOOCS	-	-	-	-	-	-
	TOTAL	**22**	**22**	**22**	**24**	**90**	**100**

NB: The students are required to choose one elective paper from PHPE-302 & 303 and another elective paper from PHPE 304 & 305 in 3rd semester. Those who will opt PHPE 304 in 3rd semester, they have to opt PHPE 402 & 404 in 4th semester and who will opt PHPE 305 in 3rd semester, have to opt PHPE 403 & 405 in respective semester. The students are required to choose one other elective paper from PHOE 306 & 307.

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M.Sc. PHYSICS SYLLABUS STRUCTURE

(Choice Based Credit System-2020-22)

Semester	Course	Course Title	Hrs per week L-T-P	Credit L--P	Exam Hrs L -- P	Marks		Total
						Mid Sem	End Sem	
I	PHPC101	Mathematical Methods in Physics	4	4	3	30	70	100
	PHPC102	Classical Mechanics	4	4	3	30	70	100
	PHPC103	Computer programming and numerical analysis	4	4	3	30	70	100
	PHPC104	Quantum Mechanics-I	4	4	3	30	70	100
	PHPC105	Computer programming in Physics, **(Laboratory)**	6	4	6	0	100	100
	PHPC106	Seminar & Project-I	2	2	2	0	50	50
			24	**22**				**550**
II	PHPC201	Classical Electrodynamics	4	4	3	30	70	100
	PHPC202	Basic Nuclear physics	4	4	3	30	70	100
	PHPC203	Solid State Physics	4	4	3	30	70	100
	PHPC204	Quantum Mechanics-II	4	4	3	30	70	100
	PHPC205	Optics, **(Laboratory)**	6	4	6	0	100	100
	PHPC206	Seminar and Technical Writing	2	2	2	0	50	50
			24	**22**				**550**

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(Choice Based Credit System-2020-22)

Semester	Course	Course Title	Hrs per week L-T-P	Credit L ---P	Exam Hrs L --P	Marks		Total
						Mid sem	End Sem	
III	PHPC301	Relativistic Quantum Mechanics& Field theory	4	4	3	30	70	100
	PHPE302	Electronics or	4	4	3	30	70	100
	PHPE303	General Theory of Relativity						
	PHPE304	Condensed Matter & Materials Physics-1 or	4	4	3	30	70	100
	PHPE305	Nuclear Science-1(NP)						
	PHCBOE306	Fiber Optics & Optoelectronics or	4	4	3	30	70	100
	PHCBOE307	Environmental Physics						
	PHPC308	Modern Physics, (laboratory)	6	4	6	0	100	100
	PHPC309	Summer Internship	2	2	0	0	50	50
			26	**22**				**550**
IV	PHPC401	Elementary Particle Physics	4	4	3	30	70	100
	PHPE402	Condensed Matter & Materials Physics-2	4	4	3	30	70	100
	PHPE403	Nuclear Science-2(FT &PP)						
	PHOE404	Ethics & IPR	4	4	3	30	70	100
	PHPE405	Condensed Matter & Materials Physics, (Laboratory)	6	4	6	0	100	100
	PHPE406	Nuclear science, (laboratory)						
	PHPC407	Major Project / Dissertation	10	8	0	0	200	200
	VAC408	Value added course	-	-	-	-	-	-
			28	**24**				**600**
Grand Total			**102**	**90**				**2250**

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Course Code:	PHPC101	No. of Credits:	4
Course Name:	MATHEMATICAL METHODS OF PHYSICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1 : To focus on partial derivative and its methods.
CEO2 : To make them understand about Laplace and Fourier transform.
CEO3 : To calculate the gradients and directional derivatives of functions of several variables
CEO4 : To introduce the concept of Vector differentiation and integration that finds applications in various fields like solid mechanics, fluid flow, heat problems and potential theory

Course Outcomes:
Upon successful completion of this course, students should be able to:

CO1: Explain about the complex variable and to solve different contour integrals.
CO2: Understand the concepts of tensor analysis and representation.
CO3: Develop a complete idea about the group theory and group representations.
CO4: Acquire information on special functions for various applications in physical problems.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Complex Analysis **[10 Hours]**

Analytic functions, Contour integrals, Laurent's series, the residue Theorem, improper integration, evaluation of single and multivalued functions, branch points and branch cuts, Contour integration involving branch point.

Unit-II Tensor Analysis **[10 Hours]**

Introduction, Types of tensor, Invariant tensor, epsilon tensor, Pseudo tensor, Algebra of tensor, Quotient law, Covariant derivative of tensor, Fundamental Tensor, Cartesian tensor, Christoffel symbol.

`Unit-III Group Theory **[10 Hours]**

Definition of groups, subgroups and classes, Types of groups, Cayley's theorem, Group representations, characters, irreducible representations of SU(2) and O(3) groups.

Unit-IV (Self Study)
Mathematical transformations and Special Functions **[10 Hours]**

Fourier transform and Laplace transform, Legendre Polynomials, generating functions, Recurrence formulae, orthogonal of Legendre's polynomial, Bessel generating function, Recurrence formula, orthogonality properties of Bessel's polynomials.

Text books:

1. Mathematical Methods of Physics by Mathews and Walker (W. A. Benjamin Inc.)
2. Elements of Group Theory by A. W. Joshi (New Age International Publisher)
3. Matrices and Tensors in physics by A. W. Joshi (New Age International Publisher)
4. Mathematical Methods for Physicist by G. Arfken and H. Weber, Academic Press (Elsevier)

Reference Books:

1. Mathematical Physics by B. D. Gupta (Vikas Publishing House)
2. Mathematical Physics by P. K. Chattopadhyaya (New Age International)

Course Code:	PHPC102	No. of Credits:	4
Course Name:	CLASSICAL MECHANICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1: To interpret the concepts of Hamiltonian Mechanics.
COE2: To explain generating function, canonical transformation & Poisson brackets.
COE3: To illustrate the dynamics of a rigid body and non-inertial frames of reference.
COE4: To formulate the concepts of coupled oscillators.

Course Outcomes:
Upon successful completion of this course, students should be able to:

CO1: The Lagrangian and Hamiltonian approaches in classical mechanics.

CO2: The classical background of Quantum mechanics and get familiarized with Poisson brackets and Hamilton -Jacobi equation

C03: Kinematics and Dynamics of rigid body in detail and ideas regarding Euler's equations of motion

CO4: Theory of small oscillations in detail along with basis of Free vibrations.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Rigid body kinematics and dynamics [10 Hours]

Generalized co-ordinates for rotation, rotation as orthogonal transformation, general motion of a rigid body, Euler- angles, angular momentum and kinetic energy of rotation in terms of the Euler-angles, rate of change of a vector, inertia tensor and moments of inertia, Euler's equations of motions, motion of a heavy symmetrical top, coriolis force.

Unit-II Hamiltonian formulation [10 Hours]

Survey of elementary principles: review of the Newtonian mechanics, constraints, D'Alembert's principle, Lagrange's equation, its application to simple problems. Variational Principles and Lagrange's equations: calculus of variations, Hamilton's principle, derivation of Lagrange's equation from Hamilton's principle, its application, Hamilton's equation of motion: Legendre transformations and Hamilton's equation, cyclic coordinates, Routh's procedure, physical significance of Hamiltonian

Unit-III Canonical Transformations [10 Hours]

Types of Generating Function, conditions for canonical transformation, Integral Invariance of Poincare, Poisson Bracket and Lagrange Bracket, Poisson and Lagrange Brackets as Canonical Invariant, , Liouville's theorem .

Hamilton Jacobi Theory: Hamilton-Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator and Kepler problem by Hamilton-Jacobi Method, Action-Angle Variables for completely Separable System, Kepler Problem in Action-Angle Variables.

Unit-IV (Self Study) [10 Hours]

Formulation of the problem, example of two coupled oscillators, eigenvalue equation, principal axis transformation, normal coordinates & normal mode of vibration, free vibration of triatomic molecule

Text book:

1. Classical Mechanics- by H. Goldstein (Addison-Wesley)

Reference books:

1. Classical Mechanics by S. N. Biswas, Books and allied Publisher Ltd.
2. Classical Mechanics by J.C. Upadhya, Himalaya Publishing House.
3. Classical Mechanics by Landau and Liftshitz (Butter Worth)

Course Code:	PHPC103	No. of Credits:	4
Course Name:	COMPUTER PROGRAMMING AND NUMERICAL ANALYSIS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1 : To focus on concept of C-Programming and C-Programs problems.
CEO2 : To make them understand about numerical analysis and matrices.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1: Understand C programming and execute sub program.
CO2: Construct C programming based upon Numerical methods.
CO3: Explain numerical analysis and solve mathematical problems.
CO4: Interpret interpolation, approximation, numerical differentiations and integration.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: C-Programming: [10 Hours]

Data types, expressions, statements, input and output commands, conditional and interactive constructs (control statements), character and data managements, array manipulations, User defined functions.

Unit-II: C-Programs problems: [10 Hours]

Numerical integrations by trapezoidal and Simpson method, finding the root of an equation by Newton-Raphson method, finding prime numbers, Runga-Kutta method, interpolation sorting, matrix inversion, Matrix addition, subtraction, and multiplication .

Unit-III:Numerical Analysis -I: [10 Hours]

Error and types of error, Solution of simultaneous linear equations, Gaussian elimination, Pivoting, Iterative Method, Matrix Inversion, Root of a transcendental equation by Newton- Rapson Method, Bi section method, Iteration method, Least square fitting(first order and second).

Unit-IV (Self Study) Numerical Analysis-II: [10 Hours]

Eigen values and eigenvectors of matrices, power and Jacobi method, Finite Differences, Interpolation with equally Spaced and unevenly spaced points (Newton's and Lagrange's method), Forward and Backward Interpolation, Extrapolation, Numerical Integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method, Euler method.

Text books:

1. Fundamentals of Computers by V. Rajaraman, Prentice Hall of India Ltd Publishers
2. Numerical Mathematical Analyses by J. B. Scarborough, Oxford and IBH Publishing Company.

Reference Books:

1. Numerical methods for engineering and scientific computation by M K Jain (Wiley Eastern)
2. Computer programming in Fortran-77 by V. Rajaraman, Prentice Hall of India Ltd Publishers.

Course Code:	PHPC104	No. of Credits:	4
Course Name:	QUANTUM MECHANICS-I	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1: Providing fundamental knowledge about the operators and to familiar with different quantum picture and properties of materials.
CEO2: Providing knowledge of mathematical concepts and angular, spin and total operator angular momentum operators.

Course Outcomes:

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

CO1: Know basic principles of quantum mechanics and operator formulation of quantum mechanics
CO2: Understand the idea of wave function and different pictures.
CO3: Understand Rotation and Orbital Angular Momentum
CO4: Understand Spin angular momentum and total angular momentum

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Operator Method in Quantum Mechanics: [12 Hours]

Linear vector space[Hilbert space], Dirac's Ket and Bra notations & its properties, Scalar product of vectors and their properties, Dirac delta function, Different types of operators: linear operators, Adjoint operators, Unitary Operators, Expectation values of dynamical variables and physical interpretation of Hermitian operators, Eigen values and eigen vectors, orthonormality of eigen vectors, probability interpretation, Degeneracy, Schmidt method of orthogonalisation,
Expansion theorem, Completeness and closure properties of the basis set, Coordinate and momentum representations, compatible an Incompatible observables, Commutator algebra, uncertainty relation as a consequence of non- commutability, minimum uncertainty wave packet, Representations of Ket and Bra vectors[Dual space]

Unit-II Matrix Formulation of QM and Quantum Dynamics: [12 Hours]

Linear Transformations, Matrix form of an operator , Change of Basis, Similarity and Unitary transformation of basis vectors and operators. Schrodinger Equation and the Eigenvalue problem: Energy Representation.
Time evolution of quantum states, Time evolution operator and its properties, Schrödinger picture, Heisenberg picture and Interaction picture, comparison of three pictures, Symmetry principle and conservation laws, the one dimensional Harmonic oscillator in Matrix method, Matrix representation and time evolution of creation and annihilation operators

Unit-III Orbital Angular Momenta and their properties: [8 Hours]

Orbital angular momentum operators as generators of rotation, L_x, L_y, L_z and L^2 and their Commutation relations, Raising and Lowering operators (L_+, L_-), L_x, L_y, L_z and L^2 in spherical Polar coordinates, Eigen values and Eigen functions of L_z and L^2 (operator method), Matrix representation of L_x, L_y, L_z and L^2

Unit-IV (Self Study)
Spin and Total Angular momentum and their properties: **[8 Hours]**

Spin ½ particles, Pauli spin matrices and their properties, Eigen values and Eigen functions, Spin and rotations.
Total angular momentum: Total angular momentum J, Eigen value problem of J_z and J^2, Angular momentum matrices, Addition of angular momentum and C. G. coefficients for the states with (i) $j_1 = ½$ and $j_2 = ½$ (ii) $j_1 = 1$ and $j_2 = ½$.
Recursion relation of C.G coefficients.

Text book:

1. Quantum Mechanics concepts and Applications by Nouredine Zettili, John Wiley and sons, Publications

Reference books:

1. Quantum Mechanics by L. I. Schiff, International Student edition.
2. Quantum Mechanics by D. Griffith, Pearson Publishers.
3. Quantum Mechanics by S. Gassiorowicz, John Willey edition.
4. Quantum Mechanics by Eugene Merzbecher, Willey International Edition

Course Code:	PHPC105	No. of Credits:	4
Course Name:	COMPUTER PROGRAMMING IN PHYSICS (Laboratory work)	Sem End Exam	100

Course Educational Objectives:
This course enables the students:

CEO1 : To focus on programming of numerical problems
CEO2 : To make them understand programming techniques.

Course Outcomes:

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

CO1: Know basic principles c programming
CO2: Understand the idea of program writing .
CO3: Understand the numerical programs
CO4: Understand the writing and develop the c programs for numerical programs.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										

LIST OF THE EXPERIMENTS/PROGRAMMINGS/TASKS:

1. Numerical integration by trapezoidal method
2. Numerical integration by Simpson method
3. Solution of first and second order differential equation by Runga Kutta Method
4. Matrix addition, subtraction, multiplication and manipulation
5. Matrix inversion
6. Finding the roots of an equation by Newton-Rapson method
7. Least square fitting of linear parameters
8. Determination of prime numbers.
9. To arrange a set of numbers in increasing or decreasing order
10. Sum of A.P and G.P series, Sine and Cosine series
11. Factorial of a number
12. Evaluation of log and exponentials by summing of series
13. Any other suitable programs

Course Code:	PHPC106	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-I	End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

SEMESTER-II

Course Code:	PHPC201	No. of Credits:	4
Course Name:	CLASSICAL ELECTRODYNAMICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:

This course enables the students:

CEO1: Introducing the mathematical tools used in electrodynamics
CEO2 : Teaching basic principles of waveguides and transmission lines.
CEO3: Rendering insights into fields generated by oscillating sources, and their applications

Course Outcomes:

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

CO1: After taking this course, students are able to appreciate the need and necessity of four vector notation. They have applied it for Lorentz transformation and written the dual field tensor which is one of the major aspects of theoretical physics

CO2: They have understood the difference between covariance and invariance of various quantities and applied it.

CO3: One of the major advantages of this course is that it is very much related to the real life where the ionosphere is playing very important part.

CO4: Students now know the basics of scattering and absorption and relate them to real life phenomena.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: Electromagnetic Waves [10 Hours]

Wave equation, Plane waves in free space and isotropic dielectrics, Energy transmitted by a plane wave, Waves in conducting media, Skin depth. Reflection and Refraction of electromagnetic waves at plane interface, relations. Reflection and transmission coefficients, EM wave guides, TE, TM and TEM waves, Rectangular wave guides. Energy flow and attenuation in wave guides.

Unit-II: Electromagnetic Radiation [10 Hours]

Field of a uniformly moving electron, Lienard-Wiechart potential, Convection potential, Radiation from an accelerated charge, Fields of an accelerated charge radiation at low velocity, Larmor formula, radiation from circular orbits.

Unit-III: Scattering and dispersion [10 Hours]

Radiative damping of a charged harmonic oscillator, forced vibrations, scattering by an individual free electron, scattering by a bound electron, absorption of radiation by an oscillator, equilibrium between an oscillator and a radiation field, effect of a volume distribution of scatters, scattering from a volume distribution, Rayleigh scattering, the dispersion relation.

Unit-IV (Self Study) Plasma physics [10 Hours]

Introduction to plasma, Quasineutrality of a plasma, Plasma behavior in a magnetic field, Magnetohydrodynamics, Magnetic confinement-pinch effect, Instabilities, Plasma wave, Reflection from a plasma(Ionosphere).

Text book:

1. Classical Electricity and Magnetism by W. K. H. Panofsky and M. Phillips (Addition-Wesley**)**

Reference books:

1. Classical Electrodynamics- J.D. Jackson, John Wiley and Sons.
2. Introduction to electrodynamics- D.J. Griffiths, Pearsons Publishers.
3. Lorrain, P. and Corson, D., *Electromagnetic Fields and Waves*, CBS Publishers, 2003.

Course Code:	PHPC202	No. of Credits:	4
Course Name:	BASIC NUCLEAR PHYSICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives

This course enables the students:

CEO1 : To focus on nuclear properties and nuclear scattering problem

CEO2 : To make them understand about nuclear **r**eactions and nuclear models

Course Outcomes:
Upon successful completion of this course, students should be able to:

CO1: Know properties of the atomic nucleus and deuteron

CO2: Understand processes of nuclear scattering and nuclear reactions.

CO3: Understand nuclear energy.

CO4: Describe basic models of the atomic nucleus

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: Nuclear Properties [10 Hours]

Nuclear Radius, Nuclear Mass and Binding Energy, Angular Momentum, Parity and Symmetry, Magnetic Dipole Moment and Electric Quadruple Moment.
Two Nucleons Bound State Problem: Central and non central force, the deuteron, tensor forces, magnetic moment and quadruple moment of deuteron.

Unit-II:Nuclear Scattering Problem [10 Hours]

Fundamental terms related to Scattering, n-p scattering at low energy, scattering cross section and scattering length, effective range theory. Meson theory of nuclear force and Yukawa interaction.

Unit-III:Nuclear Reactions [10 Hours]

Nuclear reaction and resonances, Breit-Wigner formula for s-waves, compound nucleus.
Nuclear Energy: Liquid drop model, Bohr-Wheeler theory of fission, nuclear fusion

Unit-IV (Self Study) Nuclear Models [10 Hours]

Single particle model of nucleus, magic numbers, spin-orbit coupling, angular momenta and parities of nuclear ground states, magnetic moments and Schmidt lines, Collective model of Bohr and Mottelson.

Text Book:

1. Nuclear Physics by R.R. Roy and B.P. Nigam (John Wiley)
2. Introductory Nuclear Physics, Kenneth S. Krane, Wiley

Reference Books:

1. Physics of the nucleus by M.A. Preston (Addison-Wesley)
2. Nuclear Physics by S.S.M. Wong (Prentice Hall)
3. Introduction to Nuclear Physics by Von H. A. Enge (Addison-Wesley)
4. Atomic and nuclear physics. 2. Nuclear physics, S. N. Ghoshal, S. Chand Limited.

Course Code:	PHPC203	No. of Credits:	4
Course Name:	SOLID STATE PHYSICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:

This course enables the students:

CEO1 : To focus on crystal binding and specific heat of insulators
CEO2 : To make them understand about energy bands and semiconductor crystals

Course Outcomes:

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

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1: Understand types of bonding and crystal vibration. *Solid State Physics*
CO2: Explain about specific heat of insulators and thermal conductivity of metal

CO3: Illustrate about the energy band and classification of materials on band theory.
CO4: Know basic information about semiconductor crystals and classification of crystal defects.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: Crystal Binding: **[10 Hours]**

Crystals of inert gases, Ionic crystals, covalent crystals, cohesive energy of ionic crystals, Madelung constant, Hydrogen bonded crystals, Vander wall's interaction, Metallic Bonds, Lattice Dynamics-Vibrations of a mono atomic linear chain, Vibration of a diatomic linear chain, Dispersion relations, Acoustic and Optic modes, Long-wavelength limits

Unit-II: Specific heat of insulators: **[10 Hours]**

Phonon heat Capacity, Debye model for density of states, Debye T^3 law, Einstein's theory of the specific heat Free Electron Fermi gas-Energy levels in one-dimension, Effect of temperature on the Fermi-Dirac distribution function, Free electron gas in three dimension, Heat Capacity of the electron gas, Electrical conductivity and Ohm's law, Motion in magnetic fields, Static magneto-conductivity tensor, Hall effect, Thermal conductivity of metals, Wiedemann- Franz law

Unit-III: [self study] **Energy bands:** **[10 Hours]**

Nearly free electron model, origin of the energy gap, Bloch functions, Kronig-Penney model, Wave equation of electron in a periodic potential, restatement of Bloch theorem, solution of the central equation, approximate solution near a zone boundary, number of orbitals in a band, metals and insulators

Unit-IV: Semiconductor crystals: **[10 Hours]**

Band gap, Electrons and Holes, effective mass, intrinsic carrier concentration and fermi levels of intrinsic and extrinsic semiconductors Band gap. Direct and indirect gap semiconductors. intrinsic mobility, impurity conductivity, donor states, acceptor states, thermal ionization of donors and acceptors.

Defects -Classification of defects, Point defects- Schottky and Frenkel defects, Line defects-Dislocation, Diffusion and ionic conductivity. Dielectrics-Types ,local electric field at an atom, Lorentz field, field of dipoles inside cavity, dielectric constant and polarisability-Claussius-Mossotti relation, Mechanisms of electronic, ionic and orientational polarisability. Piezoelectric ,pyroelectric and ferroelectric materials.

Text book:

1. Introduction to Solid State Physics by C. Kittel, 7^{th} edition, (John-Wiley, 1996)

Reference books:

1. Introduction to the theory of Solid State Physics by J. D. Patterson (Addison-Wesley,1971)
2. Solid State Physics by N. W. Ashcroft and N. D. Mermin , (Harcourt Asia PTE Ltd.)
3. Physics of Condensed Matter by Prasanta K.Misra (Academic Press, 2010)

Course Code:	PHPC204	No. of Credits:	4
Course Name:	QUANTUM MECHANICS-II	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives

This course enables the students:

CEO1 : To focus on three dimensional problems and approximate methods.

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CEO2 : To know about the perturbation method and scattering problems.

Course Outcomes:

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

CO1: Express the basic mathematical concepts of spherically symmetric field and their representations and to get the ideas of degeneracy.

CO2: Provide adequate knowledge on various approximate methods to solve quantum mechanical problems.

CO3: Illustrate about the variational methods and WKB methods to solve quantum mechanical problems.

CO4: Acquire basic information about the scattering problems and to solve various scattering problems.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Three Dimensional Problems: [10 Hours]

Spherically symmetric system: Hydrogen atom, Reduction to equivalent one body problem, radial equation, Energy Eigen values and Eigen functions, Degeneracy, Radial probability distribution, solution for Angular parts, free-particle problem, Expression of plane waves in terms of spherical waves. Solution of Three dimensional Harmonic Oscillator in spherical harmonics.

Unit-II Approximation methods: [10 Hours]

Stationary perturbation theory[Non-Degenerate case], Rayleigh Schrodinger method for non-degenerate case, first and second order perturbation, anharmonic oscillator, general theory for the degenerate case, removal of degeneracy, Normal Zeeman effect.

Stationary perturbation theory[Degenerate case]: linear Stark effect in hydrogen atom.

Unit-III Time-dependent perturbation theory: [10 Hours]

Variational method: Ground state of He atom, Transition probability, constant and harmonic perturbation, Fermi Golden rule. W. K. B. method: connection formulas, Bohr-Sommerfeld quantization rule, Harmonic oscillator and cold emission.

Unit-IV Quantum Theory of Scattering: [10 Hours]

Scattering amplitude and scattering cross section, Born approximation, application to Coulomb and screened Coulomb potentials, Partial wave analysis for scattering, optical theorem, scattering from a hard sphere, resonant scattering from a square well potential, Scattering of Identical particles, Symmetric and antisymmetric wave function, Coulomb and exchange interactions

Text book:

1. Quantum Mechanics concepts and Applications by Nouredine Zettili, John Wiley and sons, Publications

Reference books:

1. Quantum Mechanics by L. I. Schiff, International Student edition
2. Quantum Mechanics by D. Griffith, Pearson Publishers
3. Quantum Mechanics by S. Gasiorowicz, John Wiley edition
4. Quantum Mechanics by Eugene Merzbacher, Wiley International Edition

Course Code:	PHPC205	No. of Credits:	4
Course Name:	OPTICS (LABORATORY WORK)	Sem End Exam	100

Course Educational Objectives:
This course enables the students:
CEO1 : To focus on experiments on interference.
CEO2: To focus on experiments on diffraction.
CEO3: To focus on experiments on polarization.

Course Outcomes:

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

CO1: Understand the basic optical instruments and uses

CO2: Set the optical experiments

CO3: Determine the specific parameters using optical methods
CO4: Study the characteristics of polarization experiments

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										

LIST OF EXPERIMENTS:

1. Experiments with optical bench : Bi-prism
   Straight edge and narrow wire

2. Experiments with spectrometer: Single and Double split
3. Experiments with Michelson

4. interferometer : Determination of A and α
   Thickness of mica sheet
5. Fabry Perot interferometer

6. Polarization Experiments Babinet compensator Edsar-Butlerbands Quarter wave plate Mallus Law
   Study of elliptical polarized light

7. Constant Deviation Spectrography Calibration
   Zeeman effect
8. Babinet Quartz Spectrography

9. Any other suitable experiments

Course Code:	PHPC206	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-II	End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

SEMESTER-III

Course Code:	PHPC301	No. of Credits:	4
Course Name:	RELATIVISTIC QUANTUM MECHANICS AND FIELD THEORY	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives

This course enables the students:

CEO1 : To make them understand about relativistic quantum mechanics and spin orbit theory.

CEO2 : To provide an overall idea about the different fields and quantization.

Course Outcomes:

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

CO1: Understand the concept of Relativistic quantum mechanics and to develop the appropriate Schrödinger's equation to solve quantum mechanical problems.

CO2: Illustrate the Dirac equation and to get the ideas about the spin orbit coupling.

CO3: develop the important concepts of Quantum field theory and to solve problems of various fields.

CO4: Acquire basic information, methods from field quantization and to solve various field theory problems.

Mapping of COs with POs :

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Relativistic quantum mechanics: **[10 Hours]**

Brief introduction to Relativistic quantum mechanics, Notations, Klein-Gordon equation, K.G equation in the presence of electromagnetic field, application of K.G equation to hydrogen atom.and its drawbacks, Charge and current densities, Positive and negative energy states, Dirac's Hole theory, Free particle Dirac equation, Properties of the Dirac matrices, Continuity Equation, Spin of the electron,

Unit-II Spin-Orbit Theory: **[10 Hours]**

Plain wave solutions of Dirac Equation, Normalization of the wave functions, Dirac equation in an electromagnetic field, its non-relativistic correspondence, magnetic moment, Dirac equation for a central potential, spin-orbit coupling, Covariant form of the Dirac equation, Proof of its Lorentz covariance, Properties of the gamma-matrices.

Unit-III Elements of Classical Theory of Fields: **[10 Hours]**

Concept of fields, transition to Quantum field from Classical MechanicsClassical field equation, Real Scalar Field, Complex Scalar Field, Dirac Field, Schrodinger field, Maxwell field, Proca field , Noether's theorem and conservation laws, Gauge invariance and charge conservation ,

Unit-IV Quantization Fields: **[10 Hours]**

Quantum field theory, Quantization of Real scalar field, complex scalar field, Quantization procedure, Lagrangian Formulation, Hamiltonian formulation. Quantum field equation, Second Quantization, Creation, Annihilation and number operators

Field Quantization: (a) neutral scalar meson field (b) charged scalar meson field (c) Dirac field.

Text Book:

1. Relativistic quantum field theory by J.D. Bjorken and S.D. Drell , Mc Graw-Hill Book Company

Reference Books:

1. Lectures on Quantum Field Theory, Ashok Das, (World Scientific Publishing Co. Pvt. Ltd).
2. Introduction to quantum field theory by P. Roman
3. Quantum Mechanics and Field Theory by B.K. Agarwal, Asia Publishing House.

Course Code:	PHPE302	No. of Credits:	4
Course Name:	ELECTRONICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:

This course enables the students:

CEO1 : To focus on the different types of amplifier and FET,MOSFET and acquire different types of oscillatory circuits with applications.
partial derivative and its methods.
CEO2 : To focus on Operational amplifier and applications and explain about the digital circuits with logic fundamentals

Course Outcomes:

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

CO1: Understand about the different types of amplifier and FET, MOSFET.
CO2: Acquire different types of oscillatory circuits with applications.
CO3: Illustrate on Operational amplifier and applications.
CO4: Explain about the digital circuits with logic fundamentals.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I *AMPLIFIERS:* **[10 Hours]**

Transistors, Two-port network analysis, Hybrid parameters, transconductance model, Frequency response of linear amplifiers, RC and Transformer coupled amplifiers, gain bandwidth product, feedback amplifiers, effects of negative feedback, FET :Basic operation ,pinch off and saturation, ideal dc current voltage relation, MOSFET :Basic structure, principle, mechanism of operation, current voltage relation and applications, Boot-strapping the FET.

Unit-II *OSCILLATOR CIRCITS:* **[10 Hours]**

Basic principle of oscillators, Feedback criteria for oscillation, Nyquist criterion, analysis of Phase shift oscillator, Wien-Bridge oscillator, and Crystal controlled oscillator.

Unit-III *OPERATIONALAMPLIFIERS:* **[10 Hours]**

The differential amplifier, DC and AC signal analysis, integral amplifier, rejection of common mode signals, CMMR, The operational amplifier, input and output impedances, Application of operational Amplifiers, unit gain buffer, summing, integrating amplifier, Comparator, Operational amplifier as a differentiator

Unit-IV *DIGITAL CIRCUITS:* **[10 Hours]**

Logic fundamentals, Boolean theorem, Logicgates: AND, OR, NOT, NOR, NAND XOR, and EXNOR. - RTL, DTL and TTL logic, Flip-flop, RS-and JK-Flip flop, thevenins theorem, A/D(Dual slope) and D/A Convertors(weighted register and R-2R ladder type).

Text Book:

1. Electronic fundamental and application by J.D. Ryder, PHI, Learning Pvt Ltd.

References:

1. Foundation of electronics – Chattopadhyay, Rakshit, Saha and Purkait , New age International publisher
2. Electronics principles-Albert Malvino, Tata Mc Graw-Hill Edition
3. Modern Digital Electronics-R.P Jain, Tata Mc Graw-Hill Edition

Course Code:	PHPE303	No. of Credits:	4
Course Name:	GENERAL THEORY OF RELATIVITY	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:

This course enables the students:

CEO1 : To focus on Special theory of relativity
CEO2 : To make them understand about Einstein's field Equations
in various fields like solid mechanics, fluid flow, heat problems and potential theory

Course Outcomes:

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

CO1: Understand about Special theory of relativity and Lagrangian and Hamiltonian of a relativistic particle
CO2: Acquire knowledge on Equivalence Principle, The Weak and Strong Principle of Equivalence
CO3: Illustrate on the Newtonian Limit.
CO4: Explain about the and Red shift of spectral lines

Mapping of COs with POs :

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: **[10 Hours]**

Special theory of relativity: Lorentz transformations; 4-vectors, Tensors, Transformation properties, Contraction, Symmetric and antisymmetric tensors; 4-dimensional velocity and acceleration; four-momentum and four-force; Covariant equations of motion; Relativistic kinematics (decay and elastic scattering); Lagrangian and Hamiltonian of a relativistic particle.

Unit-II: **[10 Hours]**

The Equivalence Principle, The Weak and Strong Principle of Equivalence, The Equation of Motion in presence of Gravitational Forces, The affine connection, The Metric Tensor $g_{\mu u}$, Relation between Metric Tensor and Affine Connection, The Transformation of Affine Connection, Covariant derivatives.

Unit-III: **[10 Hours]**

The Newtonian Limit: Relation between g_{OO} and the Newtonian potential, Time Dilation in a Gravitational Field, Red shift of spectral lines, The Solar Red Shift.

Unit-IV: **[10 Hours]**

Definition of Curvature tensor, Algebraic Properties of the curvature Tensor, Ricci Tensor and Curvature Scalar, Bianchi identities.
Einstein's field Equations, Energy, Momentum and Angular momentum of gravitation.

Text Books:

1. Special theory of relativity, Robert Resnick, Oxford University
2. Gravitation and Cosmology by Steven Weinberg, Jon Wiley and Sons

Reference Books:

1. Introducing Einstein’s Relativity by Ray D. Inverno, Clarendon Press
2. An Introduction to General Relativity and Cosmology by Tail. Chow, Springer
3. Principles of Cosmology and Gravitation by M. Berry, Cambridge University
4. Special theory of relativity, Robert Katz D. Van, Nostrond Company, INC

Course Code:	PHPE304	No. of Credits:	4
Course Name:	CONDENSED MATTER AND MATERIALS PHYSICS-1	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:
This course enables the students:

COE1: Acquire knowledge of the behavior of electrons in solids based on classical and quantum theories.
COE2: To develop an understanding of the dielectric properties and ordering of dipoles in ferroelectrics.
COE3: To get familiarized with the different parameters associated with superconductivity.
COE4: To be familiarized with the change in density of states as a function of physical dimension of solids

Course Outcomes:

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

CO1: Explain the concepts of Quantization of lattice vibration and methods of band calculations.
CO2: Understand and solve problems of electron-electron interaction with general theory formulation.
CO3: Illustrate the concepts, theories and elaborate about the superconductivity.
CO4: Express the basic concepts of advanced and high temperature superconductors.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Lattice Vibrations and Thermal Properties: [10 Hours]

Vibration of lattice with monoatomic and diatomic basis: Dispersion relation, optical and acoustical branches. Quantization of elastic waves: Phonon, Classical theory of Specific heat. Average energy of harmonic oscillator, Phonon Density of states. Einstein and Debye models of specific heat. Electronic contribution to specific heat. Anharmonic effect: thermal expansion, Phonon collision process, Thermal conductivity

Unit-II Electron-electron interaction: [10 Hours]

Hartree approximation, Hartree-Fock approximation, Hartree-Fock theory for jellium Density functional theory-general formulation, Local Density approximation

Unit-III Superconductivity: [10 Hours]

Experimental survey, Meissner effect, Type-I and Type-II superconductors, thermodynamics of superconductors, London‟s theory, Electron-electron attractive interaction due to virtual phonon exchange, Cooper pairs and BCS Hamiltonian. Superconducting ground state and the gap equation at T = 0 K.

Unit-IV Advanced Superconductivity: [10 Hours] self study

Electron-phonon interaction, Microscopic theory of superconductivity, Quasi lectrons, Cooper pairs, BCS theory, Ground State of superconducting electron gas, elementary ideas of high T_c superconductors. High Tc superconductors**:** Basic ideas and applications

Text book:

1. Physics of Condensed Matter By Prasanta K.Misra(Academic Press, 2010)
2. Quantum Theory of Solid State by J. Callaway, Academic Press

Reference books:

1. Principles of the theory of solids, J.M.Ziman, Cambridge, University press
2. Solid State Physics By C. Kittel, John Wiley and sons, Ins Singapore.

Course Code:	PHPE305	No. of Credits:	4
Course Name:	NUCLEAR SCIENCE-1	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:
This course enables the students:

CEO1 : To focus on Rotational invariance in three dimensions.
CEO2 : To make them understand about Optical models

Course Outcomes:

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

CO1:Explain the concepts of Clebsch-Gordon coefficients
CO2: Understand Optical model, deuteron stripping
CO3: Illustrate the concepts, theories of Collective Vibrational modes of a spherical nucleus
CO4: Express the basic concepts of Rotational spectra of even-even nuc.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: **[10 Hours]**

Rotational invariance in three dimensions, eigen values and eigen functions of angular momentum operators, explicit representation of the rotation matrices, addition of angular momenta, Clebsch-Gordon coefficients, irreducible spherical tensor, matrix element of tensor operators, Wigner-Eckart theorem

Unit-II: **[10 Hours]**

Optical model, deuteron stripping and pick-up reaction, Elementary ideas of Brueckner theory

Unit-III: **[10 Hours]**

Collective Vibrational modes of a spherical nucleus, collective oscillations, quadruple deformation, Expression for moment of inertia.

Unit-IV: self study **[10 Hours]**

Rotational spectra of even-even nuclei, coupling of a particle and collective motion, electric quadruple moments, magnetic dipole moments

Text Book:

1. Nuclear Physics by R.R. Roy and B.P. Nigam, John Wiley

Reference Books:

1. Physics of the nucleus by M.A. Preston, Addison Wesley.
2. Nuclear Physics by S.S.M. Wong, Prentice Hall.
3. Introduction to Nuclear Physics by H. A. Enge, Addison Wesley
4. Structure of the Nucleus by M. A. Preston and R K Bhaduri, Addison Wesley

Course Code:	PHCBOE306	No. of Credits:	4
Course Name:	OPTICAL FIBERS & OPTOELECTRONICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1 : To focus on structure of optical fiber and signal degradation.

CEO2 : To provide on knowledge on connector, couplers, splices and optoelectronic devices

Course Outcomes:
Upon successful completion of this course, students should be able to:

CO1: Classify the structures of Optical fibers and Fabrication method.

CO2: Discuss the losses and signal degradation in optical fiber.

CO3: Classify the Optical sources and detectors and to discuss their principles.

CO4: Perform characteristics of optical fiber, sources, detectors and Optical Amplifier

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Optical fiber: [10 Hours]

Optical fiber structure: Step Index Fiber, Graded Index Fiber, Transmission of light through cylindrical waveguide by using electromagnetic theory.

Single mode and multimode fibers, modal concept, modes in step index and graded index fiber, V-number, power flow in Step Index fiber. Different types of fiber, Elementary idea on Fiber Materials, Fabrication method: Double Crucible Method, fiber optic Cables, Photonic crystal fiber and Fiber Bragg Grating

Unit-II Signal degradation in Optical Fiber: [10 Hours]

Attenuation, Absorption, bending Loss, Scattering Loss, Core Cladding losses, dispersion losses, Material dispersion, waveguide dispersion, Modal dispersion, Signal distortion in single mode fibers, Design of optimization of single mode fibers. Dispersion shifted and Dispersion flattened fiber.

Unit-III Connector, Couplers and Splices: [10 Hours]

Connector and splice, losses during coupling between source fibers, fiber to fiber, Lensing scheme for coupling improvement, Joint losses, multimode fiber joints, single mode fiber joint, Fusion splice, Mechanical Splices, Multimode splices, connector and couplers.

Unit-IV Optoelectronic devices: [10 Hours]

Principle of optical sources, Source material, Choice of materials, Integral and external quantum efficiency of LED, Structures, Types of LED: Surface emitting LED, Edge emitting LED, Modulation capability, emission pattern, power bandwidth product, Threshold condition, resonant frequency, Laser Diode Structure, Brief description of principle of optical detectors, Photomultipliers: PN,PIN and APD configuration, Photo detector noise, Noise sources, SNR, Detector response time. Optical amplifier, Semiconductor Optical amplifier (SOA), Fiber Amplifier, Rare Earth doped Fiber Amplifier, Raman and Brillion Amplifier, Expression for gain and Noise figure. (SOA only)

Textbooks:

1. R.P.Khare, Fiber Optics and Optoelectronics, Oxford University Press
2. Ajoy Ghatak and K.Thyagarajan, An Introduction to Fiber Optics, Cambridge University Press

Reference Books

1. G. Keiser, Optical Fibre Communications, Mc-Graw-Hill.
2. J. M. Senior, Optical Fibre Communications Principles and Practice, PHI.

Course Code:	PHCBOE307	No. of Credits:	4
Course Name:	ENVIRONMENTAL PHYSICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1 : To focus on human environment, atmosphere and radiation
CEO2 : To provide knowledge on wind and energy for living

Course Outcomes:

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

CO1: Understand the basic principles of laws of thermodynamics and the human body, Energy and metabolism
CO2: Describe Structure and composition of the atmosphere and Greenhouse effect.
CO3: Acquire knowledge on Physics of wind creation and Global convection
CO4: Provide adequate working knowledge and explain about Global wind patterns: Hydroelectric power, Tidal power, Wind power.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

UNIT-I The human environment: [10 Hours]

Laws of thermodynamics: First law, Second law and third law of thermodynamics, Laws of thermodynamics and the human body, Energy and metabolism: First law of thermodynamics and the human body, Second law of thermodynamics and the human body, Energy transfers: Conduction, Convection, Radiation, Evaporation, survival in cold climates, Survival in hot climates

UNIT-II Atmosphere and radiation: **[10 Hours]**

Structure and composition of the atmosphere: Residence time Photo chemical pollution, Atmospheric aerosol, Atmospheric pressure, Escape velocity,
Ozone : Ozone hole ,Ozone in polar region, Terrestrial radiation, Earth as a black body: Greenhouse effect, Greenhouse gases, Global warming.

UNIT-III Wind: [10 Hours]

Measuring the wind, Physics of wind creation: Principal forces acting on air masses Gravitational force, Pressure gradient, Coriolis inertial Force, Frictional force, Cyclones and anticyclones : Global convection, Global wind patterns.

UNIT-IV Energy for living: [10 Hours]

Global wind patterns: Hydroelectric power, Tidal power, Wind power, Wave power, Biomass, Solar power, Solar collector, Solar photovoltaic.

Text Book:

1. Enviormental Physics by M. Dželalija, University of Molise, University of Split, Valahia University of Targoviste

Course Code:	PHPC308	No. of Credits:	4
Course Name:	MODERN PHYSICS (Laboratory Work)	Sem End Exam	100

Course Educational Objectives:

This course enables the students:

CEO1 : To evaluate the ratio of charge and mass by various methods.

CEO2 : To provide knowledge on GM Counters and Logic Gates

Course Outcomes:

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

CO1: Understand the methods on e/m ratio experiments

CO2: Determine Plank's constant and verification of inverse square law by GM Counter.

CO3: Study the characteristics of Diode, Zener diode and FET

CO4: Understand Logic Gates and Boolean algebra

Mapping of COs with POs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										

LIST OF THE EXPERIMENTS:

1. Determination of e/m by

I) Braun tube method

II) Magnetron Valve method

2. Determination of Planck's constant (h) by Photo-electric effect methods
3. Measurement of velocity of light by Lecher wire
4. GM counter experiments:

I) Characteristics of the Geiger tube

II) Inverse Square Law.

III) Absorption coefficient of the Aluminium foil.

5. Characteristics of Diode and Zener diode.
6. Study of logic gates AND, OR, NOT, NAND, NOR, EXOR .
7. Making AND, OR, NOT Gates using NAND Gates.
8. Verification of Boolean algebra.
9. Verification of Dual nature.
10. Characteristics of FET (Field Effect Transistor).

Any other experiments that may be set up from time to time

Course Code:	PHPC309	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-III	End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

SEMESTER-IV

Course Code:	PHPC401	No. of Credits:	4
Course Name:	ELEMENTARY PARTICLE PHYSICS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1 : To focus on classification of elementary Particles and conservation laws.
CEO2 : To discuss on discrete symmetry and unitary symmetry and particle grouping

Course Outcomes:
Upon successful completion of this course, students should be able to:

CO1: Classify the types particle physics and their quantum number
CO2: Understand the charge independence of Nuclear force and conservation Principles.
CO3: Know about various discrete symmetries
CO4: Describe unitary symmetry and quark model.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Classification of Elementary Particles: [10 Hours]

Historical introduction Particle interactions, intermediate particles, Leptons, Hadrons: Mesons and Baryons. Quarks, Quantum numbers: Lepton number, Baryon number, Strangeness number and Color quantum number.

Unit-II Nuclear forces and conservation laws: [10 Hours]

Nuclear forces and properties, Isospin, Test for isospin conservation, Associated Production of Strange particles, Gell-Mann Nishijima scheme with examples, conservation laws in relation to particle reactions and decays.

Unit-III Discrete Symmetry: [10 Hours]

Parity (P): Parity in quantum mechanics and Field theories, Test of Parity. Time reversal (T): Time reversal in quantum mechanics and Field theories, Test of Time reversal, Charge conjugation (C): Additive quantum number, Charge conjugation in field theories, Test of Charge conjugation, CPT theorem and its consequences.

Unit-IV Unitary Symmetry and particle grouping: [10 Hours]

SU(2), SU(3), Concept of I-Spin, U-Spin, V-Spin, Quark model, Eight- fold way, Mesons and Baryons in the Octet representation, Baryon Decuplets, Evidence of color, Baryon-meson coupling.

Text Book:

1. Introduction to Elementary Particles by D. Griffiths. Prentice Hall
2. Introduction to High Energy Physics, Donald H. Perkins, Cambridge University Press

Reference books:

1. Elementary particle physics by Gasiorwicz, John Wiley & Sons Inc
2. Modern Elementary Particle Physics by G.Kane, Addison-Wesley Publishing Company
3. Quarks and Leptons by F.Halzen and A.D.Martin, World Scientific Singapore

Course Code:	PHPE402	No. of Credits:	4
Course Name:	CONDENSED MATTER AND MATERIALS PHYSICS-2	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:
This course enables the students:

COE1: To become familiar with the different types of magnetism and magnetism based phenomenon
COE2: To understand the different optical processes and photo physical properties of solids
COE3: To familiarize with different material characterization technique
COE4: Rendering insights into nano technology and its applications

Course Outcomes:
Upon successful completion of this course, students should be able to:

CO1: Understand the basic principles of optical properties and optoelectronic devices.
CO2: Describe the related theories of magnetism and their properties.
CO3: Acquire knowledge on Advanced magnetism and materials with necessary theories.
CO4: Provide adequate working knowledge and explain about the novel material, Characterization of materials, and Basic principles of Raman Effect in crystals and Mossbauer techniques.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Magnetism: [10 Hours]

Dia and Para magnetism, Langevin's equations, diamagnetic and Para magnetic susceptibility, the Curie law, quantum theory of paramagnetism, Pauli paramagnetism, Landau levels, Ferro, anti-ferro and ferrimagnetism, exchange interactions and their characterization, molecular field theory, temperature dependence, the ferromagnetic phase transition, spin waves and magnons, Bloch T3/2 law, anti ferromagnetic order, Neel temperature.

Unit-II Dielectric & Ferroelectric Materials: **[10 Hours]**

Description of static dielectric constant, Stattic dielectric constant of gases and solids, Internal field according to Lorentz, Complex dielectric constant and dielectric losses; Dielectric losses and relaxation time, Classical theory of electronic polarization and optical absorption. General properties of ferroelectrics, Classification and Properties of representative ferroelectrics, Dipole theory of ferroelectricity and its objections, Ionic displacements and theory of spontaneous polarization, Thermodynamics of ferroelectric transitions, Ferroelectric domains.

Unit-III Characterization Techniques: [10 Hours]

X-Ray Diffraction Methods, X-Ray Fluorescence, Electron Dispersion Spectroscopy, Thermo gravimetric Analysis, Differential Thermal Analysis, Differential Scanning Calorimetery, Electron Microscopy-Transmission and Scanning Electron Microscopy, STM and AFM, Compositional analysis employing AES, ESCA and Electron Probe Microanalysis. Fourier Transform Infrared Spectroscopy

Unit-IV (Self Study) Nano-structured materials: [10 Hours]

Brief introduction to different nanostructured materials, Discussion of the size dependent properties related to Mechanical, magnetic and optical properties of these nano particle, Quantum mechanical solution and the derivation for the energy spectrum and density of states for Quantum wells, Quantum wires and Quantum dots.

Text Book:

1. Physics of Condensed Matter-By Prasanta K.Misra (Academic Press, 2010)

Reference Books:

1.C. Kittel-Introduction to Solid State Physics by C. Kittel, John Wiley and Sons, Inc. Singapore.
2.Solid state Physics by Aschcroft and Mermin, Harcourt Asia PTE. Ltd. (A Harcourt publishers International company)

Course Code:	PHPE403	No. of Credits:	4
Course Name:	NUCLEAR SCIENCE-2	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:

This course enables the students:

CEO1 : To focus on field operators

CEO2 : To make them understand about Particle Physics, Spontaneous symmetry breaking.

Course Outcomes:

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

CO1: Understand the basic principles of optical unequal space time commutation and anti-commutation rules for field operators.

CO2: Describe the related theories of u nequal space time commutation and anti-commutation rules for field operators.

CO3: Acquire knowledge on Advanced magnetism and materials with necessary theories.

CO4: Provide adequate working knowledge and explain about the novel material, Characterization of materials, and Basic principles of Raman Effect in crystals and Mossbauer techniques.

Mapping of COs with POs :

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I Field Theory: [10 Hours]

Unequal space time commutation and anti-commutation rules for field operators. Propagator functions and their integral representations, Vacuum expectation values, Feynmann propagators, Feynman diagram rules in co-ordinate and momentum space, Concept of T- Product and Normal Product, Wick's Theorem, Properties of scattering matrix, Brief idea of electron-photon scattering.

Unit-II Particle Physics: [10 Hours]

Brief review of Unequal space time commutation and anti-commutation rules for field operators., SU(3) Quark Model, The Baryon and Meson State, Baryon-Meson coupling: The F and D terms, Gell-Mann-OKubo mass formula. The Magnetic Moment, The Heavy Quarks: Charm and Beyond, SU(6) and The Quark Model, SU(6) wave-function for Mesons and Baryons, Magnetic moments of Baryons.

Unit-III: [10 Hours]

Weak interaction : V-A form of weak interaction, Helicity of neutrino, Muon and Pion decay calculation, elementary notion of leptonic decays of strange particles, the cabibbo angle, intermediate vector bosons, Elements of Neutral K-meson theory : Decay of Neutral K-mesons, regeneration of K-mesons, CP violation in neutral K decay

Unit-IV: [10 Hours]

Spontaneous symmetry breaking, Higgs Mechanism, Brief idea of Salam-Weinberg Theory of Standard Model. Neutrino Physics: Neutrino Mass and Experimental limits, Neutrinoless Double- Beta decay, Neutrino oscillation, Solar neutrinos, Magnetic moment of neutrino.

Text Book:

1. Introduction to Elementary Particles by D.Griffiths, Prentice Hall
2. Relativistic quantum field theory by J.D. Bjorken and S.D. Drell, Mc Graw-Hill Book Company

Reference Books:

1. Elementary particle physics by Gasiorwicz, Addison-Wesley publishing Company
2. Elementary Particle Physics by G.Kallen, Addison-Wesley publishing Company
3. Quarks and Leptons by F.Halzen and A.D.Martin, World Scientific, Singapore
4. A modern introduction to particle physics by Fayyazuddin and Riazuddin, World Scientific, Singapore
5. Introduction to High Energy Physics by D. H. Perkins .

Course Code:	PHOE404	No. of Credits:	4
Course Name:	ETHICS & INTELLECTUAL PROPERTY RIGHTS	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:
This course enables the students:

CEO1 : To focus on introduction to Ethics.
CEO2 : To make them understand about Concept of property, rights, duties and their correlation; Intellectual property rights

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

CO1: Understand the basic principles of Ethics, Ethical dilemma, Emotional intelligence
CO2: Describe the related theories of Profession and Craftsmanship, Conflict of interest.
CO3: Acquire knowledge on . Concept of property, rights, duties and their correlation; Intellectual property
CO4: Provide adequate working knowledge and explain about basic requirement of a patentable invention-

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: **[10 Hours]**

Introduction to Ethics: 1.1 Basic terms- Moral, Ethics, Ethical dilemma, Emotional intelligence 1.2 Moral development theories of Kohlberg and Piaget 1.3 View on ethics by Aristotle 1.4 Governing factors of an individual's value system 1.5 Personal and professional ethics

Unit-II: **[10 Hours]**

Profession and Professionalism: 2.1 Clarification of the concepts: Profession, Professional, Professionalism, Professional accountability, Professional risks, Profession and Craftsmanship, Conflict of interest 2.2 Distinguishing features of a professional 2.3 Role and responsibilities of professionals 2.4 Professionals' duties towards the organization and vice-a-versa 3 Ethical Theories: 3.1 Various ethical theories and their application- Consequentialism, Deontology, Virtue theory, Rights Theory, Casuist theory 3.2 Ethical terms: Moral absolutism, Moral Relativism, Moral Pluralism etc. 3.3 Resolving Ethical Dilemma

Unit-III: **[10 Hours]**

Concept of property, rights, duties and their correlation; Intellectual property rights and its types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies.

Unit-IV: **[10 Hours]**

Basic requirement of a patentable invention- novelty, inventive step, Prior art and State of art; Patent databases; Searching International Databases; Analysis and report formation; Filing of a patent application; Role of a Country Patent Office; Precautions before patenting-disclosure/non-disclosure; International patenting-requirement; Introduction to History of GATT, WTO, WIPO, TRIPS, PCT and Implications; Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neem etc.

Text Books:

1. R. Subramanian, "Professional Ethics" , Oxford University Press, New Delhi, 2013

2. Edmund G. Seebauer and Robert L. Barry, "Fundamentals of Ethics", Oxford University Press, New Delhi, 2012.

3. Stanley SA, Bioethics, Wisdom educational services

4. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

Course Code:	PHPE405	No. of Credits:	4
Course Name:	CONDENSED MATTER AND MATERIALS PHYSICS (Laboratory work)	Sem End Exam	100

Course Educational Objectives:

This course enables the students:

CEO1 : To focus on characteristics of materials..

CEO2 : To make them understand dielectric constant and magnetic properties.

Course Outcomes:

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

CO1: Understand the energy gap of a given material.

CO2: Evaluate Hall constant and verify relation of an electric analog.

CO3: Provide adequate working knowledge on specific heat of a given sample.

CO4: Evaluate dielectric constant of a given sample and determination of B-H curve.

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										

LIST OF EXPERIMENTS:

1. Determination of energy gap of a given semiconductor by four probe method
2. Determination of Hall constant of a sample and its identification
3. Determination of energy gap by p-n junction method
4. Study of dispersion relation of an electric analog of mono atomic linear chain
5. Study of dispersion relation of an electric analog of diatomic linear chain
6. Determination of specific heat of a given sample using a thermocouple
7. Determination of dielectric constant of a given sample by lecher wire method
8. Determination of B-H curve of a given ferromagnet

Any other experiments that may be set up from time to time:

Course Code:	PHPE406	No. of Credits:	4
Course Name:	NUCLEAR SCIENCE (Laboratory work)	Sem End Exam	100

Course Educational Objectives

This course enables the students:

CEO1 : To focus on experiment with gamma ray spectrometer

CEO2 : To make them understand about CEO3 : To calculate the gradients and directional derivatives of functions of several variables high resolution of gamma ray

Course Outcomes:

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

CO1: Understand the basic principles of device high resolution of gamma ray

CO2: Describe the Verification of inverse square law

CO3: Acquire knowledge on spectroscopy Energy

CO4: Provide adequate working knowledge and explain about detector Photo pick efficiency

Mapping of COs with POs and PSOs:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	1	3										-
CO4	1	3										

LIST OF EXPERIMENTS:

1. Determination of half-life of unknown source
2. Determination of linear absorption coefficient
3. Verification of inverse square law
4. Experiment with gamma ray spectrometer
   i. Energy analysis of unknown gamma source
   ii. Spectrum analysis of 60 Co and 137 Co
   iii. Activity of Gamma emitter
5. High resolution of gamma ray spectroscopy Energy resolution with Ge (Li) detector

Photo pick efficiency for Ge(Li) detector

Any other experiments that may be set up from time to time.

Course Code:	PHPC407	No. of Credits:	8
Course Name:	MAJOR RESEARCH PROJECT /DISSERTATION	End Exam	200

Objectives:

Every student will have to complete one individual project under the guidance of the professors of the department . The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a project report with details as per the Performa and sample provided.

The project report should be hard bound and the students will have to submit ***four copies*** of the project repo*rt* for final evaluation of 200 marks based on the following criteria.

CRITERIA	Max. Marks
Literature Survey/Reference	20
Objectives/Plan of the project	20
Experimental/Theoretical Methodology	40
Significance and originality of the study	20
Depth of knowledge in the subject	20
Results and Discussions	20
Presentation/seminar/Viva	60
Total Marks	**200**

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