Annexure 2-C

PARISHKAR COLLEGE OF GLOBAL EXCELLENCE (AUTONOMOUS)

SCHEME OF EXAMINATION COURSE STRUCTURE & SYLLABUS

AS PER UGC

CHOICE BASED CREDIT SYSTEM (CBCS)

WITH

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK

FOR

M.SC. PHYSICS (2022)

Department Overview

The Department aims at developing young talent for the Physical industry and academia. The curriculum is developed by highly Qualified faculty of **Parishkar** in such a way that the students are able to venture into allied fields also. The aim of the department through the programmes is to provide "a cut above" man-power to the ever growing demands of the industry and to prepare students for higher studies and research devoted to society. The interactive method of teaching at **Parishkar College of Global Excellence** is to bring about attitudinal changes to future professionals of the industry with an edge of creativity.

Equal importance is given to practical and theoretical aspects apart from experiential and digital modes of learning. Industrial projects form an integral part of the curriculum. Along with the syllabus, the **Parishkar College of Global Excellence** emphasizes on Value Addition Programs like Holistic Education, open elective programmes and Placement Training Programs, which include training students in group discussions, facing interviews and so on.

Learning Outcomes based Curriculum

Framework The **Choice Based Credit Scheme** (CBCS) evolved into learning outcome-based curriculum framework and provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the **Cumulative Grade Point Average** (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

Objectives of the Programme

- M.Sc. Physics pass out students will have knowledge of fundamental laws and principles of physics along with their applications in diverse areas.
- The students will develop the skill to plan, execute and report on experimental and/or theoretical physics problems with effective scientific approach in future endeavour.
- After completing M.Sc. Physics, the students will become effective teacher and/or researcher; and will be able to exhibit good scientific knowledge and temperament in diverse fields/environment.
- Post graduate degree holders will develop teaching and research skills which might include advanced laboratory techniques, numerical methods, computer interfacing etc.

Programme Outcomes

On successful completions of the M.Sc. Programme students will be able to

- Understand and apply the fundamental principles, concepts and methods in key areas of science and multidisciplinary fields
- Demonstrate problem solving, analytical and logical skills to provide solutions for the scientific requirements.
- Develop the critical thinking with scientific temper.
- Communicate the subject effectively.
- Understand the importance and judicious use of technology for the sustainable growth of mankind in synergy with nature.
- Understand the professional, ethical and social responsibilities.
- Enhance the research culture and uphold the scientific integrity and objectivity.
- Engage in continuous reflective learning in the context of technological and scientific advancements.
- Express proficiency in oral and written communications to appreciate innovation in research.
- Develop industry-focused skills to lead a successful career.

Programme Outcomes

After completing the programme, the students have:

S.No	Tools	Contents
1.	Knowledge	capability of demonstrating comprehensive disciplinary knowledge gained during course of study
2.	Research Aptitude and Investigation	ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
3.	Communication	ability to communicate effectively on general and scientific topics with the scientific community and with society at large
4.	Problem Solving	Capability of applying knowledge to solve scientific and other problems using theoretical and practical techniques, skills and tools.
5.	Science and Society	ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
6.	Life-Long Learning	aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
7.	Modern Tool Usage	ability to use and learn techniques, skill and modern tools for scientific practices
8.	Project Management	ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

Programme Specific Outcomes

After completing the programme, the students:

S.No.	Contents
1.	Acquire core as well as specialized/disciplinary knowledge in physics including the major premises of classical mechanics, quantum mechanics, mathematical physics, electronics, electrodynamics, solid state physics, statistical mechanics, atomic & molecular physics, nuclear & particle physics, laser & spectroscopy, computational physics and material science & nanotechnology.
2.	Learn how to design and conduct experiments demonstrating their understanding of scientific methods/processes/phenomena; and have an understanding of analytical methods required to interpret and analyse results and draw conclusions.
3.	Develop written and oral communications skills in communicating physics-related topics; and realize and develop an understanding of the impact of science particularly physics on the society.
4.	Apply conceptual understanding and critical thinking of the physics to general real-world situations; and learn to analyse physical problems and develop correct solutions using theoretical and experimental techniques/tools and skills.

Learning Outcomes

The key learning outcomes of our course are: knowledge and understanding of the concepts, logical as well as abstract thinking and analytical approach, experimental and computational skills, research methodology, values and positive attitude.

Post Graduates should have developed following qualities

1. Understanding of basic and advanced concepts.

2. Theoretical and practical skills along with problem solving ability.

3. Logical and abstract thinking and analytical approach.

4. Ability to apply acquired knowledge and skills to the new and unknown situations in order to develop new theories, experiments and technology.

5. Understand the nature in a better way.

6. Understand and appreciate the nuances and beauties in science education.

7. Tenacity, hardworking and ability to work against odds.

8. A new perspective to look at everything from ‘Electronics’ point of view.

9. Get introduced to work environment at industrial scale and at research level.

10. Awareness of the impact in social, economic and environmental issues.

11. Willingness to take up responsibility in study and work; confidence in his/her capabilities; and motivation for life-long learning.

Learning Outcome-based Curriculum Framework in M.Sc.

The learning outcomes based approach implies that when an academic programme is planned, desirable learning outcomes are identified and considered in formulation of the plans. Course contents, learning activities and assessment types are designed to be consistent with the achievement of desired learning outcomes. The learning outcomes are in terms of knowledge, Professional attitude, work ethics, critical thinking, self-managed learning, adaptability, problem solving skills, communication skills, interpersonal skills and group works. At the end of a particular course/program, assessment is carried out to determine whether the desired outcomes are being achieved. This outcome assessment provides feedback to ensure that element in the teaching and learning environment are acting in concert to facilitate the nurturing of the desired outcomes. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn help not only in curriculum planning and development, but also in delivery and review of academic programmes.

The overall objectives of the learning outcomes based curriculum framework are:

- Help formulate student attributes, qualification descriptors, program learning outcomes and course learning outcomes that are expected to be demonstrated by the holders of qualification.
- Enable prospective students, parents, employers and others to understand the nature and level of learning outcomes or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study.
- Maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility.
- Provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning level, and periodic review of programme and academic research.

Aims of Master's Degree Programme in Physics

The overall aims of the M.Sc. Physics are:

Provide students with learning experiences that develop broad knowledge and understanding of key concepts and equip students with advanced scientific/technological capabilities for analysing and tackling the issues and problems in the field of electronics, Electrodynamics, Quantum, Optics, Classical Mechanics, Solid State Physics, Nuclear and Particle Physics, Mathematical Physics Nano Technology etc. Develop ability in student's to apply knowledge and skills they have acquired to the solution of specific theoretical and applied problems. Develop abilities in students to design and develop innovative solutions for benefits of society, by diligence, leadership, team work and lifelong learning. Provide students with skills that enable them to get employment in industries or pursue higher studies or research assignments or turn as entrepreneurs.

Proposed scheme for choice based credit system in M.Sc. Physics

Sem.	CORE COURSE (CP) (12)	Industrial & Skill Oriented Course (ISO)(01)	Discipline Specific Elective (DSE) (04)	Cr
I	Classical Mechanics (4)			34
	Mathematical Physics (4)			
	Fundamental Electronics (4)			
	Quantum Mechanics –I (4)			
	Statistical Physics (4)			
	General Lab (5)			
	Electronics Lab (5)			
	Seminar-I (4)			
II	Solid State Physics (4)	Renewable Energy And Resources (2)		34
	Classical Electrodynamics (4)			
	Nuclear Physics (4)	Internship (2)		
	Quantum Mechanics-II (4)			
	Introduction to Nonlinear Optics (4)			
	General Physics lab-I (5)			
	General Physics lab-II (5)			
III	Atomic & Molecular Physics (4)		**DSE1** Laser & Spectroscopy(4)	32
	Electrodynamics & Plasma Physics(4)		**DSE2** Advance Electronics(4)	
	Project Writing (4)		**DSE3** Computational Physics(4)	
	Paper Writing (4)		**DSE1 (LAB)** Laser & Spectroscopy Lab (4)	
			DSE2 (LAB) Advance Electronics Lab (4)	
			DSE3 (LAB) Computational Physics Lab (5)	
IV	(Project Work + SWP)/ Dissertation (8)		**DSE1** Introduction to Nano Physics(4)	20
			DSE2 Microwave Electronics(4)	
			DSE3 Material Science(4)	
			DSE1 (LAB) Microwave Electronics & Material Science Lab(4)	
			DSE2 (LAB) Nano Physics Lab(4)	
			Total	**120**

Semester-I

Course code and Title along with credits details

S. No	Course Code	Name of Course	L	T	P	Credit	CCA	ESE	Total
1.	MSc/1/PHY/CM/CC1	Classical Mechanics	4	0	0	4	30	70	100
2.	MSc/1/PHY/MP/CC2	Mathematical Physics	4	0	0	4	30	70	100
3.	MSc/1/PHY/EL/CC3	Fundamental Electronics	4	0	0	4	30	70	100
4.	MSc/1/PHY/QM/CC4	Quantum Mechanics -I	4	0	0	4	30	70	100
5.	MSc/1/PHY/SP/CC5	Statistical Physics	4	0	0	4	30	70	100
6.	MSc/1/PHY/GL/CC6	General Physics Lab	0	0	5	5	30	70	100
7.	MSc/1/PHY/EL/CC7	Electronics Lab	0	0	5	5	30	70	100
8.	NTCC	Seminar-I	0	0	0	4	30	70	100
Total						34	240	560	800

Semester-II

Course code and Title along with credits

S. No	Course Code	Name of Course	L	T	P	Credit	CCA	ESE	Total
1.	MSc/2/PHY/SS/CC1	Solid State Physics	4	0	0	4	30	70	100
2.	MSc/2/PHY/CE/CC2	Classical Electrodynamics	4	0	0	4	30	70	100
3.	MSc/2/PHY/NP/CC3	Nuclear Physics	4	0	0	4	30	70	100
4.	MSc/2/PHY/QM/CC4	Quantum Mechanics-II	4	0	0	4	30	70	100
5.	MSc/2/PHY/NO/CC5	Introduction to Nonlinear Optics	4	0	0	4	30	70	100
6.	MSc/2/PHY/GSL/CC6	General Physics Lab-I	0	0	5	5	30	70	100
7.	MSc/2/PHY/GNL/CC7	General Physics lab-II	0	0	5	5	30	70	100
Industrial & Skill Oriented Course									
8.	MSc/2/PHY/RE/ISO1	Renewable Energy And Resources	2	0	0	2	30	70	100
	NTCC	Internship	0	0	0	2			
Total						34	240	560	800

Semester-III

Course code and Title along with credits

S. No	Course Code	Name of Course	L	T	P	Credit	CCA	ESE	Total
1.	MSc/3/PHY/AM/CC1	Atomic & Molecular Physics	4	0	0	4	30	70	100
2.	MSc/3/PHY/EP/CC2	Electrodynamics & Plasma Physics	4	0	0	4	30	70	100
Choose any Two out of the following options DSC1 or DSC3 Discipline Specific Courses									
3.	MSc/3/PHY/LS/DSC1	Laser & Spectroscopy	4	0	0	4	30	70	100
4.	MSc/3/PHY/AE/DSC2	Advance Electronics	4	0	0	4	30	70	100
5.	MSc/3/PHY/CP/DSC3	Computational Physics	4	4	4	4	30	70	100
Choose any Two out of the following options DSC1 or DSC3 Discipline Specific Courses Practical Lab									
6.	MSc/3/PHY/LSL/DSC1	Laser & Spectroscopy Lab	0	0	4	4	30	70	100
7.	MSc/3/PHY/AEL/DSC2	Advance Electronics Lab	0	0	4	4	30	70	100
8.	MSc/3/PHY/CPL/DSC3	Computational Physics Lab	0	0	4	4	30	70	100
9.	NTCC	Project Writing	0	0	0	4	30	70	100
10.	NTCC	Paper Writing	0	0	0	4	30	70	100
Total						32	240	560	800

Semester-IV

Course code and Title along with credits details

S. No	Course Code	Name of Course	L	T	P	Credit	CCA	ESE	Total
Choose any two out of the following options DSC1 or DSC3 Discipline Specific Courses									
1.	MSc/4/PHY/NP/DSC1	Introduction to Nano Physics	4	0	0	4	30	70	100
2.	MSc/4/PHY/ME/DSC2	Microwave Electronics	4	0	0	4	30	70	100
3.	MSc/4/PHY/MS/DSC3	Material Science	4	0	0	4	30	70	100
Choose any one out of the following options DSC1 or DSC2 Discipline Specific Courses									
5.	MSc/4/PHY/MEL/DSC1	Microwave Electronics & Material Science Lab	0	0	4	4	30	70	100
6.	MSc/4/PHY/NPL/DSC2	Nano Physics Lab	0	0	4	4	30	70	100
7.	NTCC	(Project Work + SWP)/ Dissertation	0	0	0	8	150	350	500
Total						20	240	560	800

Core courses Offered

S.No.	Course Code	Name of Course	Credits
1.	MSc/1/PHY/CM/CC1	Classical Mechanics	4
2.	MSc/1/PHY/MP/CC2	Mathematical Physics	4
3.	MSc/1/PHY/EL/CC3	Fundamental Electronics	4
4.	MSc/1/PHY/QM/CC4	Quantum Mechanics -I	4
5.	MSc/1/PHY/SP/CC5	Statistical Physics	4
6.	MSc/1/PHY/GL/CC6	General Physics Lab	5
7.	MSc/1/PHY/EL/CC7	Electronics Lab	5
8.	NTCC	Seminar-I	4
9.	MSc/2/PHY/SS/CC1	Solid State Physics	4
10.	MSc/2/PHY/CE/CC2	Classical Electrodynamics	4
11.	MSc/2/PHY/NP/CC3	Nuclear Physics	4
12.	MSc/2/PHY/QM/CC4	Quantum Mechanics-II	4
13.	MSc/2/PHY/NO/CC5	Introduction to Nonlinear Optics	4
14.	MSc/2/PHY/GSL/CC6	General Physics lab-I	5
15.	MSc/2/PHY/GNL/CC7	General Physics lab-II	5
16.	MSc/3/PHY/AM/CC1	Atomic & Molecular Physics	4
17.	MSc/3/PHY/EP/CC2	Electrodynamics & Plasma Physics	4
18.	NTCC	Project Writing	4
19.	NTCC	Paper Writing	4
20.	NTCC	(Project Work + SWP)/ Dissertation	8

Discipline Specific Courses offered

S.No.	Corse Code	Name of Course	Cradits
1.	MSc/3/PHY/LS/DSC1	Laser & Spectroscopy	4
2.	MSc/3/PHY/AE/DSC2	Advance Electronics	4
3.	MSc/3/PHY/CP/DSC3	Computational Physics	4
4.	MSc/3/PHY/LSL/DSC1	Laser & Spectroscopy Lab	4
5.	MSc/3/PHY/AEL/DSC2	Advance Electronics Lab	4
6.	MSc/3/PHY/CPL/DSC3	Computational Physics Lab	4
7.	MSc/4/PHY/NP/DSC1	Introduction to Nano Physics	4
8.	MSc/4/PHY/ME/DSC2	Microwave Electronics	4
9.	MSc/4/PHY/MS/DSC3	Material Science	4
10.	MSc/4/PHY/MEL/DSC 1	Microwave Electronics & Material Science Lab	4
11.	MSc/4/PHY/NPL/DSC2	Nano Physics Lab	4

Industrial & Skill Oriented Course

S.No.	Course Code	Name of Course	Credits
1.	MSc/2/PHY/RE/ISO1	Renewable Energy And Resources	2
2.	NTCC	Internship	2

SYLLABUS OF MSc. I YEAR (I AND II SEMESTERS)
Semester-I

SYLLABUS (Core Course)

NAME OF PAPER: CLASSICAL MECHANICS

Paper Code: MSc/1/PHY/CM/CC1 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

The aim of this course is to familiarize the students with the Lagrangian and Hamiltonian formalisms of simple classical systems and makes them able to learn the methods of problem solving related to central force, rigid body dynamics and canonical transformation.

Course Outcome

At the end of the course, the students will be able to:

1. Understand basic formalism of constraints and Lagrangian dynamics. Application of Lagrange’s equations in real physical problems.
2. Understand Lagrangian formalism for solving Kepler’s problem.
3. Apply the Variational principles to real physical and engineering problems.
4. Enable to solve Hamilton-Jacobi equations and use it for the solution of harmonic oscillator problem.
5. Understand analytical methods of mechanics based on generalised coordinates of momenta and solve the practical problems using these concepts.
6. Understand and demonstrate the classical concepts of Physics
7. Understand the drawbacks of Newtonian Mechanics and the establishment of Classical Mechanics.
8. Develop mathematical formulation of physical problems using Lagrangian and Hamiltonian formalisms.
9. Demonstrate and solve new problems dealing with the classical aspects of Physics.
10. Apply the concepts of Poisson’s Bracket algebra and its implementation in Quantum mechanical formulations.

Unit-I **Teaching Hours: 15**

Constraints and Generalized Co-ordinates: Mechanics of a particle, mechanics of a system of particles, constraints and their classification, principle of virtual work, D’Alembert’s principle, Generalized co-ordinates.

Lagrange Dynamics: Lagrange’s equations of motion, applications of Lagrangian formulation (simple pendulum, Atwood’s machine, bead sliding in a wire).

Cyclic Coordinates & Symmetry Transform: Cyclic co-ordinates, concept of symmetry, homogeneity and isotropy, invariance under Galilean transformations. Symmetries and conservation law, Noether theorem.

Unit-II Teaching Hours: 15

Rotating Frames of Reference and Central Force: Rotating frames, inertial forces in the rotating frame, effects of Coriolis force, Foucault's pendulum, Central force: definition and examples.
Central Force Problem: Two-body central force problem, classification of orbits, stability of circular orbits, condition for closure of orbits, Kepler's laws, Virial theorem, applications.
Satellite Communication: Satellites and inter-planetary orbits. Scattering in central force field.

Unit-III Teaching Hours: 15

Canonical Transformations: Canonical transformations, generating functions, conditions of canonical transformation, examples, Legendre's dual transformation,
Poisson Bracket & Hamilton Eq. of Motion: Hamilton's function, Hamilton's equation of motion, properties of Hamiltonian and Hamilton's equations of motion, Poisson Brackets, properties of Poisson bracket, elementary PB's, Poisson's theorem, Jacobi-Poisson theorem on PBs, Invariance of PB under canonical transformations, PBs involving angular momentum, principle of Least action, Hamilton's principle, derivation of Hamilton's equations of motion from Hamilton's principle
Hamilton Jacobi Method: Hamilton-Jacobi equation. Solution of simple harmonic oscillator by Hamilton-Jacobi method. Phase plots, fixed points and their stabilities field.

Unit-IV Teaching Hours: 15

Small Oscillations: Types of equilibrium and the potential at equilibrium, Lagrange's equations for small oscillations using generalized coordinates, normal modes, vibrations of carbon dioxide molecule, forced and damped oscillations, resonance
Rigid Body Dynamics: degrees of freedom of a free rigid body, angular momentum, Euler's equation of motion for rigid body, time variation of rotational kinetic energy, Rotation of a free rigid body, Eulerian angles, Motion of a heavy symmetric top rotating about a fixed point in the body under the action of gravity. Gyroscope and their applications

Text books And Reference Books:

- Srinivasa Rao, K. N. (2002). *Classical mechanics*: University Press.
- Goldstein, H. (2001). *Classical mechanics* (3rd ed.): Addison Wesley.
- Rana, N. C., & Joag, P. S. (1994). *Classical* mechanics. New Delhi: Tata McGraw Hill

SYLLABUS (Core Course)

NAME OF PAPER: MATHEMATICAL PHYSICS

Paper Code: MSc/1/PHY/MP/CC2 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

The aim and objective of the course is to familiarize the students with the mathematical techniques necessary to approach problems in advanced physics courses. Concepts of Complex analysis, Fourier analysis, Laplace transforms, tensor analysis, Green's function, integral transform are helpful to approach problems in advanced physics courses and research

Course Outcome

At the end of the course, the students will be able to:

- Understand and apply the mathematical methods to solve quantitative problems in the study of physics and engineering. Enhance their problem solving ability and critical thinking.
- Demonstrate contour integrals in relevant problems in Physics.
- Enable to apply integral transform to solve mathematical problems of interest in physics. Can use Fourier transforms as an aid for analysing experimental data.
- Explain basic, preliminary concepts related to Green's function method and group of elements. Formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

Unit-I Teaching Hours: 15

Vector Algebra & Linear Vector: Introduction to gradient, divergence and curl operator and their physical significance. Matrices: Inverse Matrix, Orthogonal, Unitary and Hermitian Matrices, Independent elements of Orthogonal and Unitary Matrices, Matrix diagonalization, Eigen values & Eigen vectors.

Linear Vector Space: Linear Vector Space: A brief review of linear vector spaces, Inner product, norm, Schwarz inequality.

Unit-II Teaching Hours: 15

Fourier Transforms:
Fourier transform, Sine, Cosine and Complex transforms with examples, Definition, Properties and Representations of Dirac Delta Function, Properties of Fourier Transforms, Transforms of derivatives, Parseval's Theorem, Convolution Theorem,

Momentum representation, Applications to Partial differential equations, Discrete Fourier transform, Introduction to Fast Fourier transform.

Laplace Transform:

Properties and examples of Laplace Transform, Convolution theorem and its applications, Laplace transform method of solving differential equations.

Unit-III Teaching Hours: 15

Complex Analysis: Function of complex variables, Cauchy Riemann conditions, Cauchy integral theorem and formula, Taylor and Laurent's Series, Cauchy's residue theorem, Singular points and evaluation of residues, Jordans lemma, Evaluation of real definite integrals.

Unit-IV Teaching Hours: 15

Probability, Green Function & Group Theory: Introductory group theory, Group representation by matrices: SU (2), O (3). The elements of the group of Schrodinger equation. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem. Green's function, Tensors.

Text books And Reference Books:

1. Arfken, G. B. (2012). Mathematical Methods for Physicists. Netherlands: Elsevier.

2. Boas, M. L. (2005). Mathematical Methods in the Physical Sciences.New York: Wiley.

3. Rajput, B. S. (2017). Mathematical Physics. Meerut: Pragati Prakashan.

4. Goyal, J.K. (2016). Laplace and Fourier Transforms. Meerut: Pragati Prakashan.

5. Prakash, S. (2005). Mathematical Physics. New Delhi: Sultan Chand & Sons.

6. Joshi, A. W. (2018). Group Theory for Physicists. New Delhi: New Age International.

7. Chatopadhyay, P. K. (2004). Mathematical Physics. New Delhi: New Age.

8. Balakrishnan, V. (2019). Mathematical Physics. New Delhi: Ane Books.

9. Mathematical Methods for Physicists: Arfken.

10. Mathematics for Physicists and Engineers: Pipes.

11. Mathematical Method of Physics Ghatak.

12. Mathematical Methods for Physics: Wyle.

13. Mathematical Methods in Physical Sciences: Boas.

14. Group Theory: Wigner

15. S. Prakash: Mathematical Physics, S. Chand and Sons, 2004.

16. H. K. Dass: Mathematical Physics, S. Chand and Sons, 2008.

17. G. B. Arfken, H. J. Weber and F. E. Harris: Mathematical methods for physicists, 7th Edn., Academic press, 2013.

SYLLABUS (Core Course)

NAME OF PAPER: FUNDAMENTAL ELECTRONICS

Paper Code: MSc/1/PHY/EL/CC3 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

The main objective of this course is to expertise the students about various electronic circuits used in practical applications. After going through this course, the students are supposed to understand fundamental physics of semiconductor materials and the construction and operation of various electronic devices like PN-diode, BJT, FET, Op-amp under different operating conditions and two-port network analysis. In addition the topics of various number systems and their arithmetic, basic logic gates, combinational and sequential circuits and simplification techniques for Boolean Expressions will enable the students to enter into the fascinating world of digital electronics. The idea of differential amplifier and operational amplifier along with their applications is also introduced.

Course Outcome

After successful completion of the course on Fundamental of Electronics, a student will be able to:

- Aware of the general characteristics of important semiconductor materials and develop a deep understanding of the basic design, operation and characteristics of a PN-junction and a BJT along with knowledge of the two port network analysis and their application in electronic circuit. Learn to devise and analyse various transistor amplifier models.
- Acquaint with the field effect transistor like JFET, MOSFET MESFET, VMOS and CMOS along with frequency response of variously FET amplifiers and various FET biasing arrangements.
- Implement Boolean expression with basic logic gates, design and analysis of different combinational and sequential circuits to achieve desired output. Express numbers, alphabets, special characters etc. in binary representation, perform mathematical operations. Idea of different types of memories and Boolean expression simplification technique are also introduced.
- Explain the basic physics of differential amplifier, operational amplifiers, effect of feedback on opamp parameters and various applications of op-amp.

Unit-I Teaching Hours: 15

Circuit Analysis: Admittance, impedance, scattering and hybrid matrices for two and three port networks and their cascade and parallel combinations. Review of Laplace Transforms. Response functions, location of poles and zeros of response functions of active and passive systems (Nodal and Modified Nodal Analysis).

Unit-II Teaching Hours: 15

Basics Semiconductors Electronics: Introduction, Charge densities in p & n- type materials, Conduction by drift and diffusion of charge, The pn-junction, The pn-diode equation, Diode switching, Clipping and clamping circuits, The junction transistor, Transistor current components, Transistor as an amplifier, Transistor construction, Transistor configuration and characteristics(CE,CB), The Ebers- Moll model, Two port network analysis, Controlled sources, Active circuit models, Gain in decibels, Equivalent circuit for BJT, Trans conductance model, Analysis of CE, CB & CC amplifiers.

Unit-III Teaching Hours: 15

Field Effect Transistors: Introduction, Junction field effect transistor (J-FET), Volt ampere characteristics of J-FET, FET small signal Model, FET biasing, Applications of FET, Metal oxide semiconductor field effect transistor MOS-FET (Depletion & Enhancement), Metal semiconductor field effect transistor (MESFET),Comparison of p and n channel MOSFET, Comparison of JFET, MOS FET and BJT, FET as voltage variable resistor, Low frequency common source and common drain amplifiers, Complementary MOSFET (CMOS), Vertical MOSFET (VMOS), Unijunction transistor.

Unit-IV Teaching Hours: 15

Digital Electronics: Definition of digital signal, Digital(Binary) operation of a system, Basic logic gatesOR, AND , NOT gates, Universal logic gates-NAND & NOR gates, Exclusive OR gate, Boolean algebra, De-Morgan's law, K-Map up to four variables, Half adder, Full adder, Binary adder, Multiplexer and demultiplexer, Encoder and decoder, ROM and its applications, Random access memory (RAM), Flip-flops : RS, JK, T-type, D-Type & Master Slave JK flip-flop, Shift register , Asynchronous and Synchronous counters.

Text books And Reference Books:

1. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall.
2. Leach, D.P. & Malvino, A.P. (1994) Digital Principles and Applications. Europe: Mc-Graw Hill.
3. Millman, J. & Halkias, C. C. (2017) Integrated Electronics. India: Mc Graw Hill Edu.
4. Malvino, A.P., Brown, J. (2017) Digital Computer Electronics.India : Mc Graw Hill Edu.
5. Jain, R.P. (2009) Modern Digital Electronics. India: Mc Graw Hill Edu.
6. Millman, J. & Grabel(2017) Microelectronics. New Delhi: Mc Graw Hill Edu.
7. Gupta, S. (2010) Electronic devices and Circuits. New Delhi: Dhanpat Rai Pub.
8. Kaushik, D.K.(2010)Handbook of Electronics. New Delhi: Dhanpat Rai Pub.
9. Streetman, B.G. & Banerjee, S.K. (2015) Solid State Electronic Devices. India: Pearson Edu.
10. Boylestd, R.L. & Nashelsky, L.(2012)Electronic Devices and Circuit Theory. India: Pearson.
11. Network Analysis and Synthesis, F.F. Kuo (2nd Ed., Wiley, 2010)
12. Network Analysis with Applications, W.D. Stanley (4th Ed., Pearson, 2003)
13. Electronic Devices and Circuits, J. Millman and C. C. Halkias and S. Jit (4th Ed., 18 McGraw-Hill, 2015)
14. Integrated Electronics, J. Millman, C. C. Halkias and C. D. Parikh (2nd Ed., McGrawHill, 2011)
15. Communication Systems, Simon Haykins (5th Ed., Wiley, 2009)

16. Digital Signal Processing, J. G. Proakis and D. G. Manolakis (4th Ed., Pearson, 2007)
17. Solid State Electronic Devices, B.G. Streetman (7th Ed., Pearson, 2015)
18. Introduction to Semiconductor Materials and Devices, M. S. Tyagi (1st Ed., Wiley, 2012)
19. Digital Design, M. Mano (5th Ed., Pearson, 2013)
20. Digital principles and Applications, A.P. Malvino and D.P.Leach (8th Ed., McGrawHill, 2014)

SYLLABUS (Core Course)

NAME OF PAPER: QUANTUM MECHANICS - I

Paper Code: MSc/1/PHY/QM/CC4 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

Students will acquire essential understanding needed for other courses for theoretical formulation of the physical phenomena at quantum level in matter and radiation fields.

Course Outcome

- General basic foundation of quantum mechanics needed for various quantum mechanical approaches. Three quantum numbers helps to explain atomic structure, H-atom and multi-electron systems.
- Matrix formulation of quantum mechanics and three different pictures with their respective importance in physics.
- Space quantization, commutator algebra, theory of orbital and spin angular momenta. C.G. coefficients for unitary transformation.
- Stationary perturbation theoretical approach for finding approximate solution of quantum mechanical problems.

Unit-I Teaching Hours: 15

Origin of quantum mechanics: particle aspects, wave aspects and wave-particle duality, uncertainty principle, Schrodinger equation, time evolution of a wave packet, probability current density, continuity equation, orthogonality and normalization of the wave function, box normalization, admissibility conditions on the wave function.

Operators: Hermitian operators, bra and ket notation, Matrix representation of an operator Poisson brackets and commutators, Eigen values, Eigen functions, postulates of quantum mechanics, expectation values, Ehrenfest's theorems.

Unit-II Teaching Hours: 15

Shrodinger eq. & particle in Box: Bound and unbound states of a system. Application of time independent Schrodinger wave equation: Potential step, rectangular potential barriers - reflection and transmission coefficient, barrier penetration; particle in a one dimensional box and in a cubical box, density of states; rotator;
Angular Momentum Operators: Orbital angular momentum operators - expressions in cartesian and polar coordinates, eigenvalue and eigen functions, spherical harmonics
Harmonic Oscillator Problem: one dimensional linear harmonic oscillator - evaluation of expectation values of x2 and px2Rigid
Hydrogen Atom: Hydrogen atom - solution of radial equation.

Unit-III Teaching Hours: 15

Approximation methods:
Time independent perturbation theory: First and second order perturbation theory applied to non-degenerate case; first order perturbation theory for degenerate case.
Time dependent perturbation theory: First order perturbation, Harmonic perturbation, Fermi's golden rule, adiabatic approximation method, sudden approximation method. Variational method, WKB approximation, validity and application toward 1D box, SHO, etc.

Unit-IV Teaching Hours: 15

Introduction of Scattering Theory: Scattering cross section, Differential and total cross section, Partial wave analysis for scattering amplitude, expansion of a plane wave into partial waves, phase shift, cross section expansion, s-wave scattering by a square well, Optical theorem.
Born Approximation: Born approximation for the scattering amplitude, scattering by spherically symmetric potentials, screened coulomb potential

Text books And Reference Books:

1. Zettli, N. (2017). Quantum mechanics. New Delhi: Wiley India Pvt Ltd.
2. Aruldhas, G. (2010). Quantum mechanics. New Delhi: Prentice-Hall of India.
3. Ghatak, A. K. & Lokanathan, S. (1997). Quantum mechanics: McMillan India Ltd
4. Schiff, L.I. (2017) Quantum Mechanics. India: Mc Graw Hill.
5. Crasemann, B. & Powell, J.L.(2015)Quantum Mechanics. India: Dover Publications.
6. Mathews, P.M. & Venkateson, K. (2017) Quantum Mechanics. India: Mc Graw Hill.
7. Ghatak, A. & Loknathan, S. (2012) Quantum Mechanics. India: Laxmi Publications
8. Zettili, N.(2009) Quantum Mechanics. New York: Wiley Pub.
9. Bransden, B.H. & Joachain (2004) Quantum Mechanics .India:Pearson Pub.
10. Gasiorowicz, S. (2003) Quantum Mechanics .New York: Wiley
11. Sakurai, J.J. & Jim Napolitano (2020) Modern Quantum Mechanics. India: Cambridge University Press.

12. Griffiths, D.J.& Schroeter, D.F.(2019) Introduction to Quantum Mechanics. India: Pearson Pubications

13. Shankar, R. (2011) Principles of Quantum Mechanics. New York: Springer.

14. Ashok Dass

SYLLABUS (Core Course)

NAME OF PAPER: STATISTICAL PHYSICS

Paper Code: MSc/1/PHY/SP/CC5 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

The aim of this course is to help the students to relate between statistics and thermodynamics. A student will be introduced with microcanonical, canonical and grand canonical ensembles and their partition functions and phase transitions of first and second order.

Course Outcome

- A student will be able to understand the basic concepts of thermodynamics and set a relation between thermodynamics and statistics.
- A fair knowledge about the various ensembles and learn about the behavior of classical Ideal gas under various ensembles.
- A student will acquire sound knowledge of M.B., B.E. and F.D. statistics and understand the phenomenon of Bose-Einstein condensation and black body radiations.
- A student will have fair knowledge of Landau theory of phase transition, Ising model, Langevin theory of Brownian motion.

Unit-I Teaching Hours: 15

Basic Concept: Review of Thermodynamic concepts/laws required for Statistical mechanics, Thermodynamic potentials, Maxwell's relations, Chemical potential, Macroscopic and Microscopic states, Postulate of equal a priori probability, Contact between Statistics and Thermodynamics, Equipartition theorem, Entropy of mixing, Gibbs paradox, Sackur-Tetrode equation

Unit-II Teaching Hours: 15

Classical ensemble theory: Phase space, microstates and macrostates; Liouville's equation, Postulates of statistical mechanics, Microcanonical ensemble, Boltzmann relation for entropy, Definition of temperature, derivation of the laws of thermodynamics for macroscopic systems, Sackur-Tetrode equation, Canonical ensemble; partition function; Helmholtz free energy, Grand-canonical ensemble, Equivalence of the various ensembles, Application to various classical systems.

Unit-III Teaching Hours: 15

Quantum statistical mechanics: Indistinguishable particles in quantum mechanics. Bosons and Fermions. Bose-Einstein statistics, ideal Bose gas, photons, Bose-Einstein condensation. Fermi-Dirac statistics, Fermi energy, ideal Fermi gas. Density operator, Quantum Liouville equation. Pure and mixed states.

Unit-IV Teaching Hours: 15

Critical Phenomena and Phase Transition: Phase transitions and thermodynamic functions. Thermodynamic limit and its importance. Mean field theory, Landau theory. Correlation functions, Ornstein-Zernike theory, Critical behaviour, Critical exponents,
Scaling and Universality, Upper and lower critical dimensions. Renormalization group: basic i dea, flows, fixed points, Application to 2-d Ising and Potts models.

Text books And Reference Books:

1. Statistical Mechanics: Patheria.
2. Statistical Physics I and II: Kubo, Toda and Ashitsume.
3. Modern Theory of Critical Phenomena: Ma.
4. Statistical Mechanics: Landau and Lifshitz.
5. Lectures on Phase Transitions and Rnormalization Group: Goldenfeild.
6. Statistical Physics of Particles, Mehran Kardar (Cambridge University Press, 2007).
7. Statistical Mechanics, Kerson Huang (2ndEdition, Wiley-India, 2008).
8. Statistical Mechanics, R.K. Pathria (Butterworth-Heinemann, 1996).
9. Statistical Mechanics:An Advanced course with problems and solutions, Ryogo Kubo (North-Holland, 1965).

PRACTICAL LAB SYLLABUS (Core Course)

NAME OF PAPER: GENERAL PHYSICS LAB

Paper Code: MSc/1/PHY/GL/CC5 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

The major objective of this course is to expose the various types of mathematical operations like addition, subtraction using digital circuits. Students by this course will be trained to acquire practical knowledge about the characteristics of FET, MOSFET, and the applications of Op-Amp., diodes, resistors and capacitors.

Course Outcome

After completion of experimental, students will be able to:

- Perform the mathematical operations like addition, subtraction using digital circuits.

- learn the characteristics and applications of semiconductor based FET, MOSFET.
- Understand the working of various types of digital circuits and importance in our daily life.
- Understand the applications of Op-Amp., diodes, resistors and capacitors.

Experiments List

S.No.	Experiments
1.	To study the full adder and subtractor.
2.	To verify the truth table of four bit adder and subtractor.
3.	To study the switching action of FET.
4.	To plot the input and output characteristics of JFET.
5.	To study of input and output characteristics of MOSFET.
6.	To verify the truth table of various types of Flip-Flop.
7.	To plot the behavior of clipping and clamping circuits.
8.	To design the op-Amp as: subtracting, summing, scaling amplifier.
9.	To study the op-Amp in inverting and non-inverting mode.
10.	To study various types of counters.
11.	To study the Op-Amp as Schimitt trigger.
12.	To plot the characteristics of Zener diode.
13.	To study the transistor as astable multivibrator.
Any other Experiments/Innovations related to Physics can be added.	

Text/Reference books:

1. Millman, J. & Halkias, C. C. (2017). Integrated Electronics. India: Mc Graw Hill Edu.
2. Senior, J.M. (2010) Optical Fiber Communication- Principle and Practicals. India: Pearson Edu Jafer, D. (2005) Fiber Optics Communication and Technology. India: Pearson Pub.
3. Sze, S.M.(2021) Physics of Semiconductors. New York: Wiley Interscience Pub.
4. Parker, M.A. (2005) Physics of Optoelectronics. Florida:CRC Press.
5. Kothari, D.P. (2017) Basic Electronics.India: Mc Graw Hill Edu.
6. Sukhija, M.S. & Nagsarkar, T.K. (2016) Circuits and Networks. Oxford: Oxford University Press
7. Gupta, S. (2010) Electronic devices and Circuits. New Delhi: Dhanpat Rai Pub.
8. Gayakwad, R. (2015) Op-Amps and Linear Integrated Circuits. India: Pearson College.
9. Maini, A.K. (2007) Digital Electronics: Principles, Devices and Applications. New York: Wiley Pub.
10. Millman, J. & Grabel (2017) Microelectronics. India: Mc Graw Hill Edu.
11. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall
12. Jain, R.P. (2009) Modern Digital Electronics. India: Mc Graw Hill Edu.

PRACTICAL LAB SYLLABUS (Core Course)

NAME OF PAPER: ELECTRONICS LAB

Paper Code: MSc/1/PHY/EL/CC6 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

The major objective of this course is to revise the basic concepts of electronics through standard set of experiments like verification of various types of Logic Gates and their truth tables, fourier analysis, multivibrators, applications of digital electronics circuits and demonstration of CRO.

Course Outcome

After completion of experimental, students will be able to:

- Understand the law of Boolean algebra and learn about the working and applications of various types of digital circuits.
- Understand the CRO working and its applications.
- Study the importance of fourier analysis.
- Acquire the knowledge about the working and importance of BJT, Multivibrators and UJT in our daily life.

Experiments List

S.No.	Experiments
1.	To study the various types of Logic Gates and verify their truth tables.
2.	To verify the truth tables of various types of Logic Gates using NAND Gates.
3.	To study the switching action of BJT.
4.	To study CRO Demonstrator.
5.	Find out the ionization potential of a given sample using Thyratron.
6.	To study the parity checker and generator.
7.	To study Fourier analysis of different wave trains.
8.	To measure phase shift, deflection sensitivity & frequency of unknown ac signal using CRO.
9.	To verify various Boolean expressions and De Morgan's theorems.
10.	To study the UJT characteristics.
11.	To study shift registers.
12.	To verify the truth tables of different types of counters.
13.	To study the monostable and bistable multivibrators.
Any other Experiments/Innovations related to electronics can be added.	

Text/Reference books:

1. Millman, J. & Halkias, C. C. (2017). Integrated Electronics. India: Mc Graw Hill Edu.
2. Millman, J. & Grabel (2017) Microelectronics. India: Mc Graw Hill Edu.
3. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall
4. Jain, R.P. (2009) Modern Digital Electronics. India: Mc Graw Hill Edu.
5. Senior, J.M. (2010) Optical Fiber Communication-Principle and Practicals. India: Pearson Edu
6. Jafer, D. (2005) Fiber Optics Communication and Technology. India: Pearson Pub.
7. Sze, S.M. (2021) Physics of Semiconductors. New York: Wiley Interscience Pub.
8. Parker, M.A. (2005) Physics of Optoelectronics. Florida: CRC Press.
9. Kothari, D.P. (2017) Basic Electronics. India: Mc Graw Hill Edu.
10. Sukhija, M.S. & Nagsarkar, T.K. (2016) Circuits and Networks. Oxford: Oxford University Press.
11. Gupta, S. (2010) Electronic devices and Circuits. New Delhi: Dhanpat Rai Pub.
12. Maini, A.K. (2007) Digital Electronics: Principles, Devices and Applications. New York: Wiley. Pub.

Seminar

Paper Code: NTCC **Max. Marks: 100**

Course Objectives/Course Description

To improve oral and written communication skills. Exploring creative avenues of expression. Removing hesitation of speaking on a topic before audience. Development of critical thinking and confidence level.

Course Outcome:

- Students would be able to create, revise and present ideas in spoken and written forms. Acquired listening, questioning and critical thinking skills. Demonstrate ability to defend and support ideas/claims with appropriate evidence. Students gained experience for how to organize and deliver/disseminate knowledge before audience.

Semester-II

SYLLABUS (Core Course)

NAME OF PAPER: SOLID STATE PHYSICS

Paper Code: MSc/2/PHY/SS/CC1 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

This course conveys a broad knowledge of solid structure, diffraction of waves, lattice vibrations, free electron gas, Kronig-Penny model and superconductivity. The principles and techniques are basics of materials science research.

Course Outcome

- Basic knowledge of lattice structure and diffraction of waves by crystals develop an understanding of solid state.
- Formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials
- Understand the electron states of solid crystals.
- Knowledge of superconductivity and BCS theory will be imparted to the students.

Unit-I Teaching Hours: 15

Crystal Structure & lattice Dynamics: Crystalline solids, Unit cell, Direct lattice, Two and three dimensional Bravais lattices, Miller indices, Close packed structures, Reciprocal lattice and its application to diffraction technique, Brillouin zones, Diffraction of waves by crystals: X-ray diffraction, Laue, Powder and Rotating crystal methods, Scattered wave amplitude, Crystal structure factor.

Unit-II Teaching Hours: 15

Thermal Properties: Quantization of elastic waves, Phonon momentum, Dispersion relation for the Vibrations of one dimensional monoatomic and diatomic lattices, Acoustical and optical phonon modes, Inelastic scattering of neutrons by phonons, Lattice specific heat (Einstein & Debye model), Free electron Fermi gas, Energy levels and density of orbitals in one dimension, Free electron gas in three dimensions.

Unit-III Teaching Hours: 15

Dielectric & Ferroelectric: Macroscopic description, electric polarization and linear dielectrics, polarizability, sources of microscopic polarizations, theory of electronic, ionic and dipolar polarizability, local field and Clausius-Mosotti relation. Dipolar dispersion and Debye equation. Piezo-Pyro and Ferroelectric properties of crystals (qualitative discussion)

Unit-IV Teaching Hours: 15

Magnetism: Origin of magnetic moments in atoms/ions, Hund's rule, Crystal field effect, Quantum theory of paramagnetism and diamagnetism. Pauli paramagnetism Ferromagnetism: Exchange Interactions and magnetic-order, Weiss model of ferromagnetism, Magnetic domains. Band ferromagnetism & stoner criterion (qualitative discussion)

Superconductivity: Discovery, Critical temperature and Field, Perfect diamagnetism and Meissner effect, Type I and Type 2 superconductors, Phenomenological theory, London equations, thermodynamics: specific heat and energy gap, The isotope effects, Microscopic BCS theory (qualitative), Coherence of superconducting state, Flux quantization and Josephson effect (qualitative).

Text/Reference books:

1. Hofmann, P. (2015). Solid state physics -An introduction (2nd ed.): Wiley-VCH.
2. Omar, M. A. (1993). Elementary solid state physics - Principles and applications (1st ed.): Pearson.
3. Wahab, M. A. (2005). Solid state physics - Structure and properties of materials (2nd ed.): Alpha Science International
Kittel, C. (2012). Introduction to solid state physics (8th ed.): Wiley.
4. Blundell, S. (2001). Magnetism in condensed matter: Oxford University Press.
5. Pillai, S. O. (2015). Solid state physics (7th ed.): New Age International Private Ltd.
6. Singleton, J. (2014). Band theory and electronic properties of solids (1st ed.) Oxford University Press.
7. Dekker, A. J. (2008). Solid State Physics. New Delhi: Laxmi Publications.
8. Ashcroft, N., & Mermin N. D. (2003). Solid State Physics. Boston: Cengage Learning.
9. Omar, M. A. (1993). Elementary Solid State Physics. London: Pearson.
10. Srivastava,J. P. (2014). Elements of Solid State Physics. New Delhi: PHI.
11. Wahab, M. A. (2015). Solid State Physics. New Delhi: Narosa.
12. Kakani, S. L., & Hemrajani, C. (2005). Solid State Physics. New Delhi: Sultan Chand & Sons.
13. Hook, J. R., & Hall, H. E. (1991). Solid State Physics. New York: Wiley.
14. Singh, N. (2017). Solid State Physics. New Delhi: Narosa.

SYLLABUS (Core Course)

NAME OF PAPER: CLASSICAL ELECTRODYNAMICS

Paper Code: MSc/2/PHY/CE/CC2 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

This course has been conceptualized in order to give students to get exposure to the fundamentals of Electrodynamics. Students will be introduced to the topics such as Electrostatics, Magnetostatics, Electromagnetic waves, Propagation of wave through waveguide, Electromagnetic radiation and relativistic electrodynamics.

Course Outcome

By the end of the course the learner will be able to

- Understand the unification of electric and magnetic fields, condition of wave propagation in different media and concept relativistic electrodynamics.
- Understand the concepts of Maxwell's equations.
- Understand the properties of EM waves and its propagation
- Apply the knowledge of these properties to radiation mechanisms.
- Analyze and develop problem solving in electrodynamical systems

Unit-I Teaching Hours: 15

Electrostatics: Review of electrostatics, Electrostatic boundary conditions, Poisson's equation and Laplace's equation, uniqueness theorem. Solution to Laplace's equation in
a) Cartesian coordinates, applications: (1) rectangular box and (2) parallel plate condenser,
b) Spherical coordinates, applications: potential outside a charged conducting sphere and
c) Cylindrical coordinates, applications: potential between two co-axial charged conducting cylinders. **Method of images**: Potential and field due to a point charge (1) near an infinite conducting sphere and (2) In front of a grounded conducting sphere.

Boundary value problems in Electrostatics: Methods of Image, Point Charge in the presence of a grounded conducting sphere, point charge in the presence of a charged insulated conducting sphere, point charge near a conducting sphere at a fixed potential, conducting sphere in a uniform electric field by method of images, Green function for the sphere, General solution for the potential. Conducting sphere will hemispheres at a different potentials, orthogonal functions and expansion.

Unit-II Teaching Hours: 15

Magnetostatics: Currents and equation of continuity, Biot-Savart's law, Ampere's law, Differential equations of magnetostatics, Vector potential, Magnetostatic energy. Ohm's law. Boundary conditions for magnetic field at the interface. Review of magnetostatics, Multipole expansion of the vector potential, diamagnets, paramagnets and ferromagnets, magnetic field inside matter, Ampere's law in magnetized materials, Magnetic susceptibility and permeability

Unit-III Teaching Hours: 15

Time varying fields, Maxwell's equations conservation laws: Energy in a magnetic field, vector and scalar potentials, Gauge transformations, Lorentz gauge, coulomb gauge, Green function for the wave equation, Derivation of the equations of Macroscopic Electromagnetism, Poyhting's Theorem and conservation of energy and momentum for a system of charged particles and EM field. Conservation laws for macroscopic media. Electromagnetic field tensor, transformation of four potentials and four currents, tensor dissipation of Maxwell's equations.

Unit-IV Teaching Hours: 15

Electromagnetic radiation and relativistic electrodynamics: Electric dipole radiation, magnetic dipole radiation, Power radiated by a point charge, radiation reaction, mechanism responsible for radiation reaction.

Relativistic electrodynamics: Review of Lorentz transformations. Magnetism as a relativistic Phenomenon, Transformation of electric and magnetic Fields, Electric field of a point charge in uniform motion, Field tensor, Electrodynamics in tensor notation, Relativistic potentials.

Text Books and Reference Books:

1. Sadiku, M. N. O. (2010). Elements of electromagnetics (4th ed.): Oxford Press.
2. Griffiths, D. J. (2002). Introduction to electrodynamics: Prentice-Hall of India.
3. Panofsk, W. K. H., & Phillips, M. (2012). Classical electricity and magnetism (2nd ed.). New York, NY: Dover Publishing Inc.
4. Jackson, J. D. (2007). Classical electrodynamics (3rd ed.). New York, NY: Wiley India Pvt. Ltd.
5. Singh, R. N. (1991). Electromagnetic waves and fields. New York, NY: Tata McGraw Hill.
6. Lorrain, P., & Corson, D. (1986): Electromagnetic fields and waves. New Delhi: CBS Publishers and Distributors.

SYLLABUS (Core Course)

NAME OF PAPER: NUCLEAR & PARTICLE PHYSICS

Paper Code: MSc/2/PHY/NP/CC3 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

This course has been conceptualized in order to give students an exposure to the fundamentals of nuclear and particle physics. Students will be introduced to the new ideas such as the properties and structure of nucleus, different theoretical approaches to the structure of nucleus, nuclear force, Fermi's theory, fundamental particles and their interactions, particle accelerators.

Course Outcome

- To understand the underlying structure of nucleus, properties, how the nuclear radiations interact with matter and form the basis for the working of detectors.
- To apply different models to understand the structure and properties of nucleus

Unit-I Teaching Hours: 15

Introductory concepts and nuclear forces & nuclear beta and gamma decay: Basic nuclear properties: size, shape, charge distribution, spin and parity, moments and statistics, binding energy, Fundamental forces of nature, charge independence and charge symmetry of nuclear forces, Isospin. Electric and magnetic multipole moments and gamma decay, reduced transition probability, selection rules, internal conversion and zero –zero transitions. Nuclear beta decay and lepton capture, electron energy spectrum, fermi and GT transitions, Forbidden transitions, Experimental verification of parity conservation

Nuclear Models: Concept of Liquid drop model, Magic nuclei, nucleon separation energy, Single particle shell model (including Mean filed approach, spin orbit coupling), Physical concepts of the unified model (Collective Model)

Unit-II Teaching Hours: 15

Interaction of radiation with matter and elementary particles:

Interaction of radiation with matter: Interaction of charged particles with matter - energy loss of heavy charged particles in matter, Bethe-Bloch formula. Energy loss of electrons and beta particles, absorption coefficient for beta rays. Interaction of gamma rays with matter - Photoelectric, Compton and Pair production, Coherent scattering (Rayleigh and Thomson), total interaction cross-section and mass attenuation coefficient for gamma rays, scintillation detector, Scintillation mechanism in NaI(Tl), NaI(Tl) gamma ray spectrometer. Semiconductor radiation detectors - surface barrier detectors, Li ion drifted detectors (Si(Li) and Ge(Li))

Nuclear Reactions: Theories of nuclear reaction, partial wave analysis of reaction cross section, compound nucleus and breakups, resonance scattering and reaction, Britt Wigner formula, the optical model, statistical theory of nuclear reactions

Unit-III Teaching Hours: 15

Experimental Techniques: Gas filled counters, Scintillation counter, Cerenkov counters, Solid State detectors, Surface barrier detectors, Electronic circuits used with typical nuclear detector, Multiwire proportion chambers, Nuclear emulsions, techniques of measurement and analysis of tracks, proton synchrotron, Linear accelerators, Acceleration of heavy ions.

Unit-IV Teaching Hours: 15

Nucleon-nucleon scattering and potential: partial wave analysis of the neutron-proton scattering al low energy assuming central potential with square well shape, concept of the scattering length, coherent scattering of neutrons by protons in (ortho and para)hydrogen molecule; conclusion of these analyses regarding scattering length, range and depth of the potential; the effective range theory(in neutron-proton scattering)and the shape independence of nuclear potential : A qualitative discussion of proton-proton scattering at low energy: General features of two body scattering at high energy.

Reference Books:

1. Atomic and Nuclear Physics Vol. II: Ghoshal.
2. Nuclear Structure: Preston and Bhaduri.
3. Nuclear Structure: Pal.
4. Introductory Nuclear Physics: Wong.
5. Nuclear Theory: Elton.
6. Nuclear Interactions: de Benedetti.
7. Kane and A. Arbor: Modern Elementary Particle Physics-Explaining and Extending the Standard Model, 2nd Edn, Cambridge University Press, 2018.
8. H. Frisch and A. M. Thorndike: Elementary Particles, D. Van Nostrand, 1964.
9. S. Krane: Introductory Nuclear Physics, Wiley, 2003.
10. R. Roy and B. P. Nigam: Nuclear Physics, Wiley Eastern Ltd., 1967.
11. S. Kapoor and V. S. Ramamoorthy: Radiation Detectors, Wiley Eastern, 1986.
12. F. Knoll: Radiation Detection and Measurement, 2nd Edn. John Wiley, 1989.

SYLLABUS (Core Course)

NAME OF PAPER: QUANTUM MECHANICS - II

Paper Code: MSc/2/PHY/QM/CC4 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

Objective of the current course is to familiarize the students to the formal structure of the subject, idea of identical particles, relativistic quantum mechanics and their applications so that they can use such concepts in various branches of Physics as per requirement.

Course Outcome

After successful completion of the course on Quantum Mechanics-II, the outcomes are as:

- Students would be capable to learn about symmetric and anti- symmetric wave function identical particles, commutation relations, spin- statistics connection and He-atom.
- Students would be introduced to KG equation, Dirac equation, spin orbit energy and negative energy states in relativistic quantum mechanics and its contribution for advancement in quantum physics.

Unit-I Teaching Hours: 15

Identical Particles and Spin: Physical meaning of identity, Symmetric and anti- symmetric wave function, Construction of symmetric and anti- symmetric wave function from unsymmetrized functions, Distinguishability of identical particles, Pauli exclusion principle, Collision of identical particles, Pauli spin operators, Commutation relations, Spin - Statistics connection, Spin matrices and eigen functions, Electron spin function, The helium atom (Para and ortho helium).

Unit-II Teaching Hours: 15

Relativistic Formulation and Dirac Equation: Attempt for relativistic formulation of quantum theory, The Klein-Gordon equation, Probability density and probability current density, solution free particle K.G. equation in momentum representation, interpretation of negative probability density and negative energy solution. Dirac equation for a free particle, properties of Dirac matrices and algebra of gamma matrices, non-relativistic correspondence of the Pauli equation (inclusive of electromagnetic interaction). Solution of the free particle Dirac equation, orthogonality and completeness relation for Dirac spinors, interpretation of negative energy solution and whole theory.

Unit-III Teaching Hours: 15

Quantum Filed Theory: Lagrangian density and equation of motion for field and em field. Symmetries and conservation laws, Noether's theorem, cononical quantization of scalar field, Complex scalar field, electromagnetic field and Dirac field, Problem in Quantizing electromagnetic field, Gupta & Bluer method. Second quantisation of real Klein-Gordon field and complex KG field. The meson propagator, the photon propagator, interaction and gauge invariance.

Unit-IV Teaching Hours: 15

S-matrix and Expansion: S-matrix, its expansion, wicks theorem, diagrammatic representation in configurationally space, the momentum representation,
Feynman rules & Scattering: Feynman rules (without derivation), Feynman diagrams. Application of S-Matrix formulism: The Coulomb scattering, Bhabha scattering, Moller scattering, Compton scattering and pair production.

Reference Books:

1. Schiff, L.I.(2017) Quantum Mechanics. India: Mc Graw Hill.
2. Crasemann, B. & Powell, J.L.(2015)Quantum Mechanics. India: Dover Publications.
3. Mathews, P.M. & Venkateson, K.(2017)Quantum Mechanics. India: Mc Graw Hill.
4. Ghatak, A. & Loknathan, S. (2012)Quantum Mechanics. India: Laxmi Publications
5. Zettili, N.(2009) Quantum Mechanics.New York: Wiley
6. Bransden, B.H. & Joachain(2004)Quantum Mechanics . India: Pearson Pub.
7. Gasiorowicz, S. (2003) Quantum Mechanics .New York: Wiley
8. Sakurai, J.J. & Jim Napolitano (2020) Modern Quantum Mechanics. India: Cambridge University Press.
9. Griffiths, D.J.& Schroeter, D.F.(2019)Introduction to Quantum Mechanics. India: Pearson Pubications
10. Shankar , R. (2011) Principles of Quantum Mechanics. New York: Springer
11. Merzbacher, E.()Quantum Physics. New York: Wiley Pub.

SYLLABUS (Core Course)

NAME OF PAPER: INTRODUCTION TO NONLINEAR OPTICS

Paper Code: MSc/2/PHY/NO/CC5 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

Students will acquire essential understanding courses for theoretical formulation of the physical phenomena at Nonlinear Optics.

Course Outcome

A successful student should be able to:

1. demonstrate a detailed physical and mathematical understanding of a variety of systems and processes in a range of advanced topics in physics;
2. apply the concepts and theories of a range of advanced topics in physics;
3. demonstrate specialised analytical skills and techniques necessary to carry out advanced calculations in a range of advanced topics in physics;
4. approach and solve new problems in a range of advanced topics in physics;
5. Demonstrate an understanding of the close relationship between scientific research and the development of new knowledge in a global context.

Unit-I Teaching Hours: 15

Introduction to Nonlinear Optics: Refractive index, Frequency and intensity dependent refractive index, Wave propagation in an anisotropic crystal, Polarization response of materials to light, Second harmonic generation, Sum and difference frequency generation, Phase matching.

Unit-II Teaching Hours: 15

Multiphoton Processes: Two photon process, Theory and experiment , Three photon process parametric generation of light, Oscillator, Amplifier, Stimulated Raman scattering, Intensity dependent refractive index, Optical Kerr effect, Photorefractive, Electron optic effects.

Unit-III Teaching Hours: 15

Nonlinear Optical Materials: Basic requirements, Inorganics, Borates, Organics, Urea, Nitro aniline, Semi organics, Thiourea complex, Kurtz test, Laser induced surface damage threshold.

Unit-IV Teaching Hours: 15

Fibre Optics: Graded index, Fibbers wave propagation, Fibre modes, Single and multimode fibres, Numerical aperture, Dispersion, Fibre bandwidth, Fiber loss, Attenuation coefficient, Material absorption.

Reference Books:

1. B.B. Laud, Lasers and Nonlinear Optics, New Age International (P) Ltd., New Delhi, 1991.
2. Robert W. Boyd, Nonlinear Optics, Academic Press, New York, 2003.
3. Govind P. Agarwal, Fiber-Optics Communication Systems, John Wiley & Sons, Singapore 2003.
4. William T. Silvast, Laser Fundamentals, Cambridge University Press, Cambridge, 2003.
5. Nonlinear Optics, Basic Concepts D.L. Mills, Springer, Berlin, 1998.

PRACTICAL LAB SYLLABUS (Core Course)

NAME OF PAPER: GENERAL PHYSICS LAB-I

Paper Code: MSc/2/PHY/GL/CC5 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

Provide an exposure to instrumentation such as Multiplexer/Demultiplexer and Encoder/Decoder circuits. It will impart the skill on the experimental technique and will provide a hand on experience about G.M counter, capacitance of unknown sample and applications of op-amp.

Course Outcome

After completion of experimental, students will be able to:

- Understand the meaning and importance of Stefan's constant, capacitance of capacitor and Op-Amp.
- Gain the knowledge about the Network theorems.
- Understand applications of Thomson method and various types of digital circuits.
- design the different types of electronic circuits using different ICs on bread board

Experiments List

S.No.	Experiments
1.	To determine the Stefan's constant with the help of given apparatus.
2.	To estimate the efficiency of G.M counter for gamma ray source.
3.	To determine capacitance of an unknown capacitor using flashing and quenching kit.
4.	To study the e/m of an electron by Thomson method.
5.	Experimental verification of Network theorems: Kirchoff s law, superposition, Thevenin and Norton theorem for a given circuit.
6.	To measure the capacitance and permittivity of a given Sample.

7.	Demonstration and realization of Multiplexer/Demultiplexer
8.	To study the Encoder/Decoder circuits.
9.	To study Op-Amp as logarithmic and antilogrithmic amplifiers.
10.	To draw the characteristics of optoelectronics devices.
11.	To study the different characteristics of pn-junction diode.
12.	To design the various types of electronic circuits on bread board using different ICs.
Any other Experiments/Innovations related to Physics can be added.	

Text/Reference books:

1. Ghatak, A. & Tyagrajan. K.(2013) Introduction to Fiber Optics. India: Cambridge University press.
2. Sze, S.M.(2021) Physics of Semiconductors. New York: Wiley Interscience Pub.
3. Parker, M.A. (2005)Physics of Optoelectronics. Florida: CRC Press.
4. Kothari, D.P.(2017) Basic Electronics. India : Mc Graw Hill Edu.
5. Millman, J. & Halkias, C. C.(2017). Integrated Electronics. India: Mc Graw Hill Edu.
6. Senior, J.M.(2010)Optical Fiber Communication- Principle and Practicals . India: Pearson Edu
7. Jafer, D. (2005)Fiber Optics Communication and Technology. US: Pearson Edu.
8. Sukhija, M.S. & Nagsarkar, T.K. (2016) Circuits and Networks. Oxford : Oxford University Pres
9. Gupta, S.(2010) Electronic devices and Circuits. New Delhi: Dhanpat Rai Pub.
10. Gayakwad, R. (2015)Op-Amps and Linear Integrated Circuits. India: Pearson College.
11. Maini, A.K.(2007)Digital Electronics: Principles, Devices and Applications. New York: Wiley Pub.
12. Millman, J. & Grabel (2017) Microelectronics. India: Mc Graw Hill Edu.
13. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall
14. Jain, R.P.(2009)Modern Digital Electronics. India: Mc Graw Hill Edu.

PRACTICAL LAB SYLLABUS (Core Course)

NAME OF PAPER: GENERAL PHYSICS LAB-II

Paper Code: MSc/2/PHY/GL/CC6 **Credits: 04**

Total Teaching Hours: 60

Max. Marks: 100

Course Objectives/Course Description

This Lab course is designed to carry out advanced level experiments like determining the Planck's constant using LEDs, various filters, oscillators. Students will be able to gain knowledge about the gain of Chopper Amplifier applications of op-amp, FET, h-parameters of a pnp transistor in CE configuration.

Course Outcome

After completion of experimental, students will be able to:

- Understand the working of various applications of transistor based apparatus.
- Design the circuits of various types of filters and amplifiers.
- Understand the different applications of Op-Amp.
- learn about the importance of oscillators based electronics devices in our daily life

Experiments List

S.No.	Experiments
1.	To determine the h- parameters of a pnp transistor in CE configuration.
2.	To study the RF oscillator using tuned (i) Hartley's Oscillator (ii) Colpitt's Oscillator.
3.	To study the low pass and high pass Active filters.
4.	To study the band pass and band reject filters.
5.	To design and demonstrate the passive filters.
6.	To study op-amp as differentiator & integrator.
7.	To study the D.C gate control characteristics and anode current characteristics of SCR.
8.	To study the Chopper Amplifier.
9.	To study the chopped wave forms and the leakage current compensation for FET Switch.
10.	To measure the gain of Chopper Amplifier and to study the recovery of original signal
11.	To determine the Planck's Constant using LEDs.
12.	To study the OP-Amp as voltage follower.

13.	To study the OP-Amp as comparator.
14.	Study of characteristics of LED and PIN Photo Detector.
15.	Study of frequency response of optical receiver.
16.	To study attenuation in optical fibres
17.	To find numerical aperture of optical fibers.
18.	Study of noise in an optical receiver.
19.	Diffraction of light by cross wire/fine wire mesh.
20.	Gaussian nature of laser beam/beam spot measurement/ divergence measurement.
21.	Characteristics of light dependent resistor (LDR), LED, photo diode and photo transistor, solar cell.
Any other Experiments/Innovations related to Physics can be added.	

Text/Reference books:

1. Jafer, D.(2005)Fiber Optics Communication and Technology. US : Pearson Pub.
2. Sze, S.M.(2021) Physics of Semiconductors. New York : Wiley Interscience Pub.
3. Parker, M.A. (2005) Physics of Optoelectronics. Florida: CRC Press.
4. Kothari, D.P.(2017) Basic Electronics.India : Mc Graw Hill Edu.
5. Ghatak, A. & Tyagrajan. K.(2013) Introduction to Fiber Optics. India: Cambridge University Press.
6. Millman, J. & Halkias, C. C. (2017). Integrated Electronics. India: Mc Graw Hill Edu.
7. Senior, J.M.(2010)Optical Fiber Communication- Principle and Practicals. India: Pearson Edu
8. Sukhija, M.S. & Nagsarkar, T.K. (2016) Circuits and Networks. Oxford : Oxford University Pres
9. Gupta, S.(2010) Electronic devices and Circuits.New Delhi: Dhanpat Rai Pub.
10. Gayakwad, R. (2015)Op-Amps and Linear Integrated Circuits.India: Pearson College.
11. Maini, A.K.(2007)Digital Electronics: Principles, Devices and Applications. New York: Wiley Pub.
12. Millman, J. & Grabel (2017)Microelectronics. India: Mc Graw Hill Edu.
13. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall.
14. Jain, R.P. (2009)Modern Digital Electronics. India: Mc Graw Hill Edu.

Industrial & Skill Oriented Course

SYLLABUS (ISO)

NAME OF PAPER: RENEWABLE ENERGY AND ENERGY HARVESTING

Paper Code: MSc/2/PHY/RE/ISO1 **Credits: 02**

Total Teaching Hours: 30

Course Objectives/Course Description

This module makes the students familiar with the significance of Energy resources in daily life. The important energy sources like solar photovoltaic & solar thermal energy, wind energy, and ocean energy are discussed. Advancement in the field of fuel cells and hydrogen as an energy source is also highlighted.

Course Outcome

The course on Renewable Energy and Applications will help the learner to understand the development of Alternate Energy resources and its significance. It also helps them to get an idea about the emerging development in the energy research

UNIT-I **Teaching Hours-09**

S.No.	Syllabus
1.	**Fossil fuels and Alternate Sources of energy:** Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.
2.	**Solar energy:** Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

UNIT-II **Teaching Hours-08**

1.	**Wind Energy harvesting:** Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

UNIT-III **Teaching Hours-08**

1.	**Geothermal Energy:** Geothermal Resources, Geothermal Technologies.
2.	**Hydro Energy:** Hydropower resources, hydropower technologies, environmental impact of hydro power sources.
3.	**Piezoelectric Energy harvesting:** Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

UNIT-IV **Teaching Hours-05**

1.	**Electromagnetic Energy Harvesting:** Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries and power consumption. Environmental issues and Renewable sources of energy, sustainability.

Demonstrations and Experiments:

S.No.	Experiments
1.	Demonstration of Training modules on solar energy, wind energy, etc.
2.	Conversion of vibration to voltage using piezoelectric materials
3.	Conversion of thermal energy into voltage using thermoelectric modules.
Any other Experiments/Innovations related to renewable energy and energy harvesting can be added.	

Reference Books:

• Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

• Solar energy - M P Agarwal - S Chand and Co. Ltd.

• Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.

• Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.

• Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009

• J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

• http://en.wikipedia.org/wiki/Renewable_energy