SYLLABUS
M. Sc. PHYSICS

Program Code:-MSPHY

SESSION: 2023-24

MATA GUJRI COLLEGE
FATEHGARH SAHIB
(AN AUTONOMOUS COLLEGE)
AFFILIATED TO PUNJABI UNIVERSITY, PATIALA

CONTENTS

ABOUT THE PROGRAMME

Department of Physics was established in the year 1959 and introduced M.Sc. Physics course in 2010. M.Sc. Physics is a two-year Postgraduate degree program offered by the P.G. Department of Physics and degrees are affiliated to Punjabi university, Patiala. The course has semester system that is distributed annually and the course is divided into 4 semesters. Candidates enrolled in M.Sc. Physics course learn about various topics associated with the concepts of Physics. Physics is a science of observation of physical phenomena that involves the study of matter and its motion through space, along with related concepts, the main goal of physics is to understand how the universe evolved and behaves Physics often explain the fundamental mechanisms of other sciences and is governed by the laws of nature. Physics also makes significant contributions through advances in new technologies that arise from theoretical breakthroughs.

This program provides insights to experimental work and for this purpose the department has two State-of-Arts laboratories including Nuclear Physics laboratory, dark room and a store. Laboratories are fully equipped with the latest apparatus like the Advanced Scintillation Counter with MCA Card, GM Counter, ESR Resonance and Ultrasonic interferometer etc. which are essential for the students of M.Sc. for better understandings of theoretical concepts. The demonstration-type of experimental set-up like nano-technology and CDS (Constant Deviation spectrometer) are also a part of course.

PROGRAMME OBJECTIVES (POs):

After completing Post graduate program in Physical Science, a student will be

PO 1. Able to possess the understanding of conceptual knowledge and practical skills required forapplication in real world.

PO 2. Able to select and apply fundamental principles, concepts, theories and models of physics for delivering theirjob duties in various fields like in teaching, research, industry etc.

PO 3. Able to possess requisite experimentation and technical skills, teamwork and leadership skills and will beable to effectively discharge their responsibilities as Physicist.

PO 4. Able to develop an appreciation for the fundamental concepts and working of devices used in everyday life employing scientific methods/tools of physics.

PO 5. Able to develop a flavour of how research leads to new findings.

PO 6. To use experimental apparatus and computers as a tool for scientific investigations/understanding.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1. Understanding the basic concepts of physics particularly concepts in classical mechanics, quantum mechanics, statistical mechanics and electromagnetic theory to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical and mathematical reasoning.

PSO 2. Learn to carry out experiments in basic as well as certain advanced areas of physics such as nuclear physics, condensed matter physics, nanoscience, lasers and electronics.

PSO 3. Understand the basic concepts of certain sub fields such as nuclear, atomic and molecular physics, solid state physics, plasma physics and experimental techniques in physics etc.

PSO 4. Gain hands-on experience to work in applied fields.

PSO 5. Gain a through grounding in the subject to be able to teach it at college and school levels.

PSO 6. To develop research centered approach that can be applied to diverse fields.

ORDINANCE

MASTER OF PHYSICS
(SEMESTER SYSTEM EXAMINATION)

1. The course for the Degree of Master of Physics shall be spread over two academic years to be called M.Sc. Part-I and M.Sc. Part-II. Each part shall consist of two semesters. The examination for the first semester and third semester shall be held in the month of December/January and the examination for the second semester and fourth semester shall be held in the month of April/May or such other dates as may be fixed by the Academic Council.
2. (i)The amount of examination fee to be paid by a candidate for each semester: shall be as prescribed by the college from time to time.
   (ii) The medium of examination and instruction shall be English.
   (iii) The syllabus shall be such as may be prescribed by the concerned faculty from time to time.
3. (i) Each paper shall have upto 20% Internal Assessment and at least 80% marks for External Examination.
   (ii) The internal assessment will be based on all or some of the following:
   (1) Average of two internal tests based on lectures delivered
   (2) Assignments/reports/projects
   (3) Seminars
   (4) Attendance & performance in the class
   (iii) To pass in a paper the candidate must secure 35% marks in the external examination and 35% marks in aggregate (internal and external).
   (iv) For a candidate who fails in a paper(s) his internal assessment examination for that paper will be carried over and the supplementary examination will, therefore, consist of only an external examination.
4. The Part-I (M.Sc. 1st Semester) examination shall be open to any person who has been admitted to the course and fulfils the attendance requirements.

ELIGIBILITY CONDITION

For admission to M.Sc. Physics the candidate should have passed the B.Sc./B.Sc. (Hons) with physics as a main subject studied in the graduation. The admission of the candidate will be subject to the eligibility conditions in force at the time of admissions:

1. Candidates shall submit their application forms for admission to the Examination duly countersigned by the Head of the Department/Principal of the college along with a certificate from the Head of the Department/Principal of the college that the candidate satisfies the following requirements :
   (i) Having good moral character, and every candidate will be required to attend 75% of the number of lectures delivered/practicals in each paper. For late admission, the candidates, lectures delivered will be counted from his/her date of admission.
   (ii) It shall be necessary that 75% of the lectures prescribed for the course in the syllabus are delivered before session in that paper is held.

Navjeet Kaur

2. Subject to above :

(i) There will be no condition of passing papers for promotion from odd semester to even semester in an Academic Session.

(ii) To qualify for admission to 2nd year of the Course, the candidate must have passed 50% of total papers of the two semesters of the 1st year.

(iii) A candidate placed under re-appear in any paper, will be allowed two chances to clear the re-appear, which shall be available within consecutive two years/chances i.e. to pass in a paper the candidate will have a total of three chances, one as regular student and two as re-appear candidate.

(iv) The examination of re-appear papers of odd semester will be held with regular examination of the odd semester and re-appear examination of the even semester will be held with regular examination of even semester. But if a candidate is placed under reappear in the last semester of the course, he will be provided chance to pass the re-appear with the examination of the next semester, provided his reappear of earlier semester does not go beyond that next semester; Provided that for the award of the M.Sc. degree he shall have to qualify in all papers prescribed for the M.Sc. course within a period of four years from the date he joined the course.

(v) After completion of two academic years of studies (i.e. four semesters) he shall not be admitted to any semester of the same course and will not have any privileges of a regular student.

(vi) The minimum attendance requirement for taking an examination in a paper is 75% of the delivered lectures in that particular paper.

3. The grace marks shall be allowed according to the general ordinances relating to "Award of Grace Marks".

4. Three weeks after the termination of examination or as soon thereafter as possible the Controller of examination shall publish a list of candidates who have passed the examination. Each successful candidates in Part-I examination shall receive a certificate of having passed that examination. A list of successful candidates in Part-II examination be arranged in three Divisions according to Ordinance 10 and the division obtained by the candidate will be stated in his certificate/degree.

5. Successful candidate who obtain 60% or more of the aggregate marks in Part-I and Part-II examination taken together shall be placed in the first division. Those who obtain 50% or more but less than 60% shall be placed in the second division and all below 50% shall be placed in the third division.

6. *A candidate who has passed M.Sc. examination from this college shall have two chances within a period of two years after passing the examination to improve division/55% marks. Improvement shall be allowed in not more than 50% of total theory papers offered in Part-I and Part-II examination. However, previous marks of Practicals/Project will be carried forward in the paper(s) in which he appears for improvement.

7. Project work may be allotted depending upon the availability of staff.
Preleiminary work of project will be assigned in Semester III. Students can do topic analysis, literature review

and problem defining in sem III and its evaluation will be on the basis of seminar as internal Assessment.

Data analysis, writing thesis, presentation and defense will be done in Sem IV.

8 Evaluation training seminar and research Project

Research project work would be evaluated and the result would be communicated by Head of department to Controller of Examination. It is time bound and should be submitted before the commencement of next session.

Otherwise fine will be imposed.

Letter Grade	Marks
O (Out standiing)	91-100
A⁺ (Excellent)	81-90
A (Very Good)	71-80
B⁺ (Good)	61-70
B (Above Average)	51-60
C (Average)	41-50
D (Fail)	Below 40 % fail

S.No.	Assessment Parameters	Weight age (%)
1	Topic Analysis	10
2	Literature Review	20
3	Language and Writing of thesis	10
4	Quantitative data analysis	20
5	Significance of the work	10
6	Presentation and Defense	30

*Note

Out of papers taken up the candidate, will be given benefit of increase in marks, where the marks have increased in Paper/Papers.

*Note

Out of papers taken up the candidate, will be given benefit of increase in marks, where the marks have increased in Paper/Papers.

Narjeet Kaur

Ordinances Panel

Serial No.	Name and Affiliation	Designation	Signature
1.	Dr. Tajinder Singh Associate Professor, P.G. Department of Physics Mata Gujri College, Fatehgarh Sahib	Chairman	[signature]
2.	Dr. Karamjit Singh Assistant Professor Department of Physics Punjabi University Patiala	Vice Chancellor Nominee	[signature]
3.	Dr. Manoj Kumar Sharma Professor School of Physics and Materials Science Thapar Institute of Engineering and Technology	Nominee of Academic Council	[signature]
4.	Dr. Samarjit Sihotra Associate Professor Physics department Panjab University, Chandigarh	Nominee of Academic Council	[signature]
5.	Dr. Ramneek Kaur Assistant Professor,P.G. Department of Physics Mata Gujri College, Fatehgarh Sahib	Member	[signature]
6.	Dr. Deepika Jain Assistant Professor,P.G. Department of Physics Mata Gujri College, Fatehgarh Sahib	Member	[signature]
7.	Dr. Navjeet Kaur Assistant Professor,P.G. Department of Physics Mata Gujri College, Fatehgarh Sahib	Member	[signature]
8.	Dr. Gurpreet Kaur Bhullar Assistant Professor,P.G. Department of Physics Mata Gujri College, Fatehgarh Sahib	Member	[signature]
9.	Mr. Aditya Gupta Satish Brothers, Shop no 4309/20 Punjabi Mohalla, Ambala Cant., Haryana	Industry Expert	

PROGRAMME STRUCTURE

Semester	Core courses					Elective Course					Open Elective					Total Credits
	No of Papers	Credits L	T	P	Total Credits	No of Papers	Credits LTP			Total Credits	No of Papers	Credits L	T	P	Total Credits	
I	5	4		4.5	20.5	1	4			4						24.5
II	5	4		4.5	20.5	1	4			4						24.5
III	4	4		4.5 1.5	18	1	4			4						22
IV	4	4		4.5 1.5	14	2	4			8						22

Total Credits 93

SEMESTER WISE DETAILS OF THE PROGRAMME

Pass Percentage: 35%(in Theory Papers)
45% (in Practical papers)

M.Sc. Semester I		Hours (per week)	Credits L T P	External	Internal	Max. marks(**)
Core Papers						
P HY1.1.1	Mathematical Methods of Physics-I	4	4	60	20	80
P HY 1.1.2	Classical Mechanics	4	4	60	20	80
P HY 1.1.3	Classical Electrodynamics	4	4	60	20	80
P HY 1.1.4	Nuclear and Particle Physics	4	4	60	20	80
Elective papers (Choose any one)		4	4	60	20	80
P HY 1.1.5	(i) Electronics -I					
	(ii) Remote Sensing					
	(iii) Microwave and its propagation					
P HY 1.1.6	Laboratory Practice: (i)Electronic (ii) Laser-Optics Lab	9	4.5	75	25	100
		Total Credits = 24.5				Total Marks : 500

M.Sc. Semester II		Hours (per week)	Credits L T P	External	Internal	Max. marks(**)
Core Papers						
P HY 1.2.1	Mathematical Methods of Physics -II	4	4	60	20	80
P HY 1.2.2	Quantum Mechanics	4	4	60	20	80
P HY 1.2.3	Nuclear Physics	4	4	60	20	80
P HY 1.2.4	Statistical Mechanics	4	4	60	20	80
Elective papers (Choose any one)		4	4	60	20	80
P HY 1.2.5	(i) Electronics -II					
	(ii) Physics of Electronic Devices & Fabrication of integrated Circuits and Systems					
	(iii) Science and Technology of Solar Hydrogen and Other Renewable Energies					
P HY 1.2.6	Laboratory Practice: (i)Electronic (ii) Laser-Optics Lab	9	4.5	75	25	100
		Total Credits = 24.5				Total Marks : 500

Pass Percentage: 35%(in Theory Papers)
45% (in Practical papers)

M.Sc. Physics Semester III		Hours (per week)	Credits L	T	P	External	Internal	Total Max. marks (**)
Core Papers								
P HY 2.3.1	Condensed Matter Physics-I	4	4			60	20	80
P HY 2.3.2	Laser and Fiber Optics	4	4			60	20	80
P HY 2.3.3	Advanced Classical mechanics and Electrodynamics	4	4			60	20	80
Elective papers (Choose any one)		4	4			60	20	80
P HY2.3.4	(i) Computational methods and Simulations							
	(ii) Plasma Physics							
	(iii) Theoretical Nuclear Physics							
	(iv) Material Science							
P HY 2.3.5	Laboratory Practice: (Nuclear and Solid State Physics Lab)	9			4.5	80	40	120
P HY 2.3.6	Computer Laboratory	3			1.5	45	15	60
		Total Credits = 500	22					Total Marks :

M.Sc. Physics Semester IV		Hours (per week)	Credits L	T	P	External	Internal	Max. marks (**)
Core Papers								
P HY 2.4.1	Condensed Matter Physics II	4	4			60	20	80
P HY 2.4.2	Advanced Quantum Mechanics	4	4			60	20	80
Elective papers (Choose any two)		4	4			60	20	80
P HY 2.4.3/ P HY 2.4.4	(i) Experimental Techniques in Physics							
	(ii) Radiation Physics							
	(iii) High Energy Physics							
	(iv) Advanced Electronics							
	(v) Atomic and molecular Spectroscopy							
	(vi) Electronic Communication Systems							
P HY 2.4.5	Laboratory Practice: (Nuclear and Solid State Physics Lab) / Project Work*	9			4.5	80	40	120
P HY 2.4.6	Computer Laboratory	3			1.5	45	15	60
		Total Credits =	22					Total Marks : 500

FACULTY OF SCIENCES

SYLLABUS

FOR

M. Sc. PHYSICS

Program Code:-MSPHY

(Semester: I, II)

Session: 2023-24

MATA GUJRI COLLEGE

FATEHGARH SAHIB-140406, PUNJAB

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SCHEME

M.Sc. PHYSICS PART-I (I & II SEMESTER)

PROGRAM CODE: MSPHY

SESSION:-2023-2024

Pass Percentage: 35%(in Theory Papers)
45% (in Practical papers)

M.Sc. Semester I		**Hours (per week)**	**Credits**	**External**	**Internal**	**Max. marks(**)**
Core Papers						
P HY1.1.1	Mathematical Methods of Physics-I	**4**	**4**	**60**	**20**	**80**
P HY 1.1.2	Classical Mechanics	**4**	**4**	**60**	**20**	**80**
P HY 1.1.3	Classical Electrodynamics	**4**	**4**	**60**	**20**	**80**
P HY 1.1.4	Nuclear and Particle Physics	**4**	**4**	**60**	**20**	**80**
Elective papers (Choose any one)		**4**	**4**	**60**	**20**	**80**
P HY 1.1.5	(i) Electronics –I					
	(ii) Remote Sensing					
	(iii) Microwave and its propagation					
P HY 1.1.6	Laboratory Practice: (i)Electronics (ii) Laser-Optics Lab	**9**	**4.5**	**75**	**25**	**100**
		Total Credits = 24.5 24.5 Total marks: **500**				

Internal Assessment Criteria: Internal Assessment = 20 marks

(MST-50%, Attedance-20%, Assignments/Seminar/Co-curricular activities-30%)

Pass Percentage: 35%(in Theory Papers)
45% (in Practical papers)

M.Sc. Semester II			**Hours (per week)**	**Credits**	**External**	**Internal**	**Max. marks(**)**
Core Papers							
P HY	1.2.1	Mathematical Methods of Physics –II	**4**	**4**	**60**	**20**	**80**
P HY	1.2.2	Quantum Mechanics	**4**	**4**	**60**	**20**	**80**
P HY	1.2.3	Nuclear Physics	**4**	**4**	**60**	**20**	**80**
P HY	1.2.4	Statistical Mechanics	**4**	**4**	**60**	**20**	**80**
Elective papers (Choose any one)			**4**	**4**	**60**	**20**	**80**
P HY	1.2.5	(i) Electronics -II					
		(ii) Physics of Electronic Devices & Fabrication of integrated Circuits and Systems					
		(iii) Science and Technology of Solar Hydrogen and Other Renewable Energies					
P HY	1.2.6	Laboratory Practice: (i)Electronics (ii) Laser-Optics Lab	**9**	**4.5**	**75**	**25**	**100**
			Total Credits = 24.5		24.5		

Internal Assessment = 20 marks

(MST-50%, Attendance-20%, Assignments/Seminar/Co-curricular activities-30%)

Total Marks:IInd Sem. = 500

PHY1.1.1

MATHEMATICAL METHODS OF PHYSICS-I
Session 2023-2024

MaximumMarks: 60 Time allowed: 3 Hours
Pass Marks:35 % Total teaching hours:50

Course Objective*: The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.*

Course Outcomes: *On completion of this course, students will be able to*

- *To understand Generating function for Legendre polynomials and recurrence relations.*
- *Apply the method to solve certain ordinary differential equations (Legendre, Bessel etc.)*
- *Understand the concept of hermite and Laguerre Polynomials.*
- *Evaluate integrals using gamma and beta functions.*
- *Know the rules to find systematic error and Tensors.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A

Gamma and beta functions: Definition of beta and gamma functions, Evaluation of gamma (1/2), Relation between beta and gamma functions, Evaluation of integrals using beta & gamma function. Legendre differential equation: Solution of Legendre differential equation, Legendre polynomials: Rodrigue's formula, Generating function for Legendre polynomials and recurrence relations, Orthogonality of Legendre polynomials.

Bessel functions: Definition of Bessel functions of 1^{st} and 2^{nd} kind, Generating function of $J_n(x)$ and their recurrence relations and orthogonality.

Hermite Polynomials: Solution of Hermite differential equation. Hermite polynomials. Generating function and recurrence relations for Hermite polynomials. Rodrigue's formula and orthogonality.

Leguerre Polynomials: Leguerre differential equation and its solution, Properties of Leguerre and associated Leguerre functions.

SECTION B

Tensor: Cartesian tensors, Vector components and their transformation properties under three dimensional rotation in rectangular coordinates, Direct product of two and more tensors, Tensors of second and higher ranks, Symmetric and anti-symmetric tensors, Contraction and differentiation, Kronecker and alternating tensors and their isotropy property, Contra-variant and covariant tensors, Physical examples of second rank tensors.

Evaluation of Polynomials: Horner's method; Root finding; Bisection method, Regula falsi method, Newton method, System of linear equations. Gauss Seidel methods, Interpolation and Extrapolation: Lagrange's interpolation, least square fitting.

Differentiation and Integration: Difference operators, simpson and trapezoidal rules; Ordinary differential equation: Euler method, Taylor method.

Text Books:

1. Applied Mathematics, L.A. Pipes and Harwill, 2nd edition, McGraw HillPub.

2. Mathematical Physics, G.R. Arfken, H.I. Weber, 7th Edition, Academic Press, USA (Ind.Ed.)

3. Cartesian Tensors, H. Jeffreys, Cambridge University,Press.

4. Numerical Methods: J.H.Mathew, 3rd Ed Prentice Hall of India, NewDelhi.

5. Mathematical Physics: B.S. Rajput, 2nd revised Edition, Pragati Parkashan, Meerut

PHY1.1.2

CLASSICAL MECHANICS
Session 2023-2024

MaximumMarks: 60 | Time allowed: 3 Hours
Pass Marks:35% | Total teaching hours:50

***Course Objective**: The main aim of this course is to provide the knowledge regarding mechanics, Newtonian mechanics, Lagrangian formulation, Hamiltonian etc.*

***Course Outcome:** On completion of this course, student will be able to*

- *On completion of this course, student will be able to define and understand basic mechanical concepts related to discrete and continuous mechanical systems,*
- *Describe and understand the motion of a mechanical system using Lagrange-Hamiltonian formalism.*
- *Students will be able to solve problems related to mechanics and Kepler's problem.*
- *Understanding the Rigid body dynamics and Hamiltonian formulation.*

Instructions for the Paper Setter
The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates
The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

Lagrangian formulation: Conservation laws of linear, angular momentum and energy for a single particle and system of particles, Constraints and generalized coordinates, Principle of virtual work, D'Alembert principle, Lagrange's equations of motion, Velocity dependent potential and dissipation function.

Problems: Lagrangian and equations of motion for systems like motion of single particle in space, on the surface of a sphere, cone & cylinder, Atwood's machine, Bead sliding on rotating wire, Simple, spherical and compound pendulums, Projectile motion and harmonic oscillator.

Variational principle: Hamilton's principle, Calculus of variations, Lagrange's equations from Hamilton principle. Generalized momentum, Cyclic coordinates, Symmetry properties and Conservation theorems.

Problems: Applications of calculus of variations for geodesics of a plane and sphere, Minimum surface of revolution, Brachistochrone and harmonic oscillator-problems.

Two-body central force problem: Equivalent one body problem, Differential & total scattering cross-section, Scattering by inverse square law, Rutherford's formula.

Rigid body kinematics: Kinematics of rotation of rigid body about a point, Orthogonal transformation and properties of transformation matrix, Euler angles and Euler theorem, Infinitesimal rotations, Rate of change of vector in rotating frame. *Problem*: Components of angular velocity along space and body set of axes.

SECTION B

Rigid body dynamics: Angular momentum and kinetic energy of rotation of rigid body about a point, Inertia tensor and its eigen values, Principal moments, Principal axes transformation. Euler equations of motion,

Hamiltonian formulation: Legendre transformation, Hamilton's equations of motion, Hamilton's equation from variational principle, Principle of least action *Problems*: Hamiltonian and equations of motion for system like simple and compound pendulum, Harmonic oscillator, Motion of particle in central force field, on the surface of a cone, cylinder, and sphere. Charged particle's motion in electromagnetic field.

Canonical transformation: Generating function, Poisson brackets and their canonical invariance, Equations of motion in Poisson bracket formulation, Poisson bracket relations between components of linear and angular momenta. *Problems*: Harmonic oscillator problem, Check for transformation to be canonical and determination of generating function

ReferenceBook:

1. Classical Mechanics, H. Goldstein, Narosa Publishing House, New Delhi.
2. Classical Mechanics, N.C. Rana and P.S. Joag, Tata McGraw-Hill, N. Delhi,1991

PHY1.1.3

CLASSICAL ELECTRODYNAMICS
Session 2023-2024

Maximum Marks: 60 Time allowed: 3Hours
Pass Marks: 35% Total teaching hours:50

Course Objective*: The aim of this subject to apprise the students regarding the concept of electrodynamics and Maxwell equations and use them in various situations.*

Course Outcomes*: On completion of this course, student will be able to*

- *Interpret the deeper meaning of Maxwellian field equation.*
- *Formulate and solve electromagnetic problems with the help of electrodynamic potential.*
- *Calculate the electromagnetic radiation from the radiatingsystem.*
- *Formulate and solve electrodynamic problems in relativistically covariant form in four dimensional space-time*

Instructions for the Paper Setter
The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates
The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

Electrostatics: Coulomb's law, Electric field, Evaluation of electric field due to uniformly charged sphere using Coulomb's law, Differential form of Gauss law, Dirac delta function and its properties, Representation of charge density by Dirac delta function, Equations of electrostatics, Scalar potential and potential due to arbitrary charge distribution, Discontinuities in electric field, Electric potential, Poisson and Laplace equations, Dirichlet and Neumann boundary conditions, Uniqueness theorem, Electrostatic potential energy for continuous charge distributions, Energy density.

Boundary value problems in electrostatics: Boundary value problems in one and two dimensions in Cartesian, spherical and cylindrical coordinates. Methods of images, Point charge placed near a grounded sheet and near a grounded conducting sphere.

Multipoles and dielectrics: Green's function and solution of Poisson equation, Addition theorem of spherical harmonics, Dirac delta function in spherical polar coordinates, Eigen function expansion of Green function, Solution of potential problems with spherical Green function expansion, Microscopic and macroscopic fields, Equations of electrostatic field in a dielectric, Bound charge densities.

SECTION B

Magnetostatics: Continuity equation, Biot savart law, Differential equations of magnetostatics and Ampere's law, Vector potential and its calculation, Magnetic moment, Macroscopic equations, Boundary conditions on B and E, Magnetic scalar potential.

Time varying fields: Faraday's law of electromagnetic induction, Energy in the Magnetic field, Maxwell equations, Displacement current, Electromagnetic potential, Lorentz and Coulomb gauge. Maxwell equations in terms of electromagnetic potentials, Solution of Maxwell equations in Coulomb Gauge and Lorentz gauge by Green function.

Reference Book:

1. Classical Electrodynamics, J.D. Jackson, Wiley EasternLtd.
2. Electromagnetic Waves and Radiating Systems: E. D. Jordan and K.G.Balmain, Pearson: 2nd addition.
3. Introduction to Electrodynamics, David J. Grifith, PHI Ltd.

P HY 1.1.4 **NUCLEAR AND PARTICLE PHYSICS**

Session 2023-2024

Maximum Marks: 60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: The main objective of this course is to provide the knowledge regarding the interaction of charged particles with matter, nuclear radiaton detector, Mossbauer effect, Nuclear spectroscopy, safety aspects taken during calculation of radiation doserate.

Course Outcome: On completion of this course, student will be able

- *to understand the fundamental aspects of the structure of the nucleus and intrinsic properties of the atomic nucleus,*
- *explain the interaction of radiation, charged particles and neutrons withmatter,*
- *understand the concepts of radioactive decay, laws of radioactive decay and successive disintegration.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed

SECTION A

Radiation Detectors: Interaction of radiations with matter (Charged particles and electromagnetic radiations), Gas-filled counters, Scintillation and Semiconductor detectors, Energies and intensity measurements.

Alpha Decay: Why alpha decay occurs? Basic alpha decay processes, Alpha decay systematics. Theory of alpha emission. Angular momentum and Parity in Alpha Decay.

Beta Decay: Energy Released in Beta Decay. Fermi Theory of Beta Decay. Angular Momentum and Parity Selection Rules. Comparative Half Lives and Forbidden Decays. Neutrino Physics. Non-conservation of Parity.

Gamma Decay: Energetics of gamma decay, Angular momentum and Parity selection rules, Internal conversion.

SECTION B

Particles and Forces: Classification and Properties of Hadron and Leptons and Fundamental Forces.

Conservation Laws: Parity and Isospin strangeness, charm bottom non conservation, Operations and transformations, Baryons and Leptons Conservation, Tau lepton, C, P and CP Violation in Weak Interactions, K-decays, CPT invariance (Statement and consequences).

Meson Physics: Yukawa's Hypothesis, Discovery and properties of pions and muons and Tau Lepton, Spin, parity and isospin of π - mesons, Pion-proton scattering.

Strange Particles: Mass and lifetime for K-meson, Production and decay of $½^+$ hyperons charm and Bottom hadrons (spectras only).

Relativistic kinematics**,** Gellmann-Nishijima Scheme, Baryons and Meson Multiplets,

Quark Model: Development, Meson Baryon construction, Colour Quantum Number. Magnetic Moments, Nucleon Structure from Scattering and Evidence of Quark Structure, Observation of New Flavors.

Theories of Fundamental Interactions: (qualitative ideas) and Grand Unified Theory. Planck scale and Recent Developments (Qualitative ideas)

TEXT BOOKS:

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, New York
2. .Elementary Particle Physics: I.S. Hughes, Cambridge Univ. Press
3. Introductory Nuclear Physics: S.S.M. Wong, Prentice Hall of India, New Delhi
4. Introduction to Elementary Particles: D.J. Griffiths, John Wiley &Sons.

PHY 1.1.5 Elective Paper Option (i)

ELECTRONICS-I
Session 2023-2024

Maximum Marks: 60 Time allowed: 3 Hours
Pass Marks: 35% Total teaching hours:50

Course Objective: *The emphasis of the course is on applications in solving problems of interest to physicists related electronics. Students will be able to do two port network analysis, Number Systems and logic gates and flip-flops etc.*

Course Outcomes: *On completion of this course, students will be able to*

- *Understand the Active circuit model's equivalent circuit forBJT.*
- *Methods of calculating cutoff frequencies and to determine bandwidth.*
- *Understand the current voltage characteristics of semiconductor devices.*
- *Learn basic operational amplifiers characteristics, OP-AMP parameters, applications as inverter, integrator, differentiator etc.*
- *Understand the effect of biasing in FET.*
- *Analyze the number systems, combinational logic gates, binary counters.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed

SECTION A

Two port network analysis: Active circuit model's equivalent circuit for BJT, Trans conductance model: Common emitter. Common base. Common collector amplifiers. Equivalent circuit for FET. Common source amplifier. Source follower circuit.

Feedback in amplifiers: Stabilization of gain and reduction of non-linear distortion by negative feedback. Effect of feedback on input and output resistance. Voltage and current feedback.

Bias for transistor amplifier : Fixed bias circuit, Voltage feedback bias. Emitter feedback bias, Voltage divider bias method, Bias for FET.

Multistage amplifier: Direct coupled CE two stage amplifier. RC coupling and its analysis in mid- high-and low-frequency range. Effect of cascading on bandwidth. Darlington and cascade circuits.

Oscillators: Feedback and circuit requirements for oscillator, Basic oscillator analysis, Hartley, Colpitts, RC-oscillators and crystal oscillator.

SECTION B

Number Systems: Binary, octal and hexadecimal number systems. Arithmetic operations: Binary fractions, Negative binary numbers, Floating point representation, Binary codes: weighted and non-weighted binary codes, BCD codes, Excess-3code,Gray codes, binary to Gray code and Gray to binary code conversion, error detecting and error correcting codes.

Logic Gates: AND, OR, NOT, Boolean identities, Demorgan's theorem: Simplification of Boolean functions. NAND, NOR gates.

Combinational logic: Minterms, Maxterms, K-map (upto 4 variables), POS, SOP forms. Decoders. Code converters, Full adder, Multiple divider circuits.

Flip flops: RS, JK-, D- and T-flip flops set up and hold times, preset and clear operations.

Binary counters: Series and parallel Shift registers. Data in data out modes. Modified and Ring counter.

Text Books:

1. Electronic Fundamentals and Applications: J.D.Ryder, Prentice Hall of India (5^{th} Ed.), New Delhi.

2. Electronic Devices and Circuits: G.K. Mithal, Khanna Publishers

3. Digital Principles and Applications: A.P. Malvino & D.P. Leach, Tata McGraw-Hill, NewDelhi

4. An Introduction to Digital Electronics: M. Singh, Kalyani Publishers, NewDelhi

5. Basic Electronics and Linear Circuits: N. N. Bhargava, D. C. Kulshreshta, S. G. Gupta (TTTI Chandigarh), Mc. GrawHill.

PHY1.1.5 Elective Paper Option (ii)

REMOTE SENSING
Session 2023-2024

Maximum Marks: 60 Time allowed: 3 Hours
Pass Marks:35 % Total teaching hours:50

Course Objective: *The aim and objective of this course is to expose the students to detectand monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at adistance.*

Course Outcomes: *On completion of this course, student will be able to*

- *Understand the concept of remote sensing system, electromagnetic radiation.*
- *Explain electromagnetic spectrum, interaction with atmosphere, passive versusacting sensing.*
- *Understand the concept of microwaves, RADAR, polarimetry, spacebornesystems.*
- *Explain Agriculture Crop Type Mapping and Crop Monitoring, Forestry applications.*

Instructions for the Paper Setter
The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates
The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

History and scope of remote sensing: Milestones in the history of remote sensing, overview of the remote sensing process, A specific example, Key concepts of remote sensing, career preparation and professional development.

Introduction: Definition of remote sensing, Electromagnetic radiation, Electromagnetic Spectrum, interaction with atmosphere, Radiation-Target, Passive vs. Active Sensing, Characteristic of Images.

Sensors: On the Ground, In the Air & in Space, Satellite characteristics, Pixel Size and Scale, Spectral Resolution, Radiometric Resolution, Temporal Resolution, Cameras and Aerial photography, Multispectral Scanning, thermal Imaging, Geometric Distortion, Weather Satellites, Land Observation Satellites, Marine Observation Satellites, Other Sensors, Data Reception.

SECTION B

Microwaves: Introduction, Radar Basics, Viewing Geometry & Spatial Resolution, Image Distortion, Target Interaction, Image Properties, Advanced Applications, Polarimetry, Airborne vs. Space borne, Airborne & Space borne Systems.

Image Analysis: Visual Interpretation, Digital processing, Preprocessing, Enhancement, Transformations, Classification, Integration.

Applications: Agriculture—Crop Type Mapping and Crop Monitoring; Forestry---Clear cut Mapping, Species identification and Burn Mapping; Geology---Structural Mapping & Geological Units; Hydrology-----Food Delineation & Soil Moisture; Sea Ice----Type & Concentration, Ice Motion; Land Cover----Rural/Urban Change, Biomass Mapping; Mapping-----Planimetry, DEMs, Topo Mapping; Oceans & Coastal Ocean features, Ocean Colour, Oil Spill Detection.

Text Books:

1. Introduction to Remote Sensing : James B.Cambell
2. Fundamentals of Remote Sensing: Natural Resources, Canada Centre of Remote Sensing.

PHY 1.1.5 Elective Paper Option (iii)

MICROWAVE AND ITS PROPAGATION
Session 2023-2024

Maximum Marks: 60 Time allowed: 3 Hours
Pass Marks:35% Total teaching hours:50

Course Objectives*: The aim of this subject is to develop an ability to analyze the cylinder wave functions and various cylindrical shaped microwave components and their properties for different modes in cylindrical coordinate systems.*

Course Outcomes: *On completion of this course, student will be able to*

- *Differentiate microwaves, radio waves and observe e m spectra.*
- *Distinguish transmission lines and wave guides.*
- *Analyze propagation of signal in differentmodes.*
- *Identify the use of microwavecomponents.*
- *Demonstrate various applications of microwave components.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed

SECTION A

Microwave linear beam tubes: Conventional vacuum tubes, Klystrons, resonant cavities, velocity modulation process, branching process, output power and beam loading ;multi cavity klystron amplifiers, reflex klystrons, helix travelling wave tubes, slow wave structures

.**Microwave crossed field tubes**: Magnetron oscillators: cylindrical, linear and coaxial, forward wave crossed field amplifier, backward wave crossed field amplifier, backward wave crossed field oscillator, their principle of operation and characteristics.

Microwave transistor and tunnel diodes: Microwave bipolar transistors, physical structures, configurations, principles of operation, amplification phenomena, power-frequency limitations, heterojunction bipolar transistors, physical structures, operational mechanism and electronic applications, microwave tunnel diodes, principles of operation, microwave characteristics.

Microwave field effect transistors: Junction field effect transistors, metal semiconductor field effect transistors, high electron mobility transistors, metal oxide semiconductor field effect transistors, physical structures, principle of operation and their characteristics. MOS transistor and memory devices: NMOS, CMOS and memories.

Charged coupled devices: Operational mechanism, surface channel CCD's dynamic characteristics.

SECTION B

Transferred electron devices: Gunn effect diodes, Ridley-Walkins-Hilsum theory, modes of operation, LSA diodes, InP diodes, CdTe diodes, microwave generation and amplification.

Avalanche transit time devices: Read diode, IMPATT diodes, TRAPATT diodes, BARITT diodes, their physical structure, principle of operation and characteristics.

Microwave measurements: Measurement of impedance, attenuation, insertion loss, coupling and directivity, frequency, power and wavelength at microwave frequencies.

Microwave transmission lines: Transmission line equations and solutions, reflection coefficient and transmission coefficient, standing wave and standing wave ratio, line impedance and admittance, Smith chart, impedance matching. Microwave cavities, microwave hybrid circuits, directional couplers, circulators and isolators.

Text Books:

1. Microwave Devices and Circuits: Sameul Y. Liao, Pearson Education 2.Microwaves: K.C. Gupta, Wiley Eastern Limited.

PHY 1.1.6

LABORATORY PRACTICE
: i) Electronic Lab ii) Laser-Optics Lab

MaximumMarks:100 Time allowed: 3Hours
Pass Marks: 45% Total teaching hours: 125

Out of 100 Marks, internal assessment (based on seminar, viva-voce of experimental reports, number of experiments performed and attendance) carries 25 marks, and the final examination at the end of the semester carries 75 marks.
This laboratory comprises of experiments based on **Lasers and Optics** in one group and **Electronics** in the other group.

GROUP-I ELECTRONICS EXPERIMENTS: (10 out of the followings)

1. Study the characteristics of encoder and decoder.
2. Study of Clipping & Clamping circuits.
3. Study of half wave and full wave rectifier and calculate the ripple factor.
4. Find the energy gap of a given semi conductor by reverse bias junction method.
5. To calculate the temperature coefficient of Thermistor.
6. Study the logic gates namely AND, OR, NAND, NOR, XOR and verify their truthtable.
7. Study the characteristics of ripple counter.
8. To study the given operational amplifier as an inverting and non- inverting amplifier.
9. To study the given operational amplifier as a summer and subtractor.
10. To study the given operational amplifier as a differentiator and integrator.
11. To study the 4 bit digital to analog convertor.
12. Study of various types of Flip-Flops.
13. To study characteristics of FET and determine its various parameters.
14. Study the characteristics of Zener diode.
15. To plot the input and output characteristics of a given transistor having CE configuration.
16. Study of biasing techniques of BJT.
17. To study Frequency Modulation and Demodulation.
18. Fourier series analysis of square, triangular and rectified wavesignals.
19. To study the static RAM.
20. To study the frequency response of common emitter single stage RC coupled amplifier and hence to find the voltage gain.

<u>GROUP-II LASERS AND OPTICS EXPERIMENTS:</u> (10 out of the followings)

1. To study the optical bench model of microscope and to determine the numerical aperture of the microscope.
2. To study the optical bench model of telescope and to determine the angular field of view and magnifying power by entrance and exit pupil method.
3. To study the characteristics of solarcell.
4. To find the wavelength of light by using Michelson interferometer.
5. To study the optical thickness of mica sheet using channel spectrum interferometry.
6. To determine the Planck's constant using photovoltaic cell.
7. To find the wavelength of red light and hence to verify Bragg's law.
8. To study the aberrations of a convex lens.
9. To study the electro-optic effect in $LiNbO_3$ crystal using He-Ne laser.
10. To study B-H curve.
11. To study the characteristics of optoelectronic devices (LED, Photodiode, Photodiode, Phototransistor, LDR).
12. To study the diffraction pattern by pin hole, single slit, double slit and grating and to calculate the wavelength of He-Ne laser.
13. To study microwave optics system for reflection, refraction, polarization phenomena.
14. To calibrate the prism spectrometer using mercury lamp and to determine the refractive index of material of the prism for a given wavelength of light.
15. Measurement of Brewster angle and refractive index of materials like glass and fused silica (with He-Ne laser) with a specially designed spectrometer.
16. Particle size determination by diode laser
17. Study of optical fiber communication kit.

PHY1.2.1

MATHEMATICAL METHODS OF PHYSICS-II
Session 2023-2024

Maximum Marks 60: Time allowed: 3 Hours
Pass Marks:35% Total teaching hours:50

Course Objective*: The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.*

Course Outcomes: *On completion of this course, students will be able to*

- *Understand the Laplace transforms.*
- *Understand proof of Fundamental Theorem of Calculus and the concept of the integrals of functions and vector field*
- *Explain Complex variables, Fourier series and transform.*
- *Understand the Partial differential equations, apply formulae to solve problems like One dimensional wave equation.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed

SECTION A

Complex variables: Elements Complex analysis, Limit and continuity, Cauchy's Riemann equations, Complex integrations, Cauchy's theorem for simply and multiply connected regions, Cauchy's integral formula, Taylor and Laurent's series, Poles and singularities, Cauchy's residue theorem and its application to evaluation of definite integrals.

Laplace transforms: Definition, Conditions of existence, Functions of exponential orders, Laplace transform of elementary functions, Basic theorems of Laplace transforms, Laplace transform of special functions, Inverse Laplace transforms, its properties and related theorems, Convolution theorem, Use of Laplace transforms in the solution of differential equations with constant and variable coefficients and simultaneous differential equations.

Fourier series and transform: Dirichlet conditions, Expansion of periodic functions in

Fourier series, Complex form of Fourier series, Sine and cosine series, The finite Fourier sine and cosine transforms, Fourier integral theorem and Fourier transform, Parseval's identity for Fourier series and transforms. Convolutions theorem for Fourier transforms.

SECTION B

Partial differential equations: One dimensional wave equation, The vibrating string fixed at both ends, D'Alembert and Fourier series solutions, Vibrations of a freely hanging chain, vibrations of rectangular membrane, Vibrations of a circular membrane, Temperature distribution in a rectangular and circular plate.

Group theory: Group postulates, Multiplication table, conjugate elements and classes sub-group, Isomorphism and homomorphism, Discrete groups, Permutation groups, Lie group and Lie algebra, Reducible and irreducible representation, Young diagrams and direct product; SU(2) and SU(3) groups.

Text Books:

1. Applied Mathematics, L.A. Pipes and Harwill, McGraw HillPub.
2. Mathematical Physics, G.R.Arfken, H.I. Weber, Academic Press, USA (Ind.Ed.)
3. Laplace Transforms, M.R.Spiegel, Schaum Series, Mc Graw Hill Publication
4. Mathematical Physics: B.S. Rajput, Pragati Parkashan,Meerut.

PHY1.2.2

QUANTUM MECHANICS

Session: 2023-2024

Maximum Marks: 60 Time Allowed: 3 Hours
PassMarks:35% Total teaching hours:50

Course Objective*: The emphasis of course is to introduce the students to the need and development of and normalism of quantum mechanics, Schrodinger Equation in 1-D and 3-D as well as interaction with radiation using one and many electron atomic spectra concept. and Motion in a Central Potential.*

Course Outcomes*: On completion of this course, student will be able to*

- *Understand the basic knowledge about non relativistic quantum mechanics.*
- *Understand the time-dependent and time-independent Schrodinger wave equation for simple potentials and harmonic oscillator.*
- *Show an understanding of wave mechanics in one and three dimensions, Linear vector spaces.*
- *Describe the structure of the hydrogen atom and show an understanding of quantization of angular momentum*
- *Know about spin, angular momentum sates, angular momentum addition rules and identical particles.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A

Motion in a Central Potential: Solution of the Schrodinger equation for the hydrogen atom, Eigen values and eigen vectors of orbital angular momentum, Spherical harmonics, Radial solutions, Hydrogen atom energy spectra. Rigid rotator, Solution for three dimensional square well potential.

Linear vector spaces: State vectors, Orthonormality, Hilbert spaces, Linear manifolds and subspaces, Hermitian, unitary and projection operators and commutators; Dirac Bra and Ket Notation: Matrix representations of bras and kets and operators; Continuous basis, Change of basis-Representation theory. Coordinate and momentum representations. Fundamental postulates of quantum mechanics. Generalized uncertainty principle; time energy uncertainty principle, Density matrix. Schrodinger, Heisenberg and interaction pictures.

Symmetry Principles: Symmetry and conservation laws, Space time translation and rotations. Conservation of linear momentum, energy and angular momentum. Unitary transformation, Symmetry and Degeneracy, space inversion and parity. Time reversal invariance.

SECTION B

Linear Harmonic Oscillator: Solution of Simple harmonic oscillator; Vibrational spectra of diatomic molecule; Anisotropic three dimensional oscillator in cartesian coordinates, Isotropic three dimensional oscillator in spherical coordinates.

Matrix mechanical treatment of linear harmonic oscillator: Energy eigen values and eigen vectors of SHO, Matrix representation of creation and annihilation operators, Zero-point energy; Coherent states.

Angular momentum : Eigen values, Matrix representations of J^2,Jz, J_+,J_-; Spin: Pauli matrices and their properties, Addition of two angular momenta: Clebsch-Gordon coefficients and their properties, Spin wave functions for two spin-1/2 system, Addition of spin and orbital momentum, derivation of C.G. coefficients for ½+1/2 and ½+1, addition, Spherical tensors and Wigner-Eckart theorem (Statement only).

Reference Books:

1. Quantum Mechanics (2nd Ed.) : V.K. Thankappan, New Age International Publications, New Delhi, 1996
2. Quantum Mechanics: P.M. Mathews and K. Venkatesan, Tata-McGraw Pub., New Delhi, 1997, 23rd Rep.
3. Quantum Mechanics: L.I.Schiff (Int. Student Ed.)
4. Quantum Mechanics: W. Greiner, Springer Verlag Pub., Germany, 1994, 3rd Edition
5. Modern Quantum Mechanics:J.J.Sakurai,Addison Wesley Pub.,USA,1999, Ist ISE Rep.

PHY1.2.3

NUCLEAR PHYSICS
Session 2023-2024

Maximum Marks: 60 Time Allowed: 3 Hours
PassMarks:35% Total teaching hours:50

Course Objectives*: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen*

Course Outcomes: *On completion of this course, student will be able to*

- Demonstrate a knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.
- Explain internal and external properties of the atomic nucleus.
- Explain the processes of nuclear collisions and nuclear reactions.
- State radiation detectors and accelerators.
- Understand the nuclear accelerators and models.

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly. Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A

Nuclear Properties: Nuclear Radius, Mass and Abundance of Nuclides, Nuclear Binding Energy, Semi-empirical Mass Formula, Nuclear Angular Momentum and Parity, Nuclear Electromagnetic Moments, Nuclear Excited States, Nuclear Spin, Nuclear Moments, Measuring Nuclear Moments

Forces between Nucleons: Deuteron problem, Nucleon-Nucleon scattering, Proton-Proton and Neutron-Neutron interactions, Properties of Nuclear Forces, Exchange Force Model

Nuclear Models: Single and Many Particle Shell Model, Even-Z Even-N Nuclei and Collective Structure, Nilsson Model.

SECTION B

Nuclear Reactions-I: Types of Nuclear Reactions and Conservation Laws, Energetics of Nuclear Reactions, Isospin, Reaction cross-sections.

Nuclear Reactions-II: Experimental Techniques, Coulomb Scattering, Nuclear Scattering, Optical Model, Compound-Nucleus Reactions, Direct Reactions, Resonance Reactions, Heavy Ion Reactions, Fission and Fusion.

Neutron Physics: Neutron Sources, Absorption and Moderation of Neutrons, Neutron Detectors

Accelerators: Cyclotron, Van de Graaff & Pelletron Accelerators, Synchrotrons, Colliding Beam Accelerator.

Text Books:

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, NewYork
2. Nuclear Physics: D.C. Tayal, Himalaya Publishing House

Reference Books:

1. Nuclear Physics: R. R. Roy and B. P. Nigam, New Age Pub., N.Delhi
2. Nuclear Physics: W.E. Burcham and M. Jobes (Ind. Ed.), AddisonWesley

PHY1.2.4

STATISTICAL MECHANICS
Session 2023-2024

Maximum Marks: 60 | Time allowed: 3 Hours
Pass Marks: 35 % | Total teaching hours:50

Course Objective: *The emphasis of course is the evaluation of the laws of classical thermodynamics for solving the problems of canonical ensembles.*
Apply the concepts and principles of Black- macroscopic systems using the properties of its atomic particles.
Course Outcomes: On completion of this course, students will be able to

- *Identify and describe the statistical nature of concepts and laws in thermodynamics.*
- *Use the statistical physics methods such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac and Bose-Einstein distribution.*
- *Body radiation to analyze radiation phenomenon.*
- *Apply the concepts and laws of thermodynamics to solve problems such as gases, heat engines*

Instructions for the Paper Setter
The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.
Instructions for the candidates
The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

The Statistical Basis of Thermodynamics: Postulates of classical statistical mechanics, the macroscopic and microscopic states, contact between statistics and thermodynamics, connection between statistical and thermodynamic quantities, Classical Ideal Gas,

Elements of Ensemble Theory: Phase space, Liouville's theorem, Representation of Ensembles in Phase space

Micro Canonical Ensemble: Micro canonical ensemble, Gibb's micro canonical distribution, Ideal gas in micro canonical ensemble, Entropy of an ideal gas, Gibb's paradox, Sackur-Tetrode equation.

Canonical Ensemble: Canonical ensemble and its thermodynamics, Partition function, Partition function in phase space, *Problems in canonical ensembles:* Classical ideal gas, System of independent harmonic oscillators, Dielectrics, Para magnetisms, Rotational partition function. Equipartition and Virial theorems

Grand Canonical Ensemble: Grand canonical ensemble and its thermodynamics, Energy and Density fluctuations. Equivalence of canonical and the grand canonical ensembles. Classical Ideal gas in grand canonical ensemble

SECTION B

Formulation of Quantum Statistics: Postulates of Quantum Statistical Mechanics, Density matrix, Different ensembles in quantum statistical mechanics for different Ideal gases (Ideal Fermi Gas, Ideal Bose Gas and Boltzman Gas): Distribution function for different ideal gases, density of states for an ideal gas.

Ideal Bose Systems: Equation of state of an Ideal Bose gas, Bose-Einstein condensation, Thermodynamics of an Ideal Bose gas, Black body radiation (The photon gas)

Ideal Fermi Systems: Equation of state of an Ideal Fermi Gas, Degeneracy, Fermi energy at T=0 and at low temperatures. Thermodynamics of an ideal Fermi gas, Free electron gas in metal

Phase Transitions: Phase transition, Introduction to first and second order phase transition: the Clausius Clapeyron equation, Ising model in zeroth approximation, random walk and brownian motion, Fick's diffusion formula, Fick's law, Einstein relation.

Text Books:

1. Statistical Mechanics: Kerson Huang, (John Wiley & Sons, 2ndEd.)
2. Statistical Mechanics: R.K. Pathria (2nd Ed.), Butterworth Oxford
3. Statistical mechanics, Bipin K.Aggarwal, Melvin Eisner, 3rd Edition, New Age International Publishers, N. Delhi

PHY 1.2.5
Elective Paper Option (i)

ELECTRONICS-II
Session 2023-2024

MaximumMarks: 60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours:50

Course Objective: *The emphasis of the course is on understanding of band pass amplifiers, Comparator and applications. Students will be able to understand voltage regulator and other devices.*

Course Outcomes: *On completion of this course, students will be able to*

- *Understand the amplifiers and their applications.*
- *Methods of calculating cutoff frequencies and to determine bandwidth.*
- *Understand the current voltage characteristics of semiconductor devices.*
- *Learn basic operational amplifiers characteristics, OP-AMP parameters, applications as Comparator etc.*
- *Analyze the 555 timer.*

Instructions for the Paper Setter
The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.
Instructions for the candidates
The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A
Band-pass amplifiers: Parallel resonant circuit and its bandwidth. Tuned primary and tuned secondary amplifiers.

Power amplifiers: Operating conditions, Power relations, Nonlinear distortion, Class A power amplifier, Push-pull principle, Class B Push pull amplifier.

Fundamentals of modulation: Frequency spectrum in amplitude modulation, Methods of amplitude modulation, Frequency modulation, Linear demodulation of AM signals, SSB system, AM and FM transmission, Receiving systems.

Operational amplifiers: Ideal operational amplifier. Inverting and non-inverting amplifiers.Differential amplifiers. CMMR. Internal circuit of operational amplifier. Examples of practical operational amplifier. Operational amplifier characteristics. DC and AC characteristics, slew rate.

SECTION B

Operational amplifier applications: Instrumentation amplifier. AC amplifier. V to I and I to V converters. Precision diode circuits (Half Wave Rectifier, Full Have Rectifier, Clipper, Clamper, Peak Detector, Sample and Hold Time circuit). Log and antilog amplifiers. Differentiator and integrator.

Comparator and applications: Regenerative comparator. Square wave generator, bi stable multi vibrator. Triangular wave generator. Sine wave generator.

Voltage regulators: series Op. Amp. regulator, IC regulators and 723 general purpose regulator.
555 Timer: Functional Diagram, mono stable, a stable operations and their applications

Text Books:

1. Electronic Fundamentals and Applications: J.D. Ryder, Prentice Hall of India (5^{th} Ed.), N.Delhi.
2. Linear Integrated Circuit: D. Roy Choudury and Shail Jain, Wiley Eastern, NewDelhi
3 Integrated Electronics, Jacob Millman, Christos Halkias, Chetan D.Pariks , 2^{nd} edition, Tata McGraw Hill.

PHY 1.2.5

Elective Paper Option (ii) **Session 2023-2024**

PHYSICS OF ELECTRONIC DEVICES & FABRICATION OF INTEGRATED CIRCUITS AND SYSTEMS

Maximum Marks: 60 Time allowed: 3 Hours

Pass Marks:35% Total teaching hours:50

Course Objective*: The aim of this course is to provide information regarding operations of semiconductor devices to analyze logic processes, to analyze the sequential circuits*

.

Course Outcomes*: On completion of this course, student will be able to*

- *Understand the current voltage characteristics of semiconductor devices.*
- *Analyze the dc circuits and relate ac models of semiconductor devices with their physical operation.*
- *Design and analyze of electroniccircuits.*
- *Evaluate frequency response to understand the behaviour of electronic circuits.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A

Semiconductor Materials: Energy Bands, Intrinsic carrier concentration, Donors and Acceptors, Direct and Indirect band semiconductors. Degenerate and compensated semiconductors. Elemental (Si) and compound semiconductors (GaAs). Replacement of group III element and Group V elements to get tertiary alloys such as $Al_xGa_{(1-x)}$ As or $GaP_yAs_{(1-y)}$ and quaternary $In_xGa_{(1-x)}P_yAs_{(1-y)}$) alloys and their important properties such as band gap and refractive index changes with x and y Doping of Si (GroupIII and Group V (p) compounds and GaAs (group II (p), IV (n.p) and VI (n compounds). Diffusion of Impurities. Thermal Diffusion, Constant Surface Concentration, Constant Total Dopant Diffusion, Ion Implantation

Carrier Transport in Semiconductors: Carrier Drift under low and high fields in (Si and GaAs), saturation of drift velocity. High field effects in two valley semiconductors. Carrier Diffusion, Carrier Injection, Generation Recombination Processes-Direct, Indirect band gap semiconductors. Minority Carrier Life Time, Drift and Diffusion of Minority Carriers (Haynes-Shockley Experiment) Determination of: Conductivity (a) four probe and (b) Van der Paw techniques. Hall Coefficient, Minority Carrier Life Time. Junction Devices: (i)p-n junction-Energy Band diagrams for homo and hetro junctions. Current flow mechanism in p-n junction, effect of indirect and surface recombination currents on the forward and reverse bias diffusion current, p-n junction diodes-rectifiers (high frequency limit) (ii) Metal-semiconductor (Schottky Junction): Energy band diagram, current flow mechanisms in forward and reverse bias, effect of interface states. Applications of Schottky diodes, iii) Metal-Oxide-Semiconductor (MOS) diodes. Energy band diagram, depletion and inversion layer. High and low frequency Capacitance Voltage (C-V) characteristics. Smearing of C-V curve, flat band shift. Applications of MOS Diode.

Microwave Devices: Tunnel diode, transfer electron devices (Gunn diode) Avalanche Transit time devices (Read, impatt diodes, and parametric devices)

SECTION B

Memory and other Electronic Devices: Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, non-volatile-NMOS, magnetic, optical and ferroelectric memories, charge coupled devices (CCD).

Others Electronic Devices: Electro-Optic, Magneto-Optic and Acousto-Optic Effects. Material Properties related to get these effects. Important Ferroelectric, Liquid Crystal and Polymeric materials for these devices. Piezoelectric, Electrostrictive and magnetostrictive Effects, Important materials exhibiting these properties, and their applications in sensors and actuator devices. Acoustic Delay lines, piezoelectric resonators and filters. High frequency piezoelectric devices-Surface Acoustic Wave Devices. Pyroelectric effect. Inorganic oxide and Polymer pyroelectric materials and their applications

Text and Reference Books

1. The Physics of Semiconductor Devices by D.A, Eraser, Oxford Physics Series(1986)
2. Semiconductor Devices-Physics and Technology, by SM Sze Wiley(1985)
3. Introduction to semiconductor devices, M.S.Tyagi, John Wiley &Sons
4. Measurement, Instrumentation and Experimental Design in Physics and Engineering by M.Sayer and A. Mansingh, Prentice Hall, India(2000)
5. Thin film phenomena byK.L.Chopra
6. The material science of thin films, Milton S.Ohring

7. Optical electronics by Ajoyghatak and K.Thyagarajan, Cambridge Univ.Press
8. Material Science for Engineers, by James F. Shackelford, PrenticeHall
9. Deposition techniques for films and coatings, R.F Bunshah (Noyespublications)
10. Solid state electronics, BenG.Streetman.

PHY 1.2.5 Elective Paper Option (iii) **Session 2023-2024**

SCIENCE AND TECHNOLOGY OF SOLAR HYDROGEN AND OTHER RENEWABLE ENERGIES

Maximum Marks: 60 Time allowed: 3Hours
Pass Marks:35% Total teaching hours:50

Course Objective: *To provide knowledge on energy resources, technologies and systems energy management fundamentals, and capable in innovative technological intervention towards the present and potential future energy issues.*

***Course Outcomes*:** *On completion of this course, student will be able to*

- *Understand the concept of photovoltaic energy and its properties.*
- *Learn the aspects of solar radiation and estimate it different locations.*
- *Explain direct and indirect transition in semiconductors.*
- *Understand the concept of hydrogen energy and hydrogen production.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

Solar Energy

Fundamentals of Photovoltaic Energy Conversion Physics and Material Properties Basic to Photovoltaic Energy Conversion: Optical properties of Solids. Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carriers.

Type of Solar Cells, p-n junction solar cell , Transport Equation, Current Density, Open circuit voltage and short circuit current, Brief descriptions of single crystal silicon and amorphous silicon solar cells, elementary ideas of advanced solar cells e.g. Tandem Solar Cells. Solid Liquid Junction Solar Cells, Nature of Semiconductor, Electrolyte Junction, Principles of Photo-electrochemical solar cells.

SECTION B

Hydrogen Energy

Relevance in relation to depletion of fossil fuels and environmental considerations

Hydrogen Production

Solar Hydrogen through Photoelectrolysis and Photocatalytic process. Physics of material characteristic for production of Solar Hydrogen

Storage of Hydrogen

Brief discussion of various storage processes, special features of solid state hydrogen storage materials, structural and electronic characteristics of storage materials. New Storage Modes.

Safety and Utilization of Hydrogen

Various factors relevant to safety, use to Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, Elementary concepts of other Hydrogen Based devices such as Air Conditioners and Hydride Batteries.

Other Renewable Clean Energies: Elements of Solar Thermal Energy Conversion.

Text and Reference Books

1. Fonash: Solar Cell Devices Physics
2. Fahrenbruch& Bube: Fundamentals of Solar Cells Photovoltaic SolarEnergy
3. Chandra: Photo eloectrochemical Solar Cells
4. Winter &Nitch (Eds): Hydrogen as an Energy Carrier Technologies Systems Economy

P HY 1.1.6 LABORATORY PRACTICE: i) Electronic Lab ii) Laser-Optics Lab

MaximumMarks:100 Time allowed: 3Hours
PassMarks:35% Total teaching hours:125

Out of 100 Marks, internal assessment (based on seminar, viva-voce of experimental reports, number of experiments performed and attendance) carries 25 marks, and the final examination at the end of the semester carries 75 marks.

This laboratory comprises of experiments based on **Lasers and Optics** in one group and **Electronics** in the other group.

GROUP-I ELECTRONICS EXPERIMENTS

(10 out of the followings)

1. Study the characteristics of encoder and decoder.
2. Study of Clipping & Clamping circuits.
3. Study of half wave and full wave rectifier and calculate the ripple factor.
4. Find the energy gap of a given semi conductor by reverse bias junction method.
5. To calculate the temperature coefficient of Thermistor.
6. Study the logic gates namely AND, OR, NAND, NOR, XOR and verify their truth table.
7. Study the characteristics of ripple counter.
8. To study the given operational amplifier as an inverting and non- inverting amplifier.
9. To study the given operational amplifier as a summer and subtractor.
10. To study the given operational amplifier as a differentiator and integrator.
11. To study the 4 bit digital to analog convertor.
12. Study of various types of Flip-Flops.
13. To study characteristics of FET and determine its various parameters.
14. Study the characteristics of Zener diode.
15. To plot the input and output characteristics of a given transistor having CE configuration.
16. Study of biasing techniques of BJT.
17. To study Frequency Modulation and Demodulation.
18. Fourier series analysis of square, triangular and rectified wave signals.
19. To study the static RAM.
20. To study the frequency response of common emitter single stage RC coupled amplifier and hence to find the voltage gain.

GROUP-II LASERS AND OPTICS EXPERIMENTS:

(10 out of the followings)

1. To study the optical bench model of micro scope and to determine the numerical aperture of the microscope.
2. To study the optical bench model of telescope and to determine the angular field of view and magnifying power by entrance and exit pupil method.
3. To study the characteristics of solar cell.
4. To find the wavelength of light by using Michelson interferometer.
5. To study the optical thickness of mica sheet using channel spectrum interferometry.
6. To determine the Planck's constant using photovoltaic cell.
7. To find the wavelength of red light and hence to verify Bragg's law.
8. To study the aberrations of a convex lens.
9. To study the electro-optic effect in $LiNbO_3$ crystal using He-Ne laser.
10. To study B-H curve.
11. To study the characteristics of optoelectronic devices (LED, Photodiode, Photodiode, Phototransistor, LDR).
12. To study the diffraction pattern by pin hole, single slit, double slit and grating and to calculate the wavelength of He-Nelaser.
13. To study microwave optics system for reflection, refraction, polarization phenomena.
14. To calibrate the prism spectrometer using mercury lamp and to determine the refractive index of material of the prism for a given wavelength of light.
15. Measurement of Brewster angle and refractive index of materials like glass and fused silica (with He-Ne laser) with a specially designed spectrometer.
16. Particle size determination by diode laser.
17. Study of optical fiber communication kit.

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FACULTY OF SCIENCES
SYLLABUS
FOR
M.Sc. PHYSICS
Program code:-MSPHY
(Semester: III & IV)
Sessions: 2023-24

MATA GUJRI COLLEGE

FATEHGARH SAHIB-140406, PUNJAB

Website: matagujricollege.org Email: mgcfgs@rediffmail.com

Phone numbers. 01763-232247, 01763-233715

SCHEME
M.Sc. PHYSICS PART-II (III & IV SEMESTER)
PROGRAM CODE:-MSPHY
SESSION 2023-24

Pass Percentage: 35% (in Theory Papers)
45% (in Practical papers)

M.Sc. Physics Semester III		**Hours (per week)**	**Credits**	**External**	**Internal**	**Max. marks (**)**
Core Papers						
P HY 2.3.1	Condensed Matter Physics-I	**4**	**4**	**60**	**20**	**80**
P HY 2.3.2	Laser and Fiber Optics	**4**	**4**	**60**	**20**	**80**
P HY 2.3.3	Advanced Classical Mechanics and Electrodynamics	**4**	**4**	**60**	**20**	**80**
Elective papers (Choose any one)		**4**	**4**	**60**	**20**	**80**
P HY2.3.4	(i) Computational methods and Simulations					
	(ii) Plasma Physics					
	(iii) Theoretical Nuclear Physics					
	(iv) Material Science					
P HY 2.3.5	Laboratory Practice: (Nuclear and Solid State Physics Lab)	**9**	**4.5**	**80**	**40**	**120**
P HY 2.3.6	Computer Laboratory	**3**	**1.5**	**45**	**15**	**60**
Total Credits = 22						

M.Sc. Physics Semester IV		**Hours (per week)**	**Credits**	**External**	**Internal**	**Max. marks(**)**
Core Papers						
P HY 2.4.1	Condensed Matter Physics II	**4**	**4**	**60**	**20**	**80**
P HY 2.4.2	Advanced Quantum Mechanics	**4**	**4**	**60**	**20**	**80**
Elective papers (Choose any two)		**4**	**4**	**60**	**20**	**80**
P HY 2.4.3/ P HY 2.4.4	(i) Experimental Techniques in Physics					
	(ii) Radiation Physics					
	(iii) High Energy Physics					
	(iv) Advanced Electronics					
	(v) Atomic and molecular Spectroscopy					
	(vi) Electronic Communication Systems					
P HY 2.4.5	Laboratory Practice: (Nuclear and Solid State Physics Lab) / Project Work*	**9**	**4.5**	**80**	**40**	**120**
P HY 2.4.6	Computer Laboratory	**3**	**1.5**	**45**	**15**	**60**
Total Credits = 22						

Total Marks: IIIrd Sem. = 500 IVth Sem. = 500

*Project work may be allotted depending upon the availability of staff.

**Preleiminary work of project will be assigned in Semester III. Students can do topic analysis, literature review and problem defining in sem III and its evaluation will be on the basis of seminar as internal Assessment.

Data analysis, writing thesis, presentation and defense will be done in Sem IV.

Session: 2023-2024

P HY 2.3.1 **CONDENSED MATTER PHYSICS-I**

Maximum Marks:60 Time allowed: 3 Hours

Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim of the course on Condensed Matter Physics I is to expose the students to the topics like structure of Materials, elasticity, lattice vibrations, energy band theory and various other properties of matter such as electric, optical etc. and transport theory so that they are equipped with the techniques used in investigating these aspects of the matter in condensed phase.*

Course Outcomes: *On completion of this course, student will be able to*

- *Have a basic knowledge of binding in crystal systems and elastic properties.*
- *Understand the concept of various models and theories of condensed matter physics such as Drude model, Free electron theory.*
- *Know the significance of band theory and kronig-penney model.*
- *Know the concept of phonons.*
- *Understand the concept of semiconductors and superconductors, ordered phases.*

Instructions for the Paper Setter The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A

Crystal structure: Bravais Lattices in plane and space, Binding in Solids, Elastic constants of a crystal: Elastic stress, Elastic Strain and Dilation: Stress components, stiffness constant,

Thermal and Electrical properties of Matter: Lattice vibrations and phonons, measurement of phonon dispersion by inelastic neutron scattering, Lattice vibrations of mono-atomic linear lattices, Lattice vibrations of diatomic linear lattices.

Electron motion in periodic potential: Free electron gas in 1-D and Free electron gas in 3-D. Heat capacity of metals, Thermal effective mass, Drude model of electrical and thermal conductivity, Wiedman-Franz law, Hall effect.

Band theory of solids: Bloch functions, Kronig-penny model, Number of Orbitals in a band, Metals and insulators and semiconductors.

SECTION B

Superconductivity: Survey of traditional and high T_c superconductors, Meissner effect, Isotope effect, London equation, Coherence length, Some basic ideas of BCS theory, Flux quantization in superconducting ring, Type I and Type II Superconductors, DC/AC Josephson effects. SQUIDS and applications.

Semiconductors and Fermi-surfaces in Metals: Band gap, Equation of motion, properties of holes, Effective mass of electrons (m*), m* in semiconductors, Intrinsic carrier concentration, Intrinsic and extrinsic conductivity, Semimetals, De Haas-Van Alphen effect, Extremal orbits,

Ordered phases of matter: Liquid Crystals, translational and orientational order, kinds of liquid crystalline order.

TEXT BOOKS:

1. Introduction to Solid State Physics; C. Kittel (7^{th} Ed.), Wiley Eastern, N. Delhi, 1995.
2. Quantum Theory of Solids: C. Kittel, Wiley, New York.
3. Solid State Physics: A.J. Dekker, Mc. Millan India Ltd.
4. Elements of solid state Physics: J P Srivastava, PHI Learning Private Limited, N. Delhi.
5. Solid State Physics, S O Pillai, New Age International Publishers, N. Delhi

PHY 2.3.2	LASER AND FIBER OPTICS	Session: 2023-24

Pass Marks: 35 %	Total teaching hours: 50	Pass Marks: 35 %
Maximum Marks:60	Time allowed: 3 Hours	Maximum Marks:60

Course Objective: *The aim and objective of the course on Laser Physics is to expose the students to the topics like interaction of radiation with matter, understanding about laser fundamentals, different types of Lasers and introduction to Optics.*

Course Outcomes*: On completion of this course, students will be able to*

- *Understand the basic fundamentals of LASER.*
- *Describe the construction and working of different types of lasers.*
- *Explain the relation between Einstein coefficients and Laser rate equation.*
- *Discuss the applications of lasers-in medical field, in industry field, holography etc.*
- *Explain the attenuation mechanisms in optical fibre.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C. Use of scientific calculators is allowed.

SECTION A

Introductory Concepts: Absorption, Spontaneous and stimulated emission, the laser idea, Properties of laser light.

Interaction of radiation with matter: Summary of black body radiation theory, Rates of absorption and stimulated emission, Allowed and forbidden transitions, Line broadening mechanisms, Transition cross-section, Absorption and gain coefficient, Non-radiative decay, Decay of many atom systems.

Pumping processes: Optical and electrical pumping, Passive optical resonators: Photon lifetime and Q.Cavity, Plane parallel resonator.

Laser rate equation: Three level and four level lasers: Optimum output coupling, Laser spiking, Q switching, Mode Locking.

Types of lasers: Ruby lasers, Nd: YAG laser, He-Ne laser, Co_2 laser, N_2 laser, Excimer laser, Dye lasers, Chemical lasers, Semiconductor lasers, Colour center and free electron lasers.

SECTION B

Optical Fibers and Fabrication: Introduction (Total internal reflection, optical fibre, coherent bundle, numerical aperture), light propagation through optical fiber, fiber materials, fiber fabrication, mechanical properties of fibers.

Signal Degradation in Optical Fibers: Attenuation in optical fibre, multimode fibre, Pulse dispersion in optical fibre, mode coupling.

Power Launching and Coupling: Source-to-fiber launching, fiber-to-fiber joints, LED coupling to single-mode fibers, fiber splicing, optical fiber connectors.

Text Books:

1. Principles of Lasers: O. Svelto,(3rd Ed.), Plenum Press
2. Lasers and its applications: A.K. Ghatak and K. Thyagrajan
3. Laser Electronics: J.T. Verdeyen (2nd Ed.), PHI
4. Keiser, G., Optical Fiber Communications, McGraw-Hill International, (2000).
5. Seniors, J.M., Optical Fiber Communications – Principles and Practice, Prentice-Hall of India, (1996).

PHY 2.3.3 **Session 2023-2024**

ADVANCED CLASSICAL MECHANICS AND ELECTRODYNAMICS

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim of Advanced Classical mechanics and Electrodynamics is to understand the nature of space-time and gravity based on the Einstein's theory of relativity, Origin of the physical inertia of matte, Maxwell inhomogeneous equations and conservation laws.*

Course Outcomes: *On completion of this course, student will be able to*

- *Understand Covariant formulation of electrodynamics to explore the unification of electricity and magnetism.*
- *Understand the concept of Origin of the electromagnetic radiation by an accelerating charge particle.*
- *Understand the scattering of electromagnetic wave by free and bound electron.*
- *Understand the concept of Electromagnetic wave propagation.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C. Use of scientific calculators is allowed.

SECTION A

Hamilton-Jacoby theory: Hamilton-Jacobi equations for Hamilton principal and characteristic functions. *Problems*: Harmonic oscillator using Hamilton-Jacobi formulation and through action- angle variables.

Special relativity: Lorentz transformation, Invariance of Space-time interval, covariant formulation, Force, momentum and energy equation in relativistic mechanics, Lagrangian formulation of relativistic mechanics. *Problems*: Applications of relativistic formulation in the study of motion under constant force and relativistic one dimensional harmonic oscillator.

Small oscillations: Formulation of problem, Eigen value equation and principal axes transformation, Frequencies of free vibration and normal modes.

Problem: Normal mode frequencies and eigen vectors of diatomic and linear tri-atomic molecule. **Continuous systems and fields**: Transition from discrete to continuous systems, Lagrangian formulation, Stress-energy tensor and conservation laws, Hamiltonian formulation, Scalar and Dirac fields (only definitions).

SECTION B

Maxwell inhomogeneous equations and conservation laws: Poynting theorem and Maxwell stress tensor, Poynting theorem for harmonic fields. Fields and radiation of a localized oscillating source, Electric dipole fields and radiation, Magnetic dipole field, Centre fed linear antenna.

Electromagnetic waves and wave propagation: Plane waves in a non-conducting medium, Polarization and Stokes parameter, Energy flux in a plane wave, Reflection and refraction across a dielectric interface, Total internal reflection, Polarization by reflection, Waves in a conducting medium and skin depth. Fields at the surface of and within a conductor, wave guides, Modes in rectangular wave guide, Energy flow and attenuation in wave guides.

TEXT BOOKS:

1. Classical Mechanics: H. Goldstein, Narosa Publishing House, NewDelhi.
2. Classical Electrodynamics, J.D. Jackson, Wiley EasternLtd.
3. Introduction to Electrodynamics, D. J. Griffith, PHILtd.

Session: 2023-2024

PHY 2.3.4 (i) **COMPUTATIONAL METHODS AND SIMULATION**

Maximum Marks:60 | Time allowed: 3 Hours
Pass Marks: 35 % | Total teaching hours: 50

Course Objective: *The objective of the course on Computational Methods and Simulations is to familiarize the of M.Sc. Physics students with the numerical methods used in computation and programming using Fortran language so that they can use these in solving simple problems pertaining to Physics.*

Course Outcomes: *On completion of this course, student will be able*

- *To understand the tools like FORTRAN language and programming to enhance knowledge of physics.*
- *To have knowledge and application of numerical methods used in computation and programming.*
- *To have understanding of Random Variables and Monte Carlo Methods.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

SECTION A

FORTRAN: Review of fundamental FORTRAN commands and programming structures (sequential, repetitive and selective), data types, subscripted variables, format directed input and output statements, handling of data files, Subprograms: Function and Subroutines.

System of Linear Equations: Gauss elimination methods, Jacobi's iterative method. Eigen values and Eigen vectors: Introduction, properties of eigen values and eigenvectors, Determination of Eigen values and Eigenvectors by Iterative (Power method) and Jacobi methods (except programming). Probability distributions: binomial, Poisson and normal distributions.

SECTION B

Solution of Ordinary Differential Equations: Runge-Kutta second order and fourth order methods, Predictor corrector methods, Solution of coupled differential equations, and second order differential equations

Random Variables and Monte Carlo Methods: Random numbers, Pseudo-random numbers, Monte Carlo integration: Moment of inertia, Monte Carlo Simulations: Buffen's needle experiment, Importance of Sampling, Random Walk.

Algorithmic development for simulation of the following physics problems:-

1. Motion in one dimension in viscous medium
2. Motion of satellite
3. Simple harmonic oscillator
4. Damped oscillator
5. Electric field and potential due to assemble of charges
6. Application of Kirchoff's laws for simple electric circuits
7. Monte Carlo method to find value of pi
8. Monte Carlo technique for simulation of nuclear radioactivity

TEXT BOOKS:-

1, V.K.Mittal, R.C.Verma and S.C.Gupta, FORTRAN for Computational Physics, Ane Books Ltd.

2. V. Rajaraman, Computer Oriented Numerical Methods, PHI Publications.

3. R.C. Verma, Computer Simulation in Physics (using FORTRAN), Anamaya Pub.

4. Numerical Methods – E Balagurusamy-Tata McGraw Hill Publishing Co Ltd-1999.

PHY 2.3.4 (ii) **PLASMA PHYSICS** **Session: 2023-2024**

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course on Plasma Physics is to expose the students of M.Sc. Physics class to motion of charged particles in a constant uniform magnetic field, constant and uniform electric and magnetic fields and Inhomogeneous magnetic field.*

Course Outcomes*: On completion of this course, student will be able to*

- *Understand the concept of motion of charged particles, adiabatic invariants, Boltzmann equation, Fokker Planck equation.*
- *Understand the theory of Ohm's law, MHD equation and stability.*
- *Learn about Plasma oscillations, Electron plasma waves, Ion waves, magneto plasma, magnetosonic waves.*
- *Understand the propagation of electromagnetic waves through a plasma and magnetoplasma.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A

Motion of charged particles: Motion of charged particles in a constant uniform magnetic field, Constant and uniform electric and magnetic fields, Inhomogeneous magnetic field. Constant non-electromagnetic forces, Time varying magnetic field, constant magnetic and time varying electric field, Adiabatic invariants, Magnetic mirrors. **Boltzmann equation**: Fluid model of a plasma, Two fluid and one fluid equations, Collision less Boltzmann equation, Moment equations and conservation laws, Transport phenomena in plasma: Fokker Planck equations.

SECTION B

Magneto hydrodynamics: Generalized Ohm's law, MHD equations, MHD equilibrium, Force free fields. MHD Stability: Normal mode technique, Sausage and kink instability in a linear pinch, Energy principle, Interchange instabilities, Cusp configuration, Two stream, Ion-acoustic drift, Firehose instabilities. **Waves in Plasma**: Plasma oscillations, Electron plasma waves, Ion waves, Electrostatic electron and ion oscillations in a magnetoplasma, Electromagnetic waves propagation through a plasma and magneto plasma, Alfven waves and magneto sonic waves.

Text Books:

1. Plasma Dynamics: Boyd, T.J.M. and Sanderson, J.J., Nelson, 1969
2. Introduction to plasma Physics, Chen, F.F., Plenum Press, N.Y. 1977
3. Elements of Plasma Physics: Goswami, S.N., New Central Book Agency, 1995
4. Introduction to Plasma Theory, Nicholson, D.R., John Wiley & Sons, 1983.

Session: 2023-2024

PHY2.3.4 (iii) THEORETICAL NUCLEAR PHYSICS

Maximum Marks:60 Time allowed: 3 Hours

Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course Theoretical Nuclear Physics is to expose the students of M.Sc. Physics class to Angular momentum operators, C-G coefficients and Matrix representation of angular momentum operators. To understand various nuclear models.*

Course Outcomes*: On completion of this course, student will be able to*

- *Understand the concept of angular momentum operators and their matrix representations, Clebsch-Gordan coefficients and their properties.*
- *Learn about nucleon-nucleon force, Isospin of two nuclear systems, Deuteron problem.*
- *Explain nuclear models like liquid drop model, single particle shell model, extended single particle shell model, two particle shell model.*
- *Understand the concept of odd-odd and even-even nuclei , Interacting Boson Model.*
- *Learn about scattering theory.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculator is allowed.

SECTION A

Angular momentum theory: Angular momentum operators and their matrix representations. Vector addition of two angular momenta. Clebsch-Gordan coefficients and their properties. Rotation operators, Rotation D-matrices and their properties.

Problems: Matrix representation of angular momentum operators for j =1 case, Evaluation of C-G coefficient For j_1=1/2 and j_2 = ½ case. Evaluation of Rotation matrices for simple cases.

Spherical tensors. Wigner-Eckart theorem and its applications, Wigner 3-j symbols. Addition of three angular momenta. Definition of Racah coefficients and their properties.

Problems: Matrix representation of angular momentum operators

Nuclear force and two nucleon systems: Symmetries of nucleon-nucleon force. Isospin of two nuclear systems. Solution of Deuteron problem, Deuteron magnetic dipole moment. Evaluation of Deuteron

Electric quadrupole moment. Tensor force and Deuteron D-state.

Problems: Evaluation of nuclear magnetic moments in the Schmidt limit. Symmetry properties of two nucleon spin and isospin wave functions.

SECTION B

Nuclear models : Deformable liquid drop and nuclear fission. Single particle shell model, spin and parity of ground state of nuclei. Extended single particle shell model, seniority scheme and reduced isospin, configuration mixing, Simple description of two particle shell model spectroscopy.

Problems: Calculation of nuclear ground state spin and parity of odd-A nuclei using shell model (with examples), Spin-orbit coupling in shell model. Description of two particle shell model spectroscopy (with examples);

Vibrational model. Rotational model, nuclear rotational wave functions and energy spectra from deformed even-even and odd-A nuclei. Nilsson model. Nilsson diagrams. Statistical model, evaporation spectra and nuclear temperature. Interacting Boson Model.

Problems: Calculation of nuclear spin and parity for deformed nuclei using Nilsson diagrams.

Scattering Theory: Elastic scattering of spin zero projectile from a spin zero target, total cross section for elastic scattering and optical theorem. Integral equation for the scattering wave function and Born approximation. Low energy scattering parameters. Scattering from a complex potential.

Problems: Discussion of low energy scattering parameters.

Text Books:

1. Introductory Nuclear Physics by S. S. M. Wong, Prentice Hall of India Pub., New Delhi
2. Nuclear Physics by R. R. Roy and B. P. Nigam, New Age Publication, New. Delhi
3. Nuclear and Particle Physics by W. E. Burcham and M. Jobes, Addison Wesley Pub. (Ind. Ed.)

Reference Books:

1. Nuclear reactions by D. F. Jackson
2. Nuclear Structure by M. K. Pal, Affiliated East-West Press
3. Physics of the Nucleus by M.A. Preston

PHY 2.3.4 (iv) **MATERIAL SCIENCE** **Session: 2023-2024**

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course on Material Science is to familiarize the students of M.Sc. Physics to the various aspects related to crystal imperfections, mechanical properties and Engineering Materials, so that they can pursue in research field of material science.*

Course Outcomes*: On completion of this course, student will be able to learn about*

- *Crystal imperfections, Classification of imperfections, dislocations.*
- *Diffusion processes, Laws of diffusion, Solution to Fick's second law, mechanical properties.*
- *Phase diagram**,** Iron-Carbon phase diagram, Transformation in steel and critical cooling curve.*
- *Casting of ingots, Plain carbon steels and applications, Properties of aluminium alloys.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

SECTION A

Crystal Imperfections: Classification of imperfections: Point imperfections, Line imperfections; Mixed dislocations. Characteristics of dislocations; Sources of dislocations, their effects and remedies; Phenomena related to behaviour of dislocations, Surface imperfections, Volumes imperfections, Whiskers.

Diffusion in solids: Diffusion controlled applications, Types of diffusion, Diffusion processes, Laws of diffusion, Solution to Fick's second law, Applications based on second law, Experimental determination of diffusivity, Factors affecting diffusivity.

Mechanical Properties: Basic properties**:** Strain, Stress, Young's modulus, Elastic constants, Isotropy, Anisotropy, Orthotropy, Homogeneity and heterogeneity; Stress-strain diagrams, Stress-strain diagram of structural steel, Elastic properties; Other mechanical properties: Strength, Stiffness, Elasticity, Plasticity, Resilience, Proof resilience, Toughness, Ductility, Brittleness and malleability, True stress-strain diagrams, Fatigue and Creep. Mechanical Tests: *Destructive tests, Tensile test, Compression tests, Shear and bending (on Flexure) tests, Torsion test, Hardness tests, Impact tests, Fatigue test and Creep test.*

SECTION B

Phases and Phase diagrams: Solid phases in alloys, Solid solution, Inter-metallic compounds and intermediate compounds, Phases, Phase diagrams, Binary phase diagram, Typical phase diagrams, Application of phase diagrams, Ternary phase diagram.

Phase Transformations and Heat Treatment: Rate of cooling and crystallization, Strengthening mechanisms; Cold and hot working; Precipitation (or Age) hardening, Dispersion hardening, Solid solution hardening, Recovery and re-crystallization, Grain growth and preferred orientation.

Purpose of heat treatment, Microstructure of steel and iron, Iron-Carbon phase diagram, Transformation in steel and critical cooling curve, Heating temperature range in various heat treatment processes, Hardening, Tempering, Annealing, Normalizing, Case hardening or carburizing, Cyaniding, Nitriding, Flame hardening, Induction hardening and Jaminy End-quenched test.

Engineering Materials (Ferrous): Production of iron and steel, Casting of ingots, Refining, Continuous casting, Steels, Plain carbon steels and applications, Alloy steels, Heat treatment of stainless-steels, Tool-steels and Cast iron.

Engineering Materials (Non-ferrous): Aluminium, Properties of aluminium alloys, Age-hardening of aluminium alloys, Copper and its production, Copper alloys, Magnesium and its alloys, Titanium alloys, Bearing materials, Alloys for cutting tools, Creep resistant materials.

Text Books:

1. Material Science and Engineering: K.M. Gupta (Ist Ed.), Umesh Pub., Delhi
2. Material Science: Abdul Mubeen and Farhat Mubeen (2nd Ed.), Khanna Pub., Delhi

PHY 2.3.5 **LABORATORY PRACTICE** **Session: 2023-24**

Maximum Marks: 120 Time allowed: 3 Hours
Pass Marks: 45% Total teaching hours: 125

The aim and objective of the course on Physics Laboratory is to expose the students of M.Sc. Physics class to experimental techniques in general physics, nuclear physics and solid state physics so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.
Out of 120 Marks, internal assessment (based on seminar, viva-voce of experimental reports, number of experiments performed and attendance) carries 40 marks, and the final examination at the end of the semester carries 80 marks.
The laboratories comprises of experiments based on **Nuclear Physics** in one group and **Solid State Physics** in the other group. Each student will be placed in one of the two groups during the entire semester.

GROUP-I: NUCLEAR PHYSICS

(10 out of the followings)

1. Study of standard deviation using G-M counter

2. Half-life of ^{40} K using G-M Counter

3. Measurement of mass absorption coefficient of beta rays in given materials

4. To find range and energy of β- particles

5. To find Dead time of a GM Tube

6. Study of energy calibration of NaI(Tl) scintillation detector

7. Study and analysis of spectrum of ^{137}Cs

8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer.

9. Study of Compton scattering law for energy of scattered photons

10. To study Internal Conversion Coefficient for ^{137}Cs (or suitable gamma source)

11. To determine the source strength of a given radioactive gamma source

12. Study and analysis of the spectrum of ^{60}Co

13. Photoelectric cross-section measurement for a given target material at known incident gamma photon energy

14. Compton cross-section measurement for known incident gamma photon energy

15. Measurement of Photo-peak (full energy peak) efficiency of Scintillation detector.

GROUP-II: SOLID STATE PHYSICS

(10 out of the followings)

1. To determine numerical aperture of optical fibre.
2. To determine the compressibility of a given liquid by using ultra sonication waves.
3. To measure the energy gap of Ge crystal using Four Probe method.
4. To study the polarization and reflection phenomena of microwave.
5. To study bending loses in optical fiber.
6. To study the microwave optics: Show that intensity is inversely proportional to square of distance.
7. To understand the concept of scaling in nanotechnology.
8. To study Hall Effect for given semi-conductor material.
9. To determine the Curie temperature of a given PZT sample.
10. Determine the coercivity, retentivity and saturation value of magnetic induction of the given sample by studying the B-H loop.
11. Measurement of magneto-resistance of a semi-conducting sample.
12. Study of Dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
13. Study of solar cell and characteristics.
14. Find the value of the ‘g’ factor in a DPPH sample by using ESR technique.
15. Frank Hertz experiment for Quantization of Bohr’s model of atom.

PHY 2.3.6 **COMPUTER LAB** **Session: 2023-2024**

Maximum Marks: 60 Time allowed: 3 Hours

Pass Marks: 45% Total teaching hours: 30

The aim and objective of the computer laboratory is to students capable for writing and interrelating the physics problems with software. It expertise them in graph plotting, simplification of calculations, etc.

Out of 60 Marks, internal assessment (based on performance of the candidate in the computer lab and attendance) carries 15 marks, and the final examination at the end of the semester carries 45 marks.

This laboratory comprises of any ten of the following physics problems to be solved using computer.

1. To find the area of triangle
2. Printing even numbers in given limits
3. Printing even and odd numbers in given limits
4. Find the sum of natural numbers
5. Finding maximum of given set of numbers
6. Find roots of quadratic equation
7. Find the mean of given data
8. Finding minimum of given set of numbers
9. Printing odd numbers in given limits
10. To construct AP and GP series.
11. To construct Sine and Cosine series.
12. Addition of two matrices.
13. Motion of horizontally thrown projectile.
14. To find perfect numbers.
15. Frequency distribution table.
16. Area under curve using trapezoidal rule.
17. Area under curve using Simpson rule
18. Multiplication of two matrices.
19. Motion of projectile thrown at an angle.
20. Simulation of Planetary motion.

Semester IV

PHY 2.4.1 **CONDENSED MATTER PHYSICS-II** Session: 2023-2024

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course on Condensed Matter Physics II is to familiarize the M.Sc. Physics students with relatively advanced topics like magnetism, optical properties, ferroelectricity, dielectrics and disordered solids so that they are confident to use the relevant concepts in their later career.*

Course Outcomes*: On completion of this course, student will be able to learn about*

- *Langevin diamagnetism equation, magnons, Ferromagnetic domains, Crystal field splitting.*
- *Cooling by adiabatic demagnetization, Ferromagnetism, Debye equations, Dipole theory of ferroelectricity.*
- *Nanoparticles, Metal nano clusters (various types), Quantum well, Quantum wire and Quantum dots (in brief) and their fabrication.*
- *Dielectrics and Plasmons, polaritons, polarons.*
- *Lattice Disorders: Burger's vector. Low angle and large angle grain boundaries. Dislocation multiplication by Frank-Read source.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Use of scientific calculators is allowed.

SECTION A

Magnetic properties: Langevin’s diamagnetism equation, Paramagnetism, Langevin’s and Quantum theory of para-magnetism, magnetism of rare earth and iron group ions, Crystal field splitting, Quenching of orbital angular momentum, Cooling by adiabatic demagnetization.

Ferromagnetism, Spin waves and magnons in ferromagnetics, Ferromagnetic domains and Weiss theory of hysteresis, Bloch wall, Origin of domains, Antiferromagnetic order and susceptibility. Ferrimagnetic order and iron garnets, Application of soft and hard magnetic materials.

Ferroelectric materials: Ferro-electric materials and their classification, Dipole theory of ferroelectricity, Objections against dipole theory, Ferroelectricity in $BaTi0_3$.

SECTION B

Nanotechnology: Introduction to nanoparticles, Metal nano clusters, Properties of semi conducting nanoparticles, Methods of synthesis of nanoparticles, Quantum well, Quantum wire and Quantum dots (in brief) and their fabrication by electron beam lithography.

Theory of Dielectrics: Plasmons, polaritons, polarons: Clausius- Mosotti relation, Dielectric function of the electron gas, Plasmons, polaritons and LST relation, polaron.

Lattice defects: Point defects, Concepts of traps, Colour centers, Line imperfections, Dislocations and its types, Burger's vector. Planar Imperfections: grain boundaries, Low angle and large angle grain boundaries. Dislocation multiplication by Frank-Read source and strength of alloys.

TEXT BOOKS:

1. Introduction to Solid State Physics; C. Kittel (7^{th} Ed.), Wiley Eastern Ltd.,1995
2. Solid State Physics: A.J. Dekker (2^{nd} Ed.), Mc Millan India Ltd.
3. Introduction to Nano Technololgy: Charles P Poople, Jr. and Frank J. Owens, John Wiley & Sons Publications, 2003.
4. Elements of solid state Physics: J P Srivastava, PHI Learning Private Limited, N. Delhi.
5. Solid State Physics, S O Pillai, New Age International Publishers, N. Delhi.

PHY.2.4.2 **ADVANCED QUANTUM MECHANICS** **Session: 2023-2024**

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course on Advance Quantum Mechanics is to introduce the students of M.Sc. Physics class to the formal structure of the subject and to equip them with the techniques of angular momentum, perturbation theory and scattering theory so that they can use these in various branches of physics as per their requirement.*

Course Outcomes*: On completion of this course, student will be able to*

- *Understand first order and second order perturbation theory for non degenerate case, Anharmonic oscillator.*
- *Learn exchange operators, Variational method, Transition probability for constant and harmonic perturbation, Golden rule.*
- *Understand the Principle of WKB, Born approximation , Optical theorem, s and p-wave scattering.*
- *Understand the theory of Klein-Gordon equation, Dirac equation, spin and magnetic moment.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

Variational Method: Rayleigh Ritz variational method for ground & excited States, *Problems:* Ground state energy of hydrogen, helium and harmonic oscillator.

Time Independent Perturbation Theory: First order and second order perturbation theory for non-degenerate case; *Problems*: Anharmonic oscillator, He-atom; Degenerate perturbation theory, *Problems*: Stark effect, Zeeman effect.

Time Dependent Perturbation Theory: Transition probability for constant and harmonic perturbation, Selection rules, Golden rule, Induced absorption and emission, Einstein coefficients; *Problems*: Radiative transitions.

WKB Method in One Dimension: Classical limit, Principle of WKB, Connection formulae for penetration of a barrier; *Problem*: Alpha decay.

SECTION B

Collision Theory: Scattering amplitudes and cross section, Green function method, Integral equation of scattering amplitude, Born approximation. Partial wave analysis: Scattering by central potential, Short range interaction, Phase shifts, Optical theorem, s and p-wave scattering, Scattering length, Effective range, Breit-Wigner formula. *Problems*: Scattering by three dimensional square well potential, Elastic scattering of electrons by an atom.

Relativistic Quantum Mechanics: Klein-Gordon equation: Probability and current densities, Continuity equation, Difficulties of K.G. equation, Plane wave solution. Dirac equation: Dirac algebra, Plane wave solutions, Hole theory, Non-relativistic limit, Spin and magnetic moment, Zitterbewegung, Hydrogen atom. *Problem:* Fine structure, Lamb shift, Spin-orbit coupling, Covariant form of Dirac equation, Bilinear covariants

Text Books:

1. Quantum Mechanics: P.M. Mathews and K. Venkatesan, Tata McGraw-Hill Publication, N. Delhi
2. Quantum Mechanics: M.P. Khanna, Har-Anand Publication, Delhi

Reference Books :

1. Quantum Mechanics: L.I.Schiff, Tata McGraw-Hill Publication.
2. Quantum Mechanics: V.K.Thankappan, New Age International

Session: 2023-2024

PHY 2.4.3 & PHY 2.4.4 Option (i) EXPERIMENTAL TECHNIQUES IN PHYSICS

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course on Experimental Techniques in Physics is to expose the students of M.Sc. Physics class to different characterization tools for topographical, optical and morphological analysis of material. Operation and transducers is also discussed in details.*

Course Outcomes*: On completion of this course, student will be able to*

- *Learn about thermal evaporation , cathodic sputtering , glow discharge sputtering.*
- *Understand the analytical and transducers techniques.*
- *Understand the theories of Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunneling Microscope, Atomic Force Microscope.*
- *Know about the basic concepts and applications of spectroscopic techniques.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

Thin Film Deposition Technology: Thermal evaporation – general considerations and evaporation methods. Cathodic sputtering – sputtering process, glow discharge sputtering, sputtering variants and low pressure sputtering. Chemical methods – electrodeposition and chemical vapour deposition. Vacuum deposition apparatus – vacuum systems and surface deposition technology.

Thickness Measurements, Analytical Techniques and Transducers Techniques: Thickness measurement – electrical methods, microbalance monitors, mechanical method, radiation absorption and radiation emission methods, optical interference methods.

Transducers: Transducers as input elements to instrumentation systems, classification of transducers, selecting a transducer, strain gauges, displacement transducers, temperature measurements, photosensitive devices.

SECTION B

Introduction: Important parameters describing the materials, Need of materials characterisation, available Characterization techniques. Optical microscopy.

Electron microscopy: Scanning Electron Microscope: Basic concepts, Instrumentation & working, Applications; Transmission Electron Microscope: Basic concepts, Instrumentation & working, Applications

Scanning probe microscopy: Scanning Tunneling Microscope: Principal, Construction & working, Applications; Atomic Force Microscope: Principal, Construction & working, Applications

Spectroscopic Techniques ***(Basic concepts, Instrumentation & working, Applications)***: UV-Visible absorption spectroscopy, X-ray photoelectron spectroscopy, Fourier Transform Infrared Spectroscopy, Photo Luminescence spectroscopy, Atomic absorption spectroscopy, Mass spectroscopy.

Text Books:

1. Thin Film Phenomena: K.L. Chopra, McGraw Hill Book Company
2. Electronic Instrumentation and Measurement Techniques: W.D. Cooper and A.D. Helfrick (3rd Ed.), Prentice Hall of India Pvt. Ltd.
3. **Springer Handbook of Nanotechnology** Edited by Bharat Bhushan, Published by Springer.
4. **Handbook of Spectroscopy** Edited by G Gaugliz an T Vo-Dinh,Published by WILEY VCH Verlag GmbH & Co.

PHY 2.4.3 & P HY 2.4.4 Option (ii)RADIATION PHYSICS Session:2023-2024

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course on Radiation Physics is to expose the students of M.Sc. Physics class to various types of neutron reactions. Analysis of nuclear spectroscopy data and details various experimental techniques.*

Course Outcomes*: On completion of this course, student will be able to*

- *Understand basics of thermal neutrons like energy distribution of thermal neutrons, effective cross section of thermal neutron.*
- *Understand the concept of nuclear chain reaction.*
- *Learn thermal Neutron diffusion, Neutron diffusion equation, Thermal diffusion length.*
- *Analyze nuclear spectrometric data and able to measure g-factors and hyperfine fields.*
- *Understand the principle, Instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

Thermal neutrons : Energy distribution of thermal neutrons, Effective cross section of thermal neutron , Slowing down of reactor neutrons, Angular and energy distribution, Transport mean free path and scattering cross-section, Average logarithmic energy decrement, Slowing down power and moderating ratio, Slowing down density, Slowing down time, Resonance escape probability.

Nuclear chain reaction: Neutron cycle and multiplication factor Neutron leakage and critical size, Nuclear reactors and their classification.

Neutron diffusion: Thermal Neutron diffusion, Neutron diffusion equation, Thermal diffusion length, Exponential pile, Diffusion length of a fuel-moderator mixture, Fast neutron diffusion and Fermi age equation, Correction for neutron capture.

SECTION B

Nuclear spectrometry and applications: Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g-factors and hyperfine fields.

Analytical Techniques: Principles, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques. Experimental techniques and applications of Mossbauer effect, Rutherford backscattering. Industrial applications of elemental analysis, Diagnostic nuclear medicine, Therapeutic nuclear medicine.

Text Books:

1. Liverhant, S.E. : Elementary Introduction to Nuclear Reactor Physics
2. Singru, R.M : Introduction to experimental nuclear physics, Wiley Eastern Pub., N. Delhi
3. Krane, K.S : Introductory Nuclear Physics, John Wiley & Sons, New York
4. H.R.Verma: Atomic and Nuclear Analytical Methods, Springer Beclin Heidelbug, New York
5. Glasstone and Edlund: The Elements of Nuclear Reactor Theory
6. Murray, Introduction to Nuclear Engineering.

PHY 2.4.3 & Option (iii) **HIGH ENERGY PHYSICS** **Session: 2023-2024**

PHY 2.4.4

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course on High Energy Physics is to expose the students of M.Sc. Physics class to the most fundamental building blocks of matter and to understand the interactions between these particles. To familiarize with Quarks, Classification of weak decays and selection rules.*

Course Outcomes*: On completion of this course, student will be able to*

- *Classify the elementary particles and fundamental interactions.*
- *Understand the concept of Gell Mann-Nishijima scheme, Quark model, need of color quantum numbers.*
- *Understand the general features of conservation laws in quantum theory.*
- *Learn the observation and properties of resonances, C and CP violation, CPT theorem.*
- *Understand the theory of Higgs Mechanism and its application in gauge theories and strong interaction theory of quarks and gluons.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.
Use of scientific calculators is allowed.

SECTION A

Particle kinematics: Classification of elementary particles and fundamental interactions, *Properties of elementary particles*. Lie algebra, Young diagrams for SU(3) representations, GellMann-Nishijima scheme, Baryon and meson multiplets, Charged and neutral pions; *Strange particles*: Masses and lifetimes, production and decays of strange mesons and baryons. Prediction of omega, Hyperon extension, Quark model: Hadron spectra and quark content, Search for quarks (Hofstadter et al. experiment, qualitative treatment), Need of colour quantum numbers.

Problems and Examples: Decomposition of 3 x 3 and 3 x 3 x 3, Flavour symmetries: SU(3) unitary groups, SU(4) charm scheme. Hadron mass formulae. Quark wave function of Meson and nucleon, Vector meson decays.

Symmetry properties: General features of conservation laws in quantum theory, Parity conservation, Operators and transformation, Isospin, G-parity, Conservation of Isospin, Generalized Pauli principle; Conservation laws: Baryon and lepton and flavour no. conservation. Problems: Positronium decay, Application of Isospin conservation to NN interaction and strong- decays.

SECTION B

Resonances: Observation and properties of Resonances; Tau-theta problem , Observation of Tau-lepton and new flavours., Parity violation in weak interaction, K0-K bar mixing, C and CP violation, CPT theorem (statement only), ***Problems***: Two body decay phase space, decay length and Dalitz plot, Breit-Wigner formula.Gauge theories of fundamental interactions, Higgs Mechanism and its application in gauge theories Elements of QED, Global and local gauge invariance, Feynman diagrams, Successes of QED; Current-current interaction and V-A theory, Cabibbo modification. Introduction to GSW model and limitations of QED. Strong interaction theory of quarks and gluons (QCD), Recent developments in high energy physics (supersymmetry, extra dimensions, neutrino oscillations) and Link with cosmology (QUALITATIVE TREATMENT ONLY). *Problems*: Classification of weak decays and selection rules.

Text Books:

1.Introduction to Elementary Particles: D.J. Griffiths

2.Elementary Particle Physics: I.S. Hughes, Cambridge University Press

PHY 2.4.3 & PHY 2.4.4 Option (iv) ADVANCED ELECTRONICS Session : 2023-2024

Maximum Marks:60 | Time allowed: 3 Hours
Pass Marks: 35 % | Total teaching hours: 50

Course Objective: *The aim and objective of the course on Advance Electronics course covers, Inter-conversion of analog and digital signals, basics of integrated circuit technology, Microprocessor 8085 Architecture, instruction set, interfacing with memory and I/O devices.*

Course Outcomes: *On completion of this course, student will be able to*

- *Understand the concept of Digital to Analog convertor and Analog to Digital convertor.*
- *Know the basic knowledge about Microprocessors.*
- *Understand the Registers, ALU, timing and control section and their arrangement in 8085 microprocessor.*
- *Know about the Microprocessor operations and its bus organization, Memory Mapping, addressing and interfacing, input/output devices.*
- *Understand 8085 assembly language programming , Stack and Subroutines.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C

SECTION A

Digital to analog and analog to digital converters: Binary equivalents of analog signals. Weighted register and binary ladder networks. Digital to analog converter, Performance criteria for digital to analog converters. Resolution and accuracy. Analog to digital converters. Performance criteria for analog to digital converters; counter; up down, Successive approximation; Dual slope analog to digital converters.

General introduction of Microprocessors, assembly and computer languages.

Microprocessor Architecture: Registers, ALU, timing and control section and their arrangement in 8085 microprocessor. Microprocessor operations and its bus organization.

Memory: ROM; Bipolar and MOS ROMs. RAM; Bipolar and Static/Dynamic MOS RAMs, Addressing of a RAM and Applications of RAM. Memory Mapping, addressing and interfacing with microprocessor.

I/O Devices and their interfacing: Input/output devices, Basic interfacing concepts; Interfacing output displays, interfacing of input devices, Memory-Mapped I/O (8085 based).
Microcomputer: Example of an 8085 based single Board microcomputer.

SECTION B

Introduction to 8085 assembly language programming: The 8085 programming model, Instruction classification, Instruction and data format.

Introduction to 8085 instructions: Data transfer (copy) operations. Arithmetic operations. Logic operations. Branch operations. Writing assembly language programs.

Programming techniques with additional instructions: Programming techniques; Looping; Counting; and indexing. Additional data transfer and 16 bit arithmetic instructions. Logic operations: Rotate, Compare.
Stack and Subroutines: Stack, Subroutine, conditional Call and Return Instructions. Introduction to Single Chip Microcontrollers, 16, 32 and 64 bits processors.

Text Books:

1. An Introduction to Digital Electronics: M.Singh, Kalyani Publishers, N.Delhi
2. Ajit Paul; Microprocessors, Principles and Applications, Tata McGraw-Hill.
3. R. S Gaonkar; Microprocessor Architecture, Programming and Applications Willey Eastern.
4. Millman and Grabel: Microelectronics, 2nd Ed., MHB.
5. Millman: Microelectronics, Digital and Analog Circuits and Systems, MHB.

Session : 2023-2024

PHY 2.4.4 & PHY 2.4.4 Option (v) ATOMIC AND MOLECULAR SPECTROSCOPY

Maximum Marks:60 — Time allowed: 3 Hours
Pass Marks: 35 % — Total teaching hours: 50

Course objective: *The aim and objective of the course on Computational Methods and Simulations is to familiarize the of M.Sc. Physics students with spectra of one and two valence electron systems. To understand the effect of external fields on atom and to understand various types of Spectroscopies.*

Course Outcomes: *On completion of this course, student will be able to*

- *Understand the concept of spectrum of hydrogen, coupling scheme, lamb shift.*
- *Understand the concept of Zeeman effect, Paschen-Back effect, Stark effect.*
- *Understand the spectroscopy terms like rotational spectroscopy , infrared spectroscopy.*
- *Know about Franck-Condon principle, Raman spectra*
- *Electronic spectra of diatomic molecules*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C

SECTION - A

Spectra of one and two valance electron systems: Vector model for one and two valance electron atoms, Spin orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology, Spectroscopic notations for L-S and J-J couplings, Spectra of alkali and alkaline earth metals, Interaction energy in L-S and J-J coupling for two electron systems, Selection and Intensity rules for doublets and triplets.

Effects of external fields on atom: The Zeeman Effect for two electron systems, Intensity rules for the Zeeman effect, The calculations of Zeeman patterns, Paschen-Back effect, LS coupling and Paschen – Back effect, Lande-g factor in LS coupling, Magnetic interaction energy in strong field, Stark effect.

SECTION-B

Microwave and Infra-Red Spectroscopy: Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations.

Raman and Electronic Spectroscopy: Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrarional Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer approximation- The Franck-Condon principle, Dissociation and pre-dissociation energy.

TEXT BOOKS:

1. Introduction to Atomic Spectra: H.E. White-Auckland Mc Graw Hill, 1934
2. Fundamentals of Molecular spectroscopy: C.B. Banwell-Tata Mc Graw Hill, 1986.
3. Spectroscopy Vol. I, II & III: Walker & Straughen
4. Introduction to Molecular Spectroscopy: G.M.Barrow-Tokyo Mc Graw Hill, 1962.
5. Spectra of Diatomic Molecules: Herzberg-New York, 1944.
6. Molecular Spectroscopy: Jeanne L McHale-NewJersy Prentice Hall, 1999.
7. Spectra of Atoms and Molecules: P.F. Bermath-New York, Oxford University Press, 1995

Session: 2023-2024

PHY 2.4.3 & PHY 2.4.4 Option (vi) ELECTRONIC COMMUNICATION SYSTEMS

Maximum Marks:60 Time allowed: 3 Hours
Pass Marks: 35 % Total teaching hours: 50

Course Objective: *The aim and objective of the course Electronic Communication Systems is to expose the students of M.Sc. Physics class to introduce the various communication systems like AM, FM, Radar system, Pulse communication system etc.*

Course Outcomes*: On completion of this course, student will be able to*

- *Have knowledge about communication systems like transmitter, channel noise, receiver, bandwidth etc.*
- *Represent AM frequency spectrum, power relations and techniques for generation of AM.*
- *Explain single side band, balanced modulator, ISB systems, VSB transmission, single and side band receivers.*
- *Describe mathematical representation, frequency spectrum, phase modulation of FM systems.*
- *Understand the concept of stereophonic FM multiplex system, FM generation techniques, FM demodulators, FM receivers.*
- *Understand the basic principle of Radar systems.*
- *Know about pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PWM transmission system, PCM transmission system.*
- *Understand about Microwave Radio communications, system gain and optical fibers.*

Instructions for the Paper Setter

The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus carrying 09 marks each. Section C will have 8 short answer type questions, which will carry 24 marks and cover the entire syllabus uniformly.

Instructions for the candidates

The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C. Use of scientific calculators is allowed.

SECTION A

Introduction to communication systems: Information, transmitter, channel noise, receiver, need for modulation, bandwidth requirements. Noise and its types.

Amplitude Modulation: Representation of AM, frequency spectrum, power relations in AM wave, techniques for generation of AM, AM transmitter, AM receiver types, single and multi-superhetrodyne receivers, communication receivers.

Single Side Band: Evolution and description of single side band, suppression of carrier, the balanced modulator, suppression of unwanted side band, pilot carrier systems, ISB systems, VSB transmission single and independent side band receivers.

Frequency Modulation: Description of FM systems, mathematical representation, frequency spectrum, phase modulation,, intersystem comparison, pre-emphasis and de-emphasis, comparison of wide band and narrow band FM, stereophonic FM multiplex system, FM generation techniques, FM demodulators, FM receivers.

Radar systems: Basic principles, pulsed radar systems, moving target indication, radar beacons, CW Doppler radar, frequency modulated CW radar, phased array radars, planar array radars.

SECTION B

Pulse Communication: Information theory, pulse modulation, types of pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PWM transmission system, PCM transmission system, telegraphy and telemetry.

Broadband communication systems: Frequency division multiplex (FDM), Time division multiplex (TDM), coaxial cables, fiber optics links, microwave links, tropospheric scatter links, submarine cables, satellite communication systems, elements of long distance telephony.

Microwave Radio communications and system gain: Advantages of microwave communication, frequency modulated microwave radio system, microwave radio repeaters, protection switching arrangements, FM microwave radio stations, path characteristics, system gain.

Optical fiber communications: History of optical fibers, type of optical fibers, optical fiber communication system (block diagram), propagation of light through an optical fiber, optical fiber configurations, losses in optical fiber cables, light and optical sources, light detectors. (Ref. 1,2,)

Text Books:

1. G. Kennedy and B. Devis, Electronic communication systems, Tata McGraw Hill Publishing Co., New Delhi.
2. W. Tomasi, Electronic communication systems, Pearson Education Asia, Delhi.

PHY 2.4.5 **LABORATORY PRACTICE** **Session :2023-2024**

Maximum Marks: 120 Time allowed: 9Hours

Pass Marks: 45% Total teaching hours: 125

The aim and objective of the course on Physics Laboratory is to expose the students of M.Sc. Physics class to experimental techniques in general physics, nuclear physics and solid state physics so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

Out of 120 Marks, internal assessment (based on seminar, viva-voce of experimental reports, number of experiments performed and attendance) carries 40 marks, and the final examination at the end of the semester carries 80 marks.

The laboratories comprises of experiments based on **Nuclear Physics** in one group and **Solid State Physics** in the other group. Each student will be placed in one of the two groups during the entire semester.

GROUP-I: NUCLEAR PHYSICS

(10 out of the followings)

1. Study of standard deviation using G-M counter

2. Half-life of ^{40} K using G-M Counter

3. Measurement of mass absorption coefficient of beta rays in given materials

4. To find range and energy of β- particles

5. To find Dead time of a GM Tube

6. Study of energy calibration of NaI(Tl) scintillation detector

7. Study and analysis of spectrum of ^{137}Cs

8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer.

9. Study of Compton scattering law for energy of scattered photons

10. To study Internal Conversion Coefficient for ^{137}Cs (or suitable gamma source)

11. To determine the source strength of a given radioactive gamma source

12. Study and analysis of the spectrum of ^{60}Co

13. Photoelectric cross-section measurement for a given target material at known incident gamma photon energy

14. Compton cross-section measurement for known incident gamma photon energy

15. Measurement of Photo-peak (full energy peak) efficiency of Scintillation detector.

<u>GROUP-II: SOLID STATE PHYSICS</u>

(10 out of the followings)

1. To determine numerical aperture of optical fibre.
2. To determine the compressibility of a given liquid by using ultra sonication waves.
3. To measure the energy gap of Ge crystal using Four Probe method.
4. To study the polarization and reflection phenomena of microwave.
5. To study bending loses in optical fibre.
6. To study the microwave optics: Show that intensity is inversely proportional to square of distance.
7. To understand the concept of scaling in nanotechnology.
8. To study Hall Effect for given semi-conductor material.
9. To determine the Curie temperature of a given PZT sample.
10. Determine the coercivity, retentivity and saturation value of magnetic induction of the given sample by studying the B-H loop.
11. Measurement of magneto-resistance of a semi-conducting sample.
12. Study of Dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
13. Study of solar cell and characteristics.
14. Find the value of the 'g' factor in a DPPH sample by using ESR technique.
15. Frank Hertz experiment for Quantization of Bohr's model of atom.

PHY 2.4.6 **COMPUTER LAB** **Session: 2023-2024**

Maximum Marks: 60 Time allowed: 3 Hours
Pass Marks: 45% Total teaching hours: 30

The aim and objective of the computer laboratory is to students capable for writing and interrelating the physics problems with software. It expertise them in graph plotting, simplification of calculations, etc
Out of 60 Marks, internal assessment (based on performance of the candidate in the computer lab and attendance) carries 15 marks, and the final examination at the end of the semester carries 45 marks.

This laboratory comprises of any ten of the following physics problems to be solved using computer.

1. To find the area of triangle
2. Printing even numbers in given limits
3. Printing even and odd numbers in given limits
4. Find the sum of natural numbers
5. Finding maximum of given set of numbers
6. Find roots of quadratic equation
7. Find the mean of given data
8. Finding minimum of given set of numbers
9. Printing odd numbers in given limits
10. To construct AP and GP series.
11. To construct Sine and Cosine series.
12. Addition of two matrices.
13. Motion of horizontally thrown projectile.
14. To find perfect numbers.
15. Frequency distribution table.
16. Area under curve using trapezoidal rule.
17. Area under curve using Simpson rule
18. Multiplication of two matrices.
19. Motion of projectile thrown at an angle.
20. Simulation of Planetary motion.