Learning Outcomes based Curriculum Framework
(LOCF)

For

M.Sc. Physics
(Postgraduate Programme)
w.e.f. Session 2021-22

Department of Physics

Chaudhary Devi Lal University

Sirsa-125055, Haryana

2021

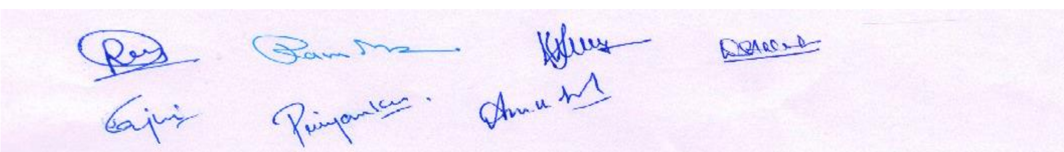
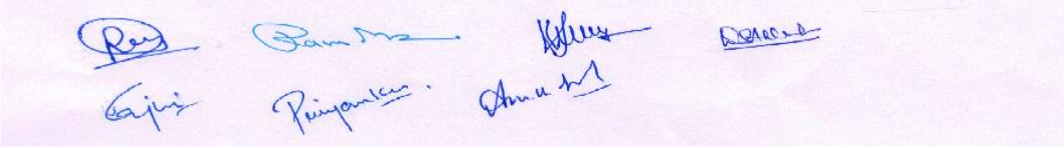


Table of Contents

1. About the Department
2. Learning Outcomes based Curriculum Framework
    - 2.1 Objectives of the Programme
    - 2.2 Programme Outcomes (POs)
    - 2.3 Programme Specific Outcomes (PSOs)
3. Programme Structure



1. About the Department

The Department of Physics, Chaudhary Devi Lal University, Sirsa was established in 2004. Presently, the Department is located in CV Raman Bhawan of the University. The first batch of M. Sc. Physics was commenced in August, 2004. The department has produced about 600 postgraduate and 27 Ph.D. scholars, and most of them are actively engaged in jobs in various fields. Currently, the department is running M.Sc. (two year) and Ph.D. programmes in Physics. The Department has two well aerated classroom for M.Sc. (Previous) and M.Sc. (Final) with proper sitting arrangement, electricity facility, projector and/or smart boards. The Department has one air-conditioned computer lab having twenty two computers with LAN internet facility. Also, the Department has two well-equipped laboratories for M.Sc. programme and three research laboratories for Ph.D. programme.

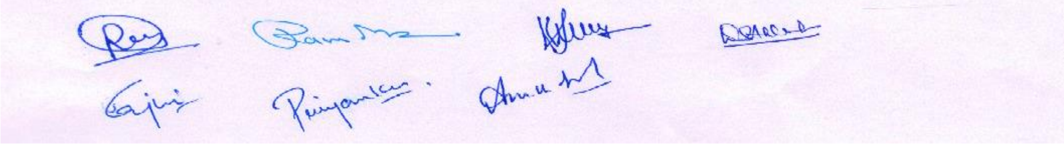
The holistic development of the students to compete the changing scenario of the world in the 21st century world is of prime importance. The Department of Physics is committed to impart quality education comprising academic knowledge and technical skills to all the students. Our aim is to increase their curiosity of knowledge and progression in learning; and to activate their full potential for academic excellence and for facing challenges of life during and beyond their study. While the pace and the path towards achieving these outcomes will vary from person to person, the goal of department for every physics student is to inculcate and possess required academic capabilities/capacities by the time they graduate. The department is making sincere efforts to produce scholars inculcated with critical thinking and problem solving, creativity and innovation, civic literacy, adaptability and other cognitive capacities necessary for successful life in the 21st century.

2. Learning Outcomes based Curriculum Framework

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

2.1 Objectives of the Programme

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



2.2 Programme Outcomes (POs)

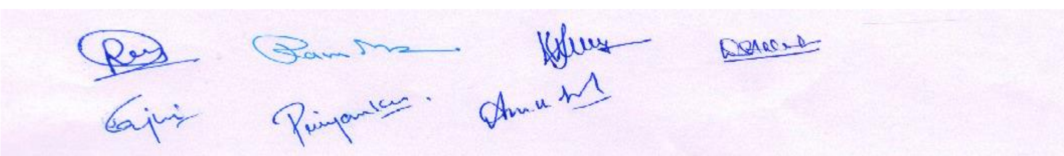
After completing the programme, the students have:

PO1	Knowledge	capability of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude and Investigation	ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO3	Communication	ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	Problem Solving	capability of applying knowledge to solve scientific and other problems using theoretical and practical techniques, skills and tools.
PO5	Science and Society	ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO6	Life-Long Learning	aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO7	Modern Tool Usage	ability to use and learn techniques, skill and modern tools for scientific practices
PO8	Project Management	ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

2.3 Programme Specific Outcomes (PSOs)

After completing the programme, the students:

PSO1	acquire core as well as specialized/disciplinary knowledge in physics including the major premises of classical mechanics, quantum mechanics, mathematical physics, electronics, electrodynamics, solid state physics, statistical mechanics, atomic & molecular physics, nuclear & particle physics, laser & spectroscopy, computational physics and material science & nanotechnology.
PSO2	learn how to design and conduct experiments demonstrating their understanding of scientific methods/processes/phenomena; and have an understanding of analytical methods required to interpret and analyze results and draw conclusions.
PSO3	develop written and oral communications skills in communicating physics-related topics; and realize and develop an understanding of the impact of science particularly physics on the society.
PSO4	apply conceptual understanding and critical thinking of the physics to general real-world situations; and learn to analyze physical problems and develop correct solutions using theoretical and experimental techniques/tools and skills.



3. Programme Structure

M.Sc. Physics - a four-semesters postgraduate programme is of 112 credits weightage consisting of Core Courses (CC), Discipline Specific Elective Courses (DSC), Skill Enhancement Courses (SEC) and Open Elective Courses (OEC).

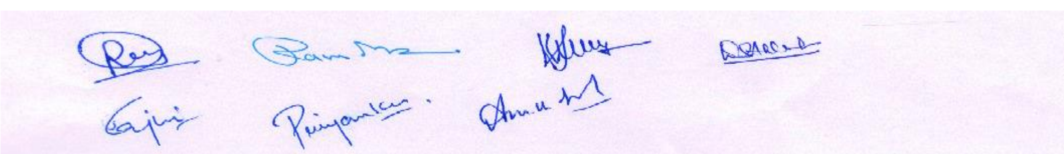
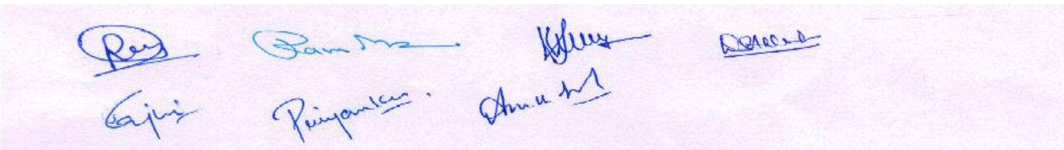


Table 1: Courses and Credit Scheme

Semester	Core Courses (CC)		Discipline Specific Elective Courses (DSC)		Skill Enhancement Courses (SEC)		Open Elective Courses (OEC)		Grand Total Credits
	1	2	3	4	5	6	7		
	No. of Courses	**Total Credits**	**No. of Courses**	**Total Credits**	**No. of Courses**	**Total Credits**	A total of 12 credits are to be earned from other Departments or from MOOCs. *Students have to opt open elective course(s) in consultation with the Chairperson of the department and the Director, University Centre for Outreach Programmes and Extension*		**2+4+6+7**
I	5	**20**	1	**4**	**-**	-			**112**
II	6	**21**	1	**4**	**-**	-			
III	3	**10**	2	**8**	2	**8**			
IV	3	**9**	2	**8**	2	**8**			
Total	**Core Credits**	**60**	**Discipline Specific Elective Credits**	**24**	**Skill Enhancement Credits**	**16**	**Open Elective Credits**	**12**	**112**
Per-cent-age (%)	**Core Credits**	**53.57**	**Discipline Specific Elective Credits**	**21.43**	**Skill Enhancement Credits**	**14.29**	**Open Elective Credits**	**10.71**	**100**

Table 2: Detailed break-up of Credit Courses

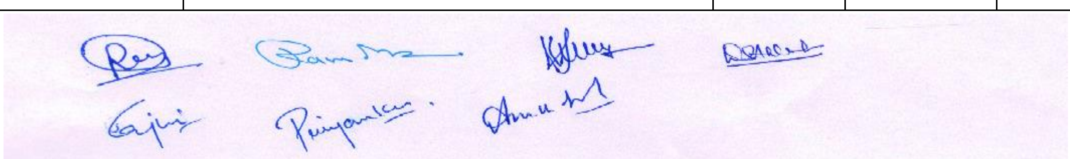
	Core Courses	**Discipline Specific Elective Courses**	**Skill Enhancement Courses**	**Open Elective Courses**	**Total Courses**
	CC	**DSC**	**SEC**	**OEC**	**CC+ DSC+ SEC**
Semester I	CC1 CC2 CC3 CC4 CC5	DSC1-A or DSC1-B	-	OECs offered by other departments or MOOCs **(Students may be enrolled in any of the four semesters).** *Students have*	**6**
Semester II	CC6 CC7 CC8 CC9 CC10 CC11	DSC2-A or DSC2-B	-		**7**



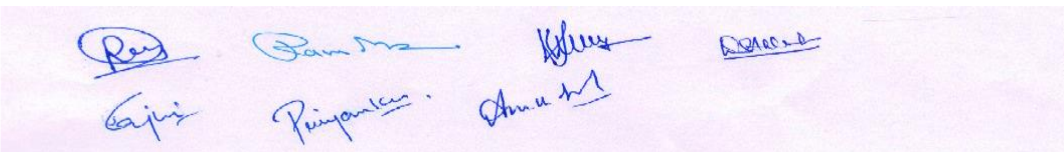
Semester III	CC12 CC13-A or CC13-B CC14	DSC3-A or DSC3-B DSC4-A or DSC4-B	SEC1-A or SEC1-B SEC2-A or SEC2-B	*to opt open elective course(s) in consultation with the Chairperson and the Director, University Centre for Outreach Programmes and Extension*	**7**
Semester IV	CC15 CC16-A or CC16-B CC17	DSC5-A or DSC5-B DSC6-A or DSC6-B	SEC3-A or SEC3-B SEC4-A or SEC4-B		**7**

Table 3: Course code and Title along with credits details

Sr. No.	Course Code	Course Title	Credits		
Semester I			**Theory**	**Practical**	**Total**
1.	MSc/Phy/1/CC1	Mathematical Physics	4	-	4
2.	MSc/Phy/1/CC2	Classical Mechanics	4	-	4
3.	MSc/Phy/1/CC3	Fundamentals of Electronics	4	-	4
4.	MSc/Phy/1/CC4	Quantum Mechanics-I	4	-	4
5.	MSc/Phy/1/CC5	Physics Lab-I (General)	-	4	4
Choose any one out of the following options DSC1-A or DSC1-B					
6.	MSc/Phy/1/DSC1-A	Physics Lab-II (Electronics)	-	4	4
	MSc/Phy/1/DSC1-B	MOOC available on SWAYAM portal			
		Total	**16**	**8**	**24**
Semester II					
1.	MSc/Phy/2/CC6	Solid State Physics	4	-	4
2.	MSc/Phy/2/CC7	Classical Electrodynamics	4	-	4
3.	MSc/Phy/2/CC8	Atomic & Molecular Physics	4	-	4
4.	MSc/Phy/2/CC9	Quantum Mechanics-II	4	-	4
5.	MSc/Phy/2/CC10	Physics Lab-III (General)	-	4	4
Choose any one out of the following options DSC2-A or DSC2-B					
6.	MSc/Phy/2/DSC2-A	Physics Lab-IV (Electronics)	-	4	4
	MSc/Phy/2/DSC2-B	MOOC available on SWAYAM portal	-	-	
7.	MSc/Phy/2/CC11	Seminar-I	1	-	1
		Total	**17**	**8**	**25**
Semester III					
1.	MSc/Phy/3/CC12	Nuclear & Particle Physics	4	-	4
Choose any one out of the following options CC13-A or CC13-B					
2.	MSc/Phy/3/CC13-A	Electrodynamics & Plasma Physics	4	-	4
	MSc/Phy/3/CC13-B	MOOC available on SWAYAM portal			
Choose any one out of the following options SEC1-A or SEC1-B					
3.	MSc/Phy/3/SEC1-A	Laser & Spectroscopy-I	4	-	4
	MSc/Phy/3/SEC1-B	Computational Physics-I			



Choose any one out of the following options DSC3-A or DSC3-B					
4.	MSc/Phy/3/DSC3-A	Materials Science-I	4	-	4
	MSc/Phy/3/DSC3-B	Advanced Electronics-I			
Choose any one out of the following options SEC2-A or SEC2-B					
5.	MSc/Phy/3/SEC2-A	Physics Lab-V(A) (Laser & Spectroscopy-I)	-	4	4
	MSc/Phy/3/SEC2-B	Physics Lab-V(B) (Computational Physics-I)			
Choose any one out of the following options DSC4-A or DSC4-B					
6.	MSc/Phy/3/DSC4-A	Physics Lab-VI(A) (Materials Science-I)	-	4	4
	MSc/Phy/3/DSC4-B	Physics Lab-VI(B) (Advanced Electronics-I)			
7.	MSc/Phy/3/CC14	Cardinal Principles of Academic Integrity and Research Ethics	2	-	2
		Total	**18**	**8**	**26**
Semester IV					
1.	MSc/Phy/4/CC15	Statistical Mechanics	4	-	4
Choose any one out of the following options CC16-A or CC16-B					
2.	MSc/Phy/4/CC16-A	Radiation Physics	4	-	4
	MSc/Phy/4/CC16-B	MOOC available on SWAYAM portal			
Choose any one out of the following options SEC3-A or SEC3-B					
3.	MSc/Phy/4/SEC3-A	Laser & Spectroscopy-II	4	-	4
	MSc/Phy/4/SEC3-B	Computational Physics-II			
Choose any one out of the following options DSC5-A or DSC5-B					
4.	MSc/Phy/4/DSC5-A	Materials Science-II	4	-	4
	MSc/Phy/4/DSC5-B	Advanced Electronics-II			
Choose any one out of the following options SEC4-A or SEC4-B					
5.	MSc/Phy/4/SEC4-A	Physics Lab-VII(A) (Laser & Spectroscopy-II)	-	4	4
	MSc/Phy/4/SEC4-B	Physics Lab-VII(B) (Computational Physics-II)			
Choose any one out of the following options DSC6-A or DSC6-B					
6.	MSc/Phy/4/DSC6-A	Physics Lab-VIII(A) (Materials Science-II)		4	4
	MSc/Phy/4/DSC6-B	Physics Lab-VIII(B) (Advanced Electronics-II)			
7.	MSc/Phy/4/CC17	Seminar-II	1	-	1
		Total	**17**	**8**	**25**

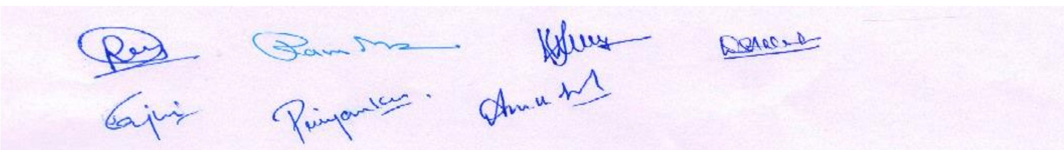


Notes:

1. For one credit of theory, one hour of lecture will be delivered while for one credit of practical, two hours of laboratory work will be conducted, per week.
2. Practical will be conducted in groups; one group will have maximum 20 students.
3. Besides credits from Core, Discipline Specific Elective and Skill Enhancement Courses, students will need to earn additional minimum 12 credits from Open Elective Courses (OECs) offered by other departments of the University or from MOOCs available on SWAYAM portal. Students are free to get enrolled for this category courses in any of the four semesters. Further, students may get enrolled in any of the various PG MOOCs available at SWAYAM portal for this category for the desired credits.
4. MOOC coordinator will display the list of MOOCs for each Discipline Specific Elective Course (DSC) before the commencement of respective semester.
5. A Discipline Specific Elective Course as well as Skill Enhancement Course will be started in the department only when at least 15 students opt for a particular course. In addition, these courses will be mainly allotted to the students in 3rd semester on the basis of their preference and percentage of marks in the 1st semester examination. In the 4th semester, students have to choose corresponding options of these courses as in the 3rd semester.
6. Each student will have to deliver one seminar on the topic allotted by the Departmental Seminar Committee in each year either in odd or in even semester of the programme. The marks will be awarded to the student by the Committee on the basis of attendance (5 marks), seminar report (5 marks), ppt presentation (10 marks) and discussion/viva-voce (5 marks).
7. Experiments in the Laboratory Courses may added/removed from time to time as per availability/necessity of them as per programme. Experiments may be performed physically or virtually as per availability/necessity.
8. The evaluation of Practical Courses (Final Term Exam) will be done by the External and Internal examiners. Experiment and Written part-70 marks, Viva-voce-20 marks and Lab Records-10 marks, (Total-100 marks).
9. Internal Assessment of each theory course is of 30 marks (Mid-term exam-20 marks, Assignment-05 marks and Regularity-05 marks).
10. The relevant Ordinance of PG programme of the university shall be followed by the department.

Table 4: Core courses Offered by the Department

Course Code	Course Title	Credits
MSc/Phy/1/CC1	Mathematical Physics	4
MSc/Phy/1/CC2	Classical Mechanics	4
MSc/Phy/1/CC3	Fundamentals of Electronics	4
MSc/Phy/1/CC4	Quantum Mechanics-I	4
MSc/Phy/1/CC5	Physics Lab-I (General)	4
MSc/Phy/2/CC6	Solid State Physics	4
MSc/Phy/2/CC7	Classical Electrodynamics	4
MSc/Phy/2/CC8	Atomic & Molecular Physics	4
MSc/Phy/2/CC9	Quantum Mechanics-II	4
MSc/Phy/2/CC10	Physics Lab-III (General)	4
MSc/Phy/2/CC11	Seminar-I	1
MSc/Phy/3/CC12	Nuclear & Particle Physics	4
MSc/Phy/3/CC13-A	Electrodynamics & Plasma Physics	4



MSc/Phy/3/CC13-B	MOOC available on SWAYAM portal	
MSc/Phy/3/CC14	Cardinal Principles of Academic Integrity and Research Ethics	2
MSc/Phy/4/CC15	Statistical Mechanics	4
MSc/Phy/4/CC16-A	Radiation Physics	4
MSc/Phy/4/CC16-B	MOOC available on SWAYAM portal	
MSc/Phy/4/CC17	Seminar-II	1
	Total	**60**

Table 5: Discipline Specific Courses offered by Department

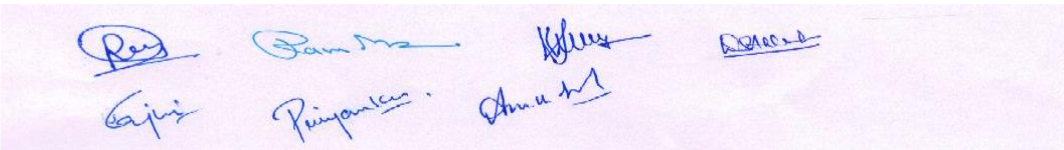
Course Code	Course Title	Credits
MSc/Phy/1/DSC1	A. Physics Lab-II (Electronics)	4
	B. MOOC available on SWAYAM portal	
MSc/Phy/2/DSC2	A. Physics Lab-IV (Electronics)	4
	B. MOOC available on SWAYAM portal	
MSc/Phy/3/DSC3	A. Materials Science-I	4
	B. Advanced Electronics-I	
MSc/Phy/3/DSC4	A. Physics Lab-VI(A) (Materials Science-I)	4
	B. Physics Lab-VI(B) (Advanced Electronics-I)	
MSc/Phy/4/DSC5	A. Materials Science-II	4
	B. Advanced Electronics-II	
MSc/Phy/4/DSC6	A. Physics Lab-VIII(A) (Materials Science-II)	4
	B. Physics Lab-VIII(B) (Advanced Electronics-II)	
	Total	**24**

Table 6: Skill Enhancement Courses offered by the Department

Course Code	Course Title	Credits
MSc/Phy/3/SEC1	A. Laser & Spectroscopy-I	4
	B. Computational Physics-I	
MSc/Phy/3/SEC2	A. Physics Lab-V(A) (Laser & Spectroscopy-I)	4
	B. Physics Lab-V(B) (Computational Physics-I)	
MSc/Phy/4/SEC3	A. Laser & Spectroscopy-II	4
	B. Computational Physics-II	
MSc/Phy/4/SEC4	A. Physics Lab-VII(A) (Laser & Spectroscopy-II)	4
	B. Physics Lab-VII(B) (Computational Physics-II)	
	Total	**16**

Table 7: Open Elective Courses offered by the Department

Course Code	Course Title	Credits
MSc/Phy/9/OEC1	Environmental Physics	4
MSc/Phy/9/OEC2	Physics in Everyday Life	4
	Total	**8**



MSc/Phy/1/CC1–Mathematical Physics

Credits: 4	**Max. Marks: 100**
Lectures: 60	**Final Term Exam.: 70**
Duration of Exam.: 3 Hrs.	**Internal Assessment: 30**

Objective: The aim and objective of the course is to familiarize the students with the mathematical techniques necessary to approach problems in advanced physics courses. The knowledge of Special functions (Bessel, Hermite, Laguerre, Legendre), concepts of Complex analysis, Fourier analysis, Laplace transforms, tensor analysis, Green's function, integral transform are helpful to approach problems in advanced physics courses and research.

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

CO1: Understand and apply the mathematical methods to solve quantitative problems in the study of physics and engineering. Enhance their problem solving ability and critical thinking.
CO2: Demonstrate contour integrals in relevant problems in Physics.
CO3: Enable to apply integral transform to solve mathematical problems of interest in physics. Can use Fourier transforms as an aid for analyzing experimental data.
CO4: Explain basic, preliminary concepts related to Green's function method and group of elements. Formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Introduction to gradient, divergence and curl operator and their physical significance. Matrices: Inverse Matrix, Orthogonal, Unitary and Hermitian Matrices, Independent elements of Orthogonal and Unitary Matrices, Matrix diagonalization, Eigen values & Eigen vectors. Introductory ideas of Fourier series and integrals transform, Fourier transform, Laplace transform: Ist and IInd shifting theorem and important applications of Fourier and Laplace transform.

Unit-II

Special functions, Frobenious method for series solutions, Legendre equation and its solution: generating function, recurrence relations, Orthogonality of $P_n(x)$, Bessel equation: Bessel's functions of first kind, generating function, recurrence relations, Orthogonality of Bessel Functions, Hermite's and Laguerre's equation: generating functions, recurrence relations, Orthogonality.

Unit-III

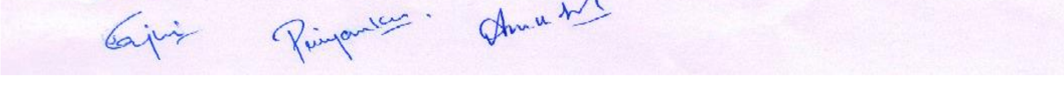
Function of complex variables, Cauchy Riemann conditions, Cauchy integral theorem and formula, Taylor and Laurent's Series, Cauchy's residue theorem, Singular points and evaluation of residues, Jordans lemma, Evaluation of real definite integrals.

Unit-IV

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

Text/Reference Books:

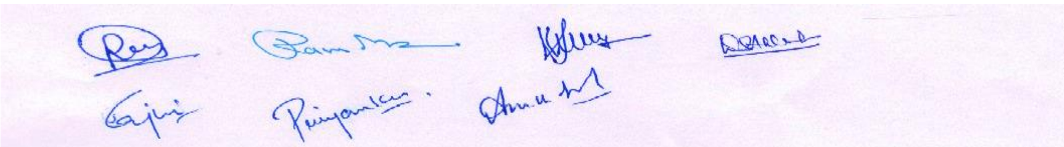
1. Arfken, G. B. (2012). Mathematical Methods for Physicists. Netherlands: Elsevier.
2. Boas, M. L. (2005). Mathematical Methods in the Physical Sciences.New York: Wiley.
3. Rajput, B. S. (2017). Mathematical Physics. Meerut: Pragati Prakashan.
4. Goyal, J.K. (2016). Laplace and Fourier Transforms. Meerut: Pragati Prakashan.



5. Prakash, S. (2005). Mathematical Physics. New Delhi: Sultan Chand & Sons.
6. Joshi, A. W. (2018). Group Theory for Physicists. New Delhi: New Age International.
7. Chatopadhyay, P. K. (2004). Mathematical Physics. New Delhi: New Age.
8. Balakrishnan, V. (2019). Mathematical Physics. New Delhi: Ane Books.

Mapping matrix of COs, POs and PSOs of MSc/Phy/1/CC1–Mathematical Physics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	3	2	3	3	2	3	3
CO2	2	2	2	3	2	2	2	2	2	2	2	3
CO3	2	3	2	3	2	2	3	3	3	2	2	3
CO4	3	2	3	2	3	2	2	2	2	2	2	2
Average	2.5	2.5	2.25	2.75	2.25	2.25	2.25	2.5	2.5	2	2.25	2.75



MSc/Phy/1/CC2–Classical Mechanics

Credits: 4	**Max. Marks: 100**
Lectures: 60	**Final Term Exam.: 70**
Duration of Exam.: 3 Hrs.	**Internal Assessment: 30**

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

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

CO1: Understand basic formalism of constraints and Lagrangian dynamics. Application of Lagrange's equations in real physical problems.
CO2: Understand Lagrangian formalism for solving Kepler's problem.
CO3:.Apply the Variational principles to real physical and engineering problems.
CO4: Enable to solve Hamilton-Jacobi equations and use it for the solution of harmonic oscillator problem.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Constraints of motion and their classification, Generalized coordinates, D'Alembert's principle, Hamilton's principle, Lagrange's equations from Hamilton's principle and D'Alembert's principle, Application of Lagrange's equations; Symmetry properties of space and time and conservation laws, Inertial and non-inertial frames, Rotating frames, Centrifugal and Coriolis forces, Foucault's pendulum.

Unit-II

Two body central force problem: Reduction to the equivalent one body problem, Equation of motion and first integrals, Classification of orbits, Virial theorem, Differential equation of the orbit, Kepler's problem, Rutherford scattering formula, Angular momentum and kinetic energy of a rigid body, Moment of inertia tensor.

Unit-III

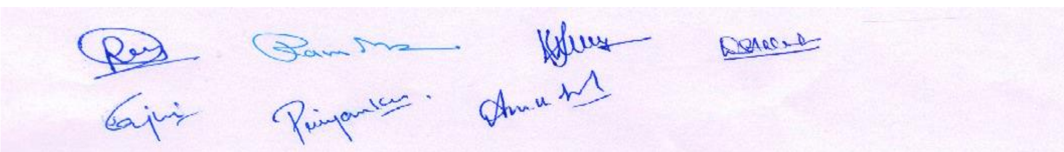
Hamilton's equations of motion, Cyclic coordinates, Hamilton's equations from variational principle, Principal of least action and its applications, Canonical transformation, Legendre transformation, Poisson bracket, Poisson theorem, Invariance of Poisson bracket under canonical transformation, Angular momentum and Poisson bracket, Jacobi identity.

Unit-IV

Hamilton-Jacobi equations and their solutions, Use of Hamilton-Jacobi method for the solution of harmonic oscillator problem, Hamilton's Principal and Characteristic functions and their properties, Small oscillations, Two coupled oscillators, Theory of small oscillations, Eigen value equation, Frequencies of free vibrations, Normal coordinates, Free vibrations of a linear triatomic molecule.

Text/Reference Books:

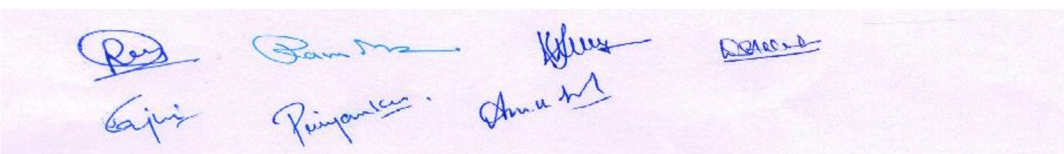
1. Goldstein, H., Poole, C. P., & Safko, J. (2011). Classical Mechanics. Noida: Pearson Education.
2. Rana, N. C., & Joag, P. S. (2017). Classical Mechanics. New Delhi: Tata Mc Graw Hill.
3. Barger, V. D., & Olsson, M. G. (1994). Classical Mechanics. New York: Mc Graw Hill Education.
4. Arya, A.P. (1997). Classical Mechanics. Noida: Pearson Education.
5. Strauch, D. (2009). Classical Mechanics. New York: Springer.
6. Mondal, C. R. (2008). Classical Mechanics. New Delhi: PHI Learning Pvt. Ltd.



7. Kibble, T. W. B., & Berkshire, F. H. (2004). Classical Mechanics. London: Imperial College Press.
8. Kleppner, D., & Kolenkow, R. (2017). An Introduction to Mechanics. Noida: Mc Graw Hill Education India.
9. Merches, I., & Radu, D. (2014). Analytical Mechanics. Florida: CRC Press.

Mapping matrix of COs, POs and PSOs of MSc/Phy/1/CC2–Classical Mechanics

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	3	2	3	2	3	3	2	3	3
CO2	3	3	2	3	2	2	2	2	2	2	2	2
CO3	2	3	2	3	2	2	3	3	3	2	2	3
CO4	2	2	2	2	2	2	2	2	2	2	2	2
Average	2.5	2.75	2	2.75	2	2.25	2.25	2.5	2.5	2	2.25	2.5



MSc/Phy/1/CC3– Fundamentals of Electronics

Credits: 4	**Max. Marks: 100**
Lectures: 60	**Final Term Exam.: 70**
Duration of Exam.: 3 Hrs.	**Internal Assessment: 30**

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

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

CO1: Aware of the general characteristics of important semiconductor materials and develop a deep understanding of the basic design, operation and characteristics of a PN-junction and a BJT along with knowledge of the two port network analysis and their application in electronic circuit. Learn to devise and analyze various transistor amplifier models.
CO2: Acquaint with the field effect transistor like JFET, MOSFET MESFET, VMOS and CMOS along with frequency response of variously FET amplifiers and various FET biasing arrangements.
CO3: Implement Boolean expression with basic logic gates, design and analysis of different combinational and sequential circuits to achieve desired output. Express numbers, alphabets, special characters etc. in binary representation, perform mathematical operations. Idea of different types of memories and Boolean expression simplification technique are also introduced.
CO4: Explain the basic physics of differential amplifier, operational amplifiers, effect of feedback on op-amp parameters and various applications of op-amp.

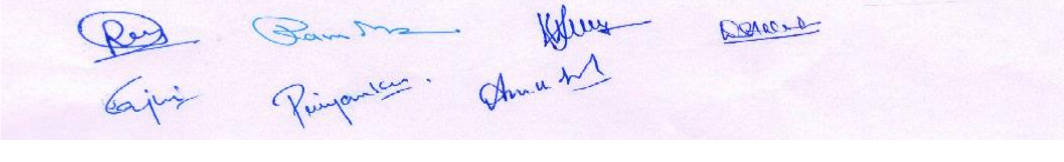
Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

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

Unit-II

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



Unit-III

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

Unit-IV

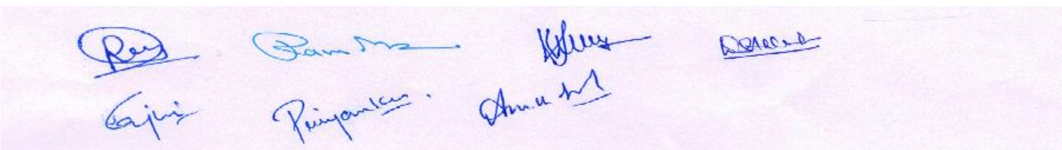
Operational Amplifier: Differential amplifier- Circuit configuration, Dual input balanced output differential amplifier : D.C. & A.C. analysis , The operational amplifier and its block diagram, Schematic symbol, Op-Amp parameters, Ideal Op-Amp, Equivalent circuit of Op-Amp, Open loop Op-Amp configurations, Block diagram representation of feedback configuration, Voltage series feedback amplifier-effect of negative feedback on closed loop voltage gain, Input resistance , Output resistance and Band width, Integrator, Differentiator, Summing, Scaling and Averaging amplifier.

Text/Reference Books:

1. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall.
2. Leach, D.P. & Malvino, A.P.(1994)Digital Principles and Applications. Europe: Mc-Graw Hill.
3. Millman, J. & Halkias, C. C.(2017)Integrated Electronics. India: Mc Graw Hill Edu.
4. Malvino, A.P., Brown, J. (2017) Digital Computer Electronics.India : Mc Graw Hill Edu.
5. Jain, R.P. (2009) Modern Digital Electronics. India: Mc Graw Hill Edu.
6. Millman, J. & Grabel(2017) Microelectronics. New Delhi: Mc Graw Hill Edu.
7. Gupta, S.(2010) Electronic devices and Circuits. New Delhi: Dhanpat Rai Pub.
8. Kaushik, D.K.(2010)Handbook of Electronics. New Delhi: Dhanpat Rai Pub.
9. Streetman, B.G. & Banerjee, S.K.(2015)Solid State Electronic Devices. India: Pearson Edu.
10. Boylestd, R.L. & Nashelsky, L.(2012)Electronic Devices and Circuit Theory. India: Pearson.

Mapping matrix of COs, POs and PSOs of MSc/Phy/1/CC3–Fundamentals of Electronics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	3	2	3	2	2	3
CO2	2	2	3	2	2	3	2	2	2	3	2	2
CO3	3	3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	2	3	2	3	3	3	3
Average	**2.75**	**2.50**	**2.75**	**2.5**	**2.25**	**2.5**	**2.75**	**2**	**2.75**	**2.75**	**2.5**	**2.75**



MSc/Phy/1/CC4– Quantum Mechanics-I

Credits: 4 — **Max. Marks: 100**
Lectures: 60 — **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. — **Internal Assessment: 30**

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

Course outcomes:
CO1: General basic foundation of quantum mechanics needed for various quantum mechanical approaches. Three quantum numbers helps to explain atomic structure, H-atom and multi-electron systems.
CO2: Matrix formulation of quantum mechanics and three different pictures with their respective importance in physics.
CO3:.Space quantization, commutator algebra, theory of orbital and spin angular momenta. C.G. coefficients for unitary transformation.
CO4: Stationary perturbation theoretical approach for finding approximate solution of quantum mechanical problems.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Introductory and quantum kinematics: Basic concepts of quantum mechanics, Time dependent and time independent Schrödinger wave equation, Hermitian operators with properties, Expectation values, Probability current density, Ehrenfest's theorem, Spreading Gaussian wave packet, Uncertainty principle, Eigenvalues and eigenfunctions, degeneracy and orthogonality, Schrödinger equation for spherically symmetric potentials, Hydrogen atom.

Unit-II

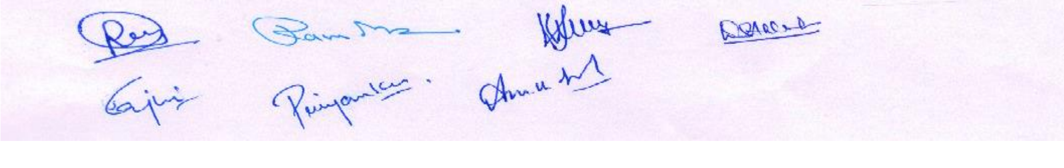
Matrix formulation and quantum dynamics: Matrix algebra, Hermitian and unitary matrices, Unitary transformation and diagonalization of matrices, Representation of dynamical variables and wave functions as matrices, Hilbert space, Dual space: Dirac's Bra & Ket notation, Time dependence of expectation values, Equation of Motion: Schrödinger, Heisenberg and Interaction pictures, Link with classical equation of motion, Quantization of a classical system, Matrix theory of harmonic oscillator.

Unit-III

Quantum theory of angular momentum: The orbital angular momentum operator and its representation in Cartesian and spherical polar coordinates, Eigenvalues and Eigenfunction for L^2, L_z, Spin angular momentum, Total angular momentum, Eigenvalues and Eigenfunction for J^2, J_z, Commutation relation for angular momentum, Addition of angular momenta: Clebsch Gordon coefficients and their calculations for (i) $j_1= j_2=1/2$ (ii) $j_1=1$, $j_2=1/2$.

Unit-IV

Stationary perturbation theory: Introduction, Non-degenerate case - First and second order corrections to energy eigenvalues and eigenfunctions, Fine structure of hydrogen atom (Relativistic and spin-orbit coupling correction), Degenerate case, Removal of degeneracy in second order , Zeeman effect without electron spin, First order stark effect in hydrogen atom, The variational (Rayleigh-Ritz) method: Expectation value of the energy, Application to excited states, Ground state of helium.

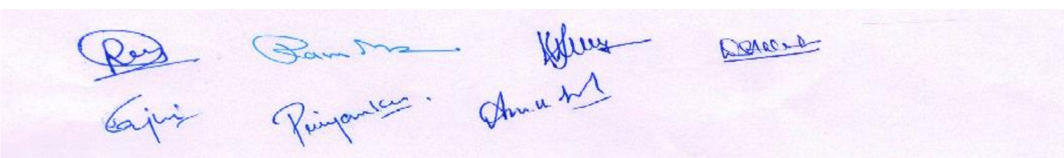


Text/Reference Books:

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

Mapping matrix of COs, POs and PSOs of MSc/Phy/1/CC4– Quantum Mechanics-I

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2.5	2	2	2	2	2	2	3	2	1.5	3
CO2	3	2	2	2	2	2	2	2	3	2	1.5	2
CO3	2.5	2	1.5	2	1.5	1.5	2	2	3	2	1.5	2
CO4	3	2	1.5	2.5	1.5	1.5	1.5	2	3	2	1.5	2
Average	2.87	2.12	1.75	2.12	1.75	1.75	1.87	2	3	2	1.5	2.25



MSc/Phy/1/CC5–Physics Lab-I (General)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam: 4 Hrs.**

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

Course outcomes: After completion of experimental, students will be able to:

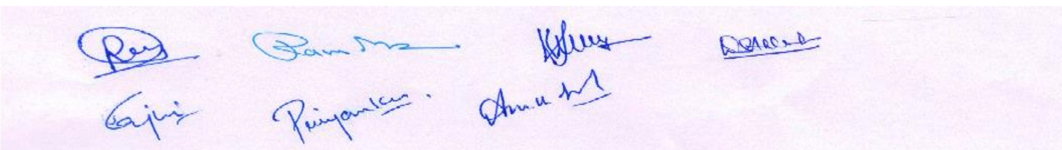
CO1: perform the mathematical operations like addition, subtraction using digital circuits.
CO2: learn the characteristics and applications of semiconductor based FET, MOSFET.
CO3: understand the working of various types of digital circuits and importance in our daily life.
CO4: understand the applications of Op-Amp., diodes, resistors and capacitors.

Experiments:

1. To study the full adder and subtractor.
2. To verify the truth table of four bit adder and subtractor.
3. To study the switching action of FET.
4. To plot the input and output characteristics of JFET.
5. To study of input and output characteristics of MOSFET.
6. To verify the truth table of various types of Flip-Flop.
7. To plot the behavior of clipping and clamping circuits.
8. To design the op-Amp as: subtracting, summing, scaling amplifier.
9. To study the op-Amp in inverting and non-inverting mode.
10. To study various types of counters.
11. To study the Op-Amp as Schimitt trigger.
12. To plot the characteristics of Zener diode.
13. To study the transistor as astable multivibrator.

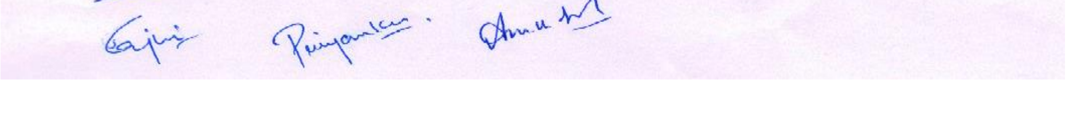
Text/Reference books:

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



Mapping matrix of COs, POs and PSOs of MSc/Phy/1/CC5–Physics Lab-I (General)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	2	2	3	2	3
CO2	2	2	2	2	2	2	2	1	2	3	2	2
CO3	2	2	2	2	2	2	2	2	2	3	2	2
CO4	3	2	2	2	2	2	2	2	2	2	2	3
Average	**2.5**	**2**	**2**	**2**	**2**	**2**	**2**	**1.75**	**2**	**2.75**	**2**	**2.5**



MSc/Phy/1/DSC1-A - Physics Lab–II (Electronics)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

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

Course outcomes: After completion of experimental, students will be able to:

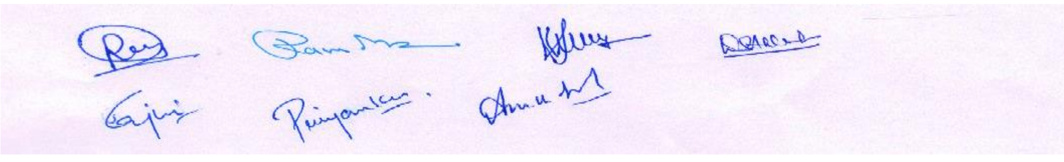
CO1: understand the law of Boolean algebra and learn about the working and applications of various types of digital circuits.
CO2: understand the CRO working and its applications.
CO3: study the importance of fourier analysis.
CO4: acquire the knowledge about the working and importance of BJT, Multivibrators and UJT in our daily life.

Experiments:

1. To study the various types of Logic Gates and verify their truth tables.
2. To verify the truth tables of various types of Logic Gates using NAND Gates.
3. To study the switching action of BJT.
4. To study CRO Demonstrator.
5. Find out the ionization potential of a given sample using Thyratron.
6. To study the parity checker and generator.
7. To study Fourier analysis of different wave trains.
8. To measure phase shift, deflection sensitivity & frequency of unknown ac signal using CRO.
9. To verify various Boolean expressions and De Morgan's theorems.
10. To study the UJT characteristics.
11. To study shift registers.
12. To verify the truth tables of different types of counters.
13. To study the monostable and bistable multivibrators.

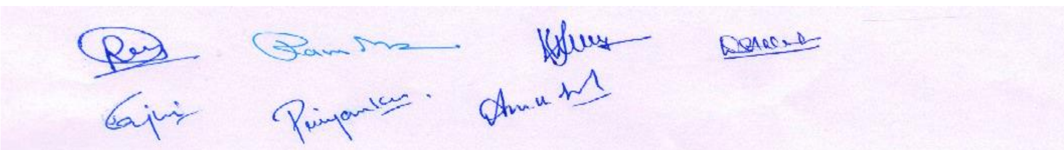
Text/Reference Books:

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



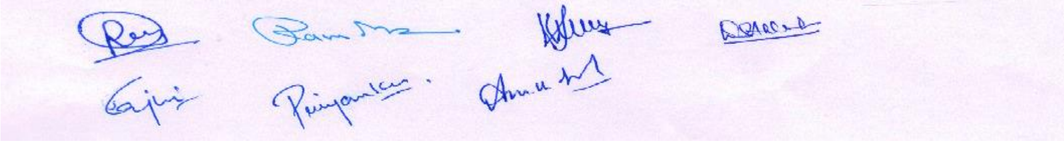
Mapping matrix of COs, POs and PSOs of MSc/Phy/1/DSC1-A - Physics Lab–II (Electronics)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	3	2	3
CO2	3	2	2	2	2	2	2	2	2	3	2	3
CO3	2	2	2	2	2	2	2	1	2	3	2	3
CO4	3	2	2	2	2	2	2	2	2	3	2	2
Average	2.5	2	2	2	2	2	1.75	1.75	2	3	2	2.75



MSc/Phy/1/DSC1-B
MOOC available on SWAYAM portal

Credits: 4 **Max. Marks: 100**



MSc/Phy/2/CC6– Solid State Physics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

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

Course Outcomes:
CO1: Basic knowledge of lattice structure and diffraction of waves by crystals develop an understanding of solid state.
CO2: Formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials
CO3: Understand the electron states of solid crystals.
CO4: Knowledge of superconductivity and BCS theory will be imparted to the students.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

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

Unit-II

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

Unit-III

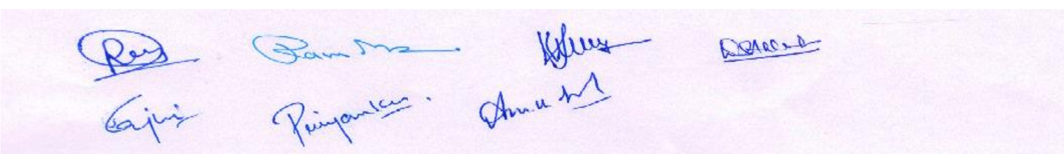
Fermi-Dirac distribution, Electronic specific heat of a metal, Electrons in a periodic lattice (Crystal Potential), Bloch theorem, Crystal potential, Kronig-Penny model, Nearly free electron model, Cyclotron resonance, Hall effect, Fermi surface, de Hass Von Alfen effect, Magneto-resistance, Quantum Hall effect.

Unit-IV

Superconductivity: Meissner effect, Critical field, Critical temperature, London equations, London penetration depth, Coherence length, Energy gap, Isotope effect, BCS theory, Type I & II superconductors, Flux quantization, Normal tunneling & Josephson effect, High T_c superconductors, Fullerenes (Elementary idea).

Text/Reference Books:

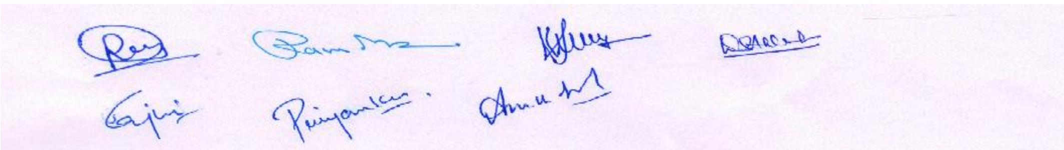
1. Kittel, C. (2012). Introduction to Solid State Physics. New York: Wiley.
2. Dekker, A. J. (2008). Solid State Physics. New Delhi: Laxmi Publications.
3. Ashcroft, N., & Mermin N. D. (2003). Solid State Physics. Boston: Cengage Learning.
4. Omar, M. A. (1993). Elementary Solid State Physics. London: Pearson.
5. Srivastava,J. P. (2014). Elements of Solid State Physics. New Delhi: PHI.
6. Wahab, M. A. (2015). Solid State Physics. New Delhi: Narosa.



7. Kakani, S. L., & Hemrajani, C. (2005). Solid State Physics. New Delhi: Sultan Chand & Sons.
8. Hook, J. R., & Hall, H. E. (1991). Solid State Physics. New York: Wiley.
9. Singh, N. (2017). Solid State Physics. New Delhi: Narosa.

Mapping matrix of COs, POs and PSOs of MSc/Phy/2/CC6– Solid State Physics

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	2	3	3	3	2	2	2
CO2	2	3	2	2	2	2	2	2	3	3	2	2
CO3	3	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	3	2	2	2	2
Average	2.5	2.75	2	2	2	2	2.25	2.5	2.5	2.25	2	2



MSc/Phy/2/CC7– Classical Electrodynamics

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Objective: This course aims to introduce the student to topics in Electrostatics, magnetostatics and Electromagnetic Theory, The course reviews and builds on the students' knowledge of conductors, dielectrics, magnetic fields and Maxwell's equations and includes a study of wave propagation in various media.

Course Outcomes:
CO1: A student having taken this course will have fair knowledge of conductors and dielectrics and will be able to solve the potential and electric field problems.
CO2: It will help the students to build analogy between electrostatics and magnetostatics.
CO3: Students will have fair knowledge of conservation laws and gauges used in electrodynamics.
CO4: A sound knowledge of electromagnetic waves in various bound and unbound media will help the students to solve the difficult problems of electrodynamics.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Electrostatics in Vacuum: Coulomb's Law, Gauss's Law, Scalar potential, conductors and their properties. Electric field inside a cavity carved in a conductor. Laplace and Poisson's equations. Electrostatic potentials, Multipole Expansion: Multipole expansion of the scalar potential of a charge distribution. Dipole moment, quadrupole moment.
Electrostatics of Dielectrics: Dielectrics, Induced dipoles, atomic polarizability, Polarization, Bound charges, Clasusius-Mossetti relations, Energy of charges in dielectic media. Boundary value Problems: Uniquencess theorm, Method of images with examples. Boundary conditions for electric field.

Unit-II

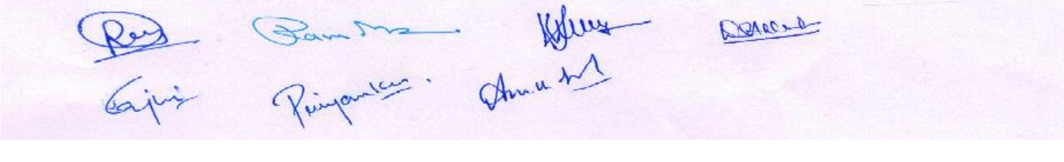
Magnetostatics: currents and equation of continuity, Biot-Savart's law, Ampere's law, Differential equations of magnetostatics, Vector potential, Magnetostatic energy. Ohm's law. Boundary conditions for magnetic field at the interface.
Time Varying Fields and Maxwell Equations: Faraday's law of induction, Displacement current, Maxwell equations, Energy and energy density of the electromagnetic field.

Unit-III

Electrodynamics: Scalar and vector potentials, Gauge transformations, Lorentz and Coulomb gauges, Conservation of energy, Poynting's theorem, Conservation of momentum. EM waves in various unbounded media: Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Waves in conducting media, skin depth, EM waves in rarefied plasma and their propagation in ionosphere.

Unit-IV

EM Waves in Various Bounded Media-Applications: Reflection and refraction of EM waves at plane dielectrics interface, Fresnel's amplitude relations. Reflection and transmission coefficients. Polarization by reflection. Brewster's angle, Total internal reflection, Wave guide: Derivation of field equations between parallel plates and propagation parameters, TE and TM waves, Rectangular wave guides and cavity resonators. Radiation from Localized Time Varying Sources: Solutions of the inhomogeneous wave equation in the absence of boundaries. Fields and radiation of a localized oscillating source. Electric dipole and electric quadrupole fields, centre fed linear antenna.

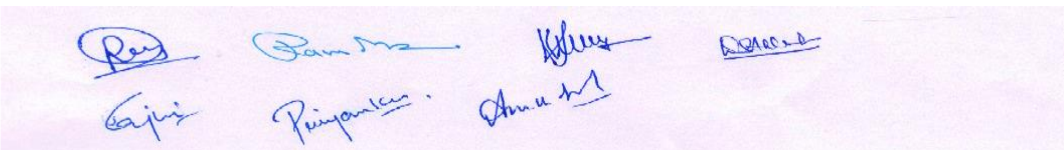


Text/Reference Books:

1. Puri, S. P. (2011). Classical Electrodynamics. India: Alpha Science International Ltd.
2. Griffiths, D. J. (2008). Introduction to Electrodynamics. New Delhi: Prentice Hall India.
3. Jackson, J. D. (1998). Classical Electrodynamics. New Delhi: Wiley Eastern.
4. Laud, B. B. (2011). Electromagnetics. New Delhi: New Age International Publisher.
5. Guru, B. S. & Hiziroglu, H. R. (2004). Electromagnetic Field Theory Fundamentals. Cambridge: Cambridge University Press.
6. Kakani, S. L. & Hemrajani, C. (2011). Electromagnetics. New Delhi: CBS Publishers.
7. Schwartz, M. (1987). Principles of Electrodynamics. New York: Dover Publications.
8. Panofsky & Phillips. (1962). Classical electricity and magnetism. New Delhi: Addison-Wesley publishing.
9. Marion, J. B. & Heald, M. A. (1965). Classical Electromagnetic Radiation. San Diego: Academic Press.

Mapping matrix of COs, POs and PSOs of MSc/Phy/2/CC7– Classical Electrodynamics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	1	1	1	1	3	1	2	2
CO2	2	1	2	2	1	2	1	2	3	2	2	2
CO3	2	1	1	2	1	1	1	1	2	1	1	1
CO4	2	2	2	2	1	1	1	1	3	1	2	2
Average	2	1.25	1.75	2.25	1	1.25	1	1.25	2.75	1.25	1.75	1.75



MSc/Phy/2/CC8– Atomic & Molecular Physics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: The main objective is to teach students the basic atomic structures with quantum mechanical approach leading to their fundamental spectroscopies. The effect of magnetic and electric field on the atomic spectra is also highlighted. To teach the students the nature of molecular spectra (rotational, vibrational, electronic and Raman), polyatomic molecules (including diatomic) are classified on the basis of their topological symmetry. The fundamentals of electronic states will also be taught.

Course Outcomes:
CO1: Students will learn the details of atomic and diatomic molecular (diatomic) structures in terms of quantum mechanical treatment elaborately beyond the basic models. It will give the descriptions of fine and hyperfine structure of atoms and molecular.
CO2: The various coupling schemes and interactions of fields with spectra will enrich the student's knowledge about transitions. The details of these spectroscopies would serve as the fundamentals for various concerned experimental studies.
CO3: Students learn to analyze the polyatomic molecules (including diatomic) and to predict the nature of their vibrational spectra depending on their symmetry using IR Raman Spectroscopy.
CO4: The complete picture of rotational, vibrational and electronic spectra of polyatomic molecules will be comprehended. This kind of specialization is expected to provide a larger scope for research in the various related and interdisciplinary areas.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

One electron system: Quantum states of an electron in an atom, Electron Probability density, Space Quantization, Electron Spin, Stern-Gerlach experiment, Spectroscopic terms and selection rules, Spin – orbit interaction energy, Quantum mechanical relativity correction, Hydrogen fine structure, Hyperfine structure, Pauli exclusion principle, Exchange symmetry of wave function.

Unit-II

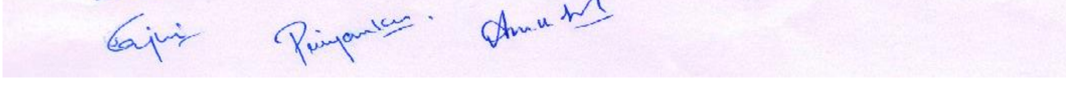
Two electron system: Atomic states arising due to two electron valence system: L-S and J-J coupling for equivalent non-equivalent electrons, Helium atom and its spectra: Ortho and para modification, Interaction with external field: Zeeman effect, Paschen-Back effect, Stark effect and their important example, Characteristics X-ray Spectra: Kossel's Explanation and Moseley Law.

Unit-III

Vibration-rotational spectra of diatomic molecules: Types of molecules, Diatomic linear symmetric-top, Asymmetric-top and Spherical-top, The diatomic molecule as rigid rotator, Harmonic oscillator, Non rigid rotator, Anharmonic oscillator and vibrating rotator (energy levels and infrared spectra), Isotopic effect on vibrational-rotational spectra, Intensity of rotation-vibration spectra, Raman spectra of diatomic molecules.

Unit-IV

Electronic spectra: Resolution of the eigen function, Electronic and total energy: Born-Oppenheimer approximation, Classification of electronic states, Vibrational structure of electronic transitions, Rotational fine structure, P, Q, R branches of a band, The Fortrat parabola, Intensity of electronic bands, Franck-Condon principle: Absorption & emission, Isotopic effect on electronic states.

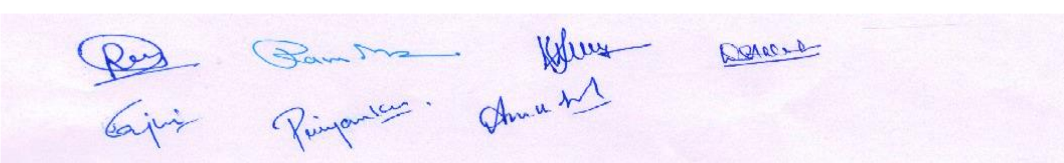


Text/Reference Books:

1. White, H. E. (1934) Introduction to Atomic Spectra: McGraw-Hill Inc. US.
2. Herzberg, G. (1944) Atomic Spectra and Structure –Vol - I & II
3. Herzberg, G. (1950) Molecular Spectra and Structure.
4. Banwell, C.N. (1994) Fundamentals of Molecular Spectroscopy: McGraw-Hill Higher ed.
5. Raj Kumar (2012) Atomic and Molecular Spectra Laser: Kedar Nath Ram Nath, Merrut, India
6. Nair, K. P. R. (2006) Atom Molecules and Laser: Alpha Science International Ltd. USA.
7. Bransden and Joachain (1982) Physics of Atom & Molecules (Prentice Hall).
8. Huber and Hertzberg (1950) Molecular Spectra and Molecular Structure: Springer.
9. Ghoshal, S. N. (1991) Atomic Physics: S-Chand
10. Aruldhas, G. (2014) Molecular Structure and Spectroscopy: PHI learning Pvt. Ltd.

Mapping matrix of COs, POs and PSOs of MSc/Phy/2/CC8– Atomic & Molecular Physics

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	2	3	2	2	3	3	2	3	3
CO2	3	3	2	3	3	3	2	2	3	3	3	3
CO3	3	2	3	2	2	2	2	3	3	2	2	3
CO4	3	3	3	3	3	3	2	3	3	1	3	3
Average	3	2.5	2.75	2.5	2.75	2.5	2	2.75	3	2	2.75	3



MSc/Phy/2/CC9– Quantum Mechanics-II

Credits: 4	**Max. Marks: 100**
Lectures: 60	**Final Term Exam.: 70**
Duration of Exam.: 3 Hrs.	**Internal Assessment: 30**

Objective: Objective of the current course is to familiarize the students to the formal structure of the subject and to equip them with techniques in various approximation methods like time dependent perturbation, concept of scattering, idea of identical particles, relativistic quantum mechanics and their applications so that they can use such concepts in various branches of Physics as per requirement.

Course Outcomes: After successful completion of the course on Quantum Mechanics-II, the outcomes are as:
CO1: Students would be able to explain the fundamentals of quantum mechanical approximation methods like WKB approximation, time dependent perturbation theory and semi- classical theory of radiations and its applications.
CO2: Students get enabled to understand the basics of quantum theory of scattering and various associated scattering phenomena like partial wave analysis, scattering by perfect rigid sphere, square well potential, Born approximation.
CO3: Students would be capable to learn about symmetric and anti- symmetric wave function identical particles, commutation relations, spin- statistics connection and He-atom.
CO4: Students would be introduced to KG equation, Dirac equation, spin orbit energy and negative energy states in relativistic quantum mechanics and its contribution for advancement in quantum physics.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit I

Approximation Methods : The WKB approximation: Introduction, The WKB solutions, The connection formulae, Energy level of a potential well, Tunneling through a barrier, Time Dependent Perturbation Theory : First order perturbation, Transition probability for constant and harmonic perturbation, Transition into a continuum of final states- Fermi Golden rule, Semi-Classical Theory of Radiation: Interaction of an atom with electromagnetic radiation, Transition probability for absorption and induced emission.

Unit II

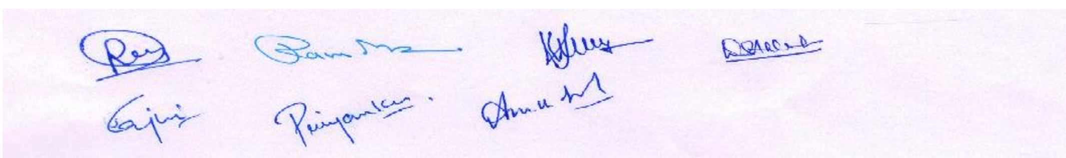
Quantum Theory of Scattering : Basic concept of scattering, Scattering cross section , Scattering amplitude, Laboratory and Centre of mass system, Method of partial wave analysis: Differential cross section, Total cross section, Optical theorem and phase shift, Relation of phase shift with potential, Scattering by perfectly rigid sphere and by square well potential, Born approximation, Validity of Born approximation and its applications to scattering of electron by screened Coulomb potential.

Unit III

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

Unit IV

Relativistic Quantum Mechanics : Introduction, The Klein-Gordan (KG) equation: Free particle, Electromagnetic potential, Probability and current densities, Difficulties of KG equation, The Dirac's relativistic equation: Free particle equation, Matrices for α and β, Free particle solution (plane wave solution), Probability and current densities, Electromagnetic potential, Existence of spin angular momentum, Spin-orbit energy, Negative energy states.

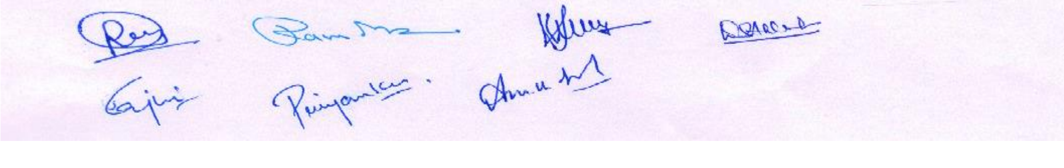


Text/Reference Books:

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

Mapping matrix of COs, POs and PSOs of MSc/Phy/2/CC9–Quantum Mechanics-II

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	2	2	3	2	2	2	2	2
CO2	3	3	2	2	3	2	3	2	3	3	3	3
CO3	2	2	2	3	2	2	2	2	2	2	3	3
CO4	3	3	2	2	2	2	2	2	3	2	2	3
Average	2.75	2.75	2.25	2.5	2.25	2	2.5	2	2.5	2.25	2.5	2.75



MSc/Phy/2/CC10–Physics Lab–III (General)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

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

Course Outcomes: After completion of experimental, students will be able to:

CO1: understand the meaning and importance of Stefan's constant, capacitance of capacitor and Op-Amp.
CO2: gain the knowledge about the Network theorems.
CO3: understand applications of Thomson method and various types of digital circuits.
CO4: design the different types of electronic circuits using different ICs on bread board.

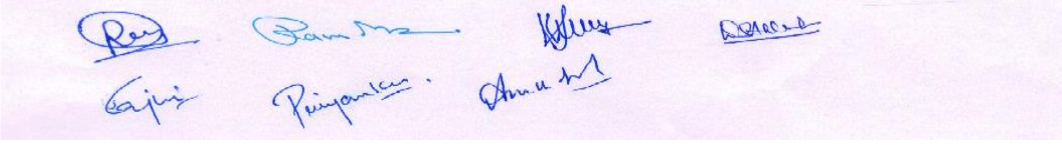
Experiments:

1. To determine the Stefan's constant with the help of given apparatus.
2. To estimate the efficiency of G.M counter for gamma ray source.
3. To determine capacitance of an unknown capacitor using flashing and quenching kit.
4. To study the e/m of an electron by Thomson method.
5. Experimental verification of Network theorems: Kirchoff s law, superposition, Thevenin and Norton theorem for a given circuit.
6. To measure the capacitance and permittivity of a given Sample.
7. Demonstration and realization of Multiplexer/Demultiplexer
8. To study the Encoder/Decoder circuits.
9. To study Op-Amp as logarithmic and antilogrithmic amplifiers.
10. To draw the characteristics of optoelectronics devices.
11. To study the different characteristics of pn-junction diode.
12. To design the various types of electronic circuits on bread board using different ICs.

Text/References Books:

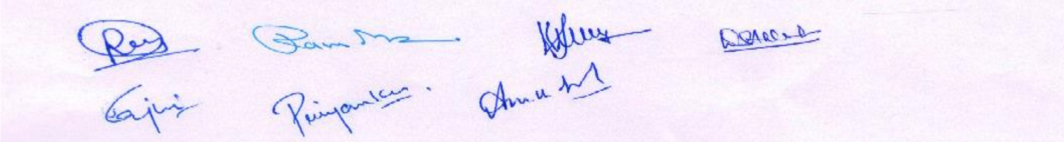
1. Ghatak, A. & Tyagrajan. K. (2013) Introduction to Fiber Optics. India: Cambridge University press.
2. Sze, S.M. (2021) Physics of Semiconductors. New York: Wiley Interscience Pub.
3. Parker, M.A. (2005) Physics of Optoelectronics. Florida: CRC Press.
4. Kothari, D.P. (2017) Basic Electronics. India: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

13. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall
14. Jain, R.P.(2009)Modern Digital Electronics. India: Mc Graw Hill Edu.



Mapping matrix of COs, POs and PSOs of MSc/Phy/2/CC10–Physics Lab–III (General)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	2	2	3	2	3
CO2	2	2	2	2	2	2	2	2	2	3	2	2
CO3	2	2	2	2	2	2	1	1	2	3	2	2
CO4	3	2	2	2	2	2	2	2	2	2	2	3
Average	2.5	2	2	2	2	2	1.75	1.75	2	2.75	2	2.5



MSc/Phy/2/DSC2-A– Physics Lab-IV (Electronics)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

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

Course Outcomes: After completion of experimental, students will be able to:

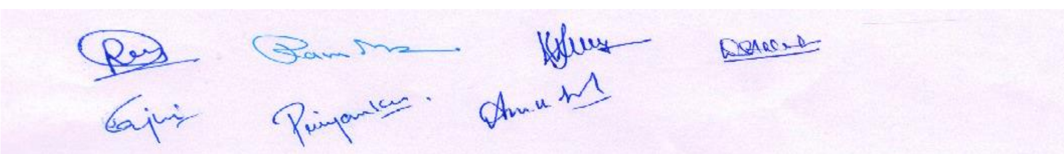
CO1: understand the working of various applications of transistor based apparatus.
CO2: design the circuits of various types of filters and amplifiers.
CO3: understand the different applications of Op-Amp.
CO4: learn about the importance of oscillators based electronics devices in our daily life.

Experiments:

1. To determine the h- parameters of a pnp transistor in CE configuration.
2. To study the RF oscillator using tuned (i) Hartley's Oscillator (ii) Colpitt's Oscillator.
3. To study the low pass and high pass Active filters.
4. To study the band pass and band reject filters.
5. To design and demonstrate the passive filters.
6. To study op-amp as differentiator & integrator.
7. To study the D.C gate control characteristics and anode current characteristics of SCR.
8. To study the Chopper Amplifier.
9. To study the chopped wave forms and the leakage current compensation for FET Switch.
10. To measure the gain of Chopper Amplifier and to study the recovery of original signal
11. To determine the Planck's Constant using LEDs.
12. To study the OP-Amp as voltage follower.
13. To study the OP-Amp as comparator.

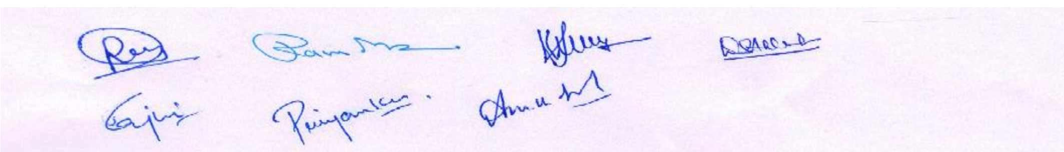
Text/References Books:

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



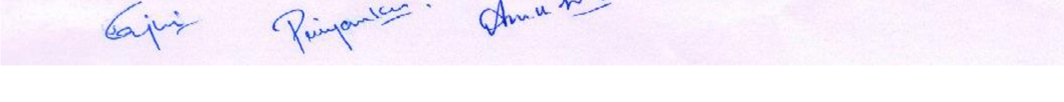
Mapping matrix of COs, POs and PSOs of MSc/Phy/2/DSC2-A – Physics Lab-IV (Electronics)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	2	2	3	2	3
CO2	2	2	2	2	2	2	2	2	2	3	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2	2	2	3	2	3
Average	2.5	2	2	2	2	2	1.75	2	2	2.75	2	2.5



MSc/Phy/2/DSC2-B
MOOC available on SWAYAM portal

Credits: 4 **Max. Marks: 100**



MSc/Phy/2/CC11- Seminar

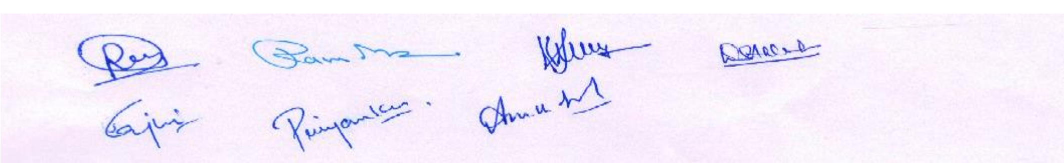
Credits: 1 **Max. Marks: 25**

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

Course Outcome:
CO1: Students would be able to create, revise and present ideas in spoken and written forms. Acquired listening, questioning and critical thinking skills. Demonstrate ability to defend and support ideas/claims with appropriate evidence. Students gained experience for how to organize and deliver/disseminate knowledge before audience.

Mapping matrix of COs, POs and PSOs of MSc/Phy/2/CC11-Seminar

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2.5	3	2.5	2	2.5	2.5	2.5	3	2.5	3	2.5
Average	3	2.5	3	2.5	2	2.5	2.5	2.5	3	2.5	3	2.5



MSc/Phy/3/CC12– Nuclear & Particle Physics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objectives: Students basic concepts building to develop ability for the understanding of nuclear structure along with advance level topics in nuclear and high energy physics.

Course outcomes:
CO1: Impart knowledge of introductory nuclear physics and deuteron as the smallest fundamental nucleus helps to understand strongest force of the nature.
CO2: Stability and properties of different nuclei explained by various nuclear models.
CO3: Radioactive α, β, γ -decay of nuclei by their respective quantum mechanical theories. Conservation laws and various nuclear reactions.
CO4: Elementary particles as the building blocks of matter and interacting fields. Conservation laws and quantum numbers for production and decay of particles.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Introductory concepts and nuclear forces: Basic nuclear properties: size, shape, charge distribution, spin and parity, moments and statistics, binding energy, Fundamental forces of nature, charge independence and charge symmetry of nuclear forces, Isospin, deuteron problem: ground state of deuteron, magnetic dipole and electric quadruple moments of the deuteron, square well solution for the deutron, central and non-central forces, Meson theory of nuclear forces.

Unit-II

Nuclear models: Weizsacher's semi-empirical mass formula, liquid drop model of the nucleous, mass parabolas: prediction of stability against β-decay for members of an isobaric family. Shell model of the nucleus: evidences that led to the shell model, assumptions of the single particle shell model, spin orbit coupling of an electron bound in an atom, spin orbit coupling in nuclei for a single particle shell model. Single particle shell model for parabolic and square well potentials.

Unit-III

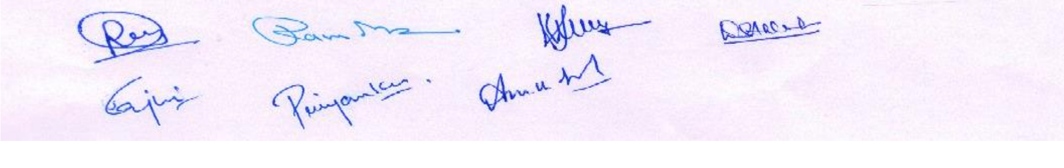
Nuclear decay and reactions: Disintegration energy of spontaneous α-decay, Alpha decay paradox- barrier penetration, Fermi's theory of β-decay, Selection rules for β-decay, Parity non-conservation in α β-decay, γ-ray emission- selection rules, Internal conversion, Types of nuclear reactions, Balance of mass and energy in nuclear reactions, Q-value equation and its solution, Basics of nuclear fission and fusion reaction.

Unit-IV

High energy physics: Classification of elementary particles, Conservation laws & symmetries: conservation of baryon and lepton numbers, concept of isospin, isospin multiplets, isospin & strangeness conservation and violation in different types of interactions, Gell–Mann–Nishijima formula, Baryons octet ($1/2^+$) and decuplet ($3/2^+$), Quark structure of hadrons and quark flavours, Introductory concept of colour quantum number and gluons, Charge conjugation (C) and parity (P) operators, C & P non-conserving property of neutrino, CPT theorem.

Text/Reference Books:

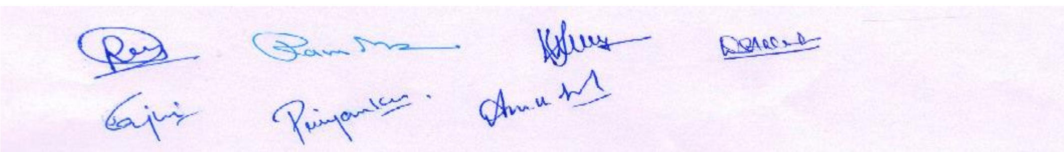
1. Perkins, D.H. (2012) Introduction to High Energy Physics: Cambridge University Press.
2. Ghosal, S. N. (1994) Nuclear Physics: S. Chand & Co.
3. Tayal, D. C. (2014) Nuclear Physics: Himalaya Publishing House.



4. Burcham, W. E. & Jobes M. (1994) Nuclear & Particle Physics: Pearson Education.
5. Patel, S.B. (2011) Nuclear Physics Wiley Eastern Ltd.
6. Joshi, Deep Chandra (2006) Introduction to Quantum Electrodynamics and Particle Physics: I.K. International.
7. Mittal, V.K., R.C. Verma and Gupta, S.C. (2011) Introduction to Nuclear and Particle Physics: PHI Learning New Delhi.

Mapping matrix of COs, POs and PSOs of MSc/Phy/3/CC12– Nuclear & Particle Physics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1.5	2	2	2.5	2	2	3	2.5	1.5	2.5
CO2	3	2.5	1.5	2.5	2	2	2	3	3	2.5	2	3
CO3	3	2.5	2.5	3	2.5	3	2.5	3	3	2.5	2	2.5
CO4	3	2.5	1.5	2.5	2	2.5	2.5	3	3	2	1.5	3
Average	3	2.37	1.75	2.5	2.12	2.5	2.25	2.7	3	2.37	1.75	2.75



MSc/Phy/3/CC13-A – Electrodynamics & Plasma Physics

Credits: 4	**Max. Marks: 100**
Lectures: 60	**Final Term Exam.: 70**
Duration of Exam.: 3 Hrs.	**Internal Assessment: 30**

Course objectives: This course will introduce the students to the fourth state of matter i.e. plasma its occurrence and its applications. It will cover special theory of relativity, Minkowski space, four vectors, covariant formulation and radiations from accelerated charges.

Course outcomes: A student will:
CO1: Acquire basic knowledge of plasma, its occurrence and applications.
CO2: Acquire fair knowledge of special theory of relativity, Lorentz transformations, four vectors and Minkowski space.
CO3: A student will be able to apply the concept of four vectors in electrodynamics and will be able to interpret the relativistic effect on a charged particle in EM fields.
CO4: A student will be able to understand the radiations produced by the accelerated charges.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Plasma as fourth state of matter, plasma parameters, elements of plasma, occurrence and importance of plasma for various applications, Charged Particle Dynamics: Non-relativistic motion in uniform constant fields: Constant uniform electric field, Constant uniform magnetic field, Crossed uniform and constant electric and magnetic fields, magnetic mirror.

Unit-II

Concepts of Relativity and Relativistic Motion of Charged Particles: Postulates of special theory of relativity, Lorentz transformation in four dimensions, Structure of space time: Four vectors, Invariant interval, Minkowski diagrams, Four velocity, Four momentum, Relativistic energy and momentum, Conservation laws of energy and momentum. Relativistic motion of a charged particle: Constant magnetic field, Constant electric field, Electromagnetic field of a plane wave.

Unit-III

Covariant Formulation of Electrodynamics in Vacuum: Four vectors in electrodynamics, four current density, four-potential, covariant continuity equation, wave equation, covariance of Maxwell equations. Electromagnetic field tensor, Transformation of EM fields. Invariants of the EM fields. Energy momentum tensor of the EM fields and conservation laws. Lagrangian and Hamiltonian of a charged particle in an EM field.

Unit-IV

Radiation from Accelerated Charges: Lienard-Wiechert Potentials, Field of a charge in arbitrary motion and uniform motion, Radiated power from an accelerated charge at low velocities- Larmour-power formula. Radiation from a charged particle with collinear velocity and acceleration. Radiation from a charged particle in a circular orbit, Radiation from an ultra-relativistic particle, Radiation reaction. Line –width and level shift of an oscillator.

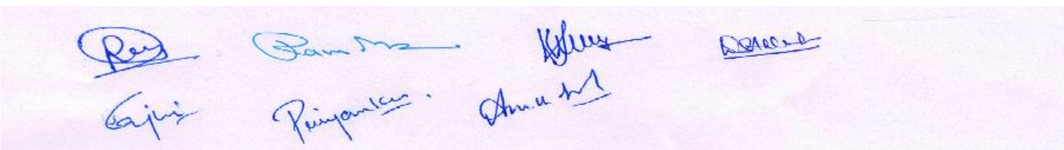
Text/Reference Books:

1. Jackson, J. D. (1998). Classical Electrodynamics. New Delhi: Wiley Eastern.
2. Griffiths, D. J. (2008). Introduction to Electrodynamics. New Delhi: Prentice Hall India.
3. Chain, F. F. (2012). Introduction to Plasma Physics. New York: Springer.
4. Bittencourt, J. A. (2004). Fundamental of Plasma Physics. New York: Springer.
5. Puri, S.P. (1990). Classical Electrodynamics. New Delhi: Narosa.

6. Marion, J. B. & Heald, M. A. (2012). Classical Electromagnetic Radiation. New York: Dover Publications.
7. Raju, G. S. N. (2004). Electrodynamics Field Theory and Transmission Lines. Noida (U.P.): Pearson Education India.

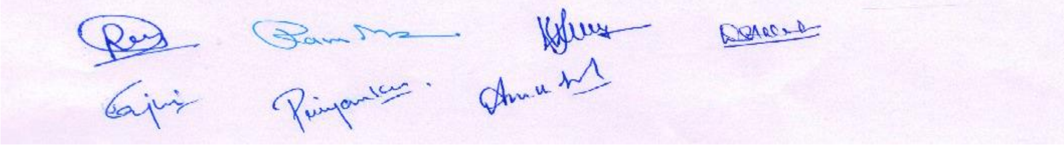
Mapping matrix of COs, POs and PSOs of MSc/Phy/3/CC13-A – Electrodynamics & Plasma Physics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	1	1	1	1	2	1	2	1
CO2	2	1	2	1	1	1	1	1	2	1	2	1
CO3	2	2	2	1	1	1	2	1	2	1	2	1
CO4	2	2	2	2	1	1	1	1	2	1	2	1
Average	2	1.5	2	1.25	1	1	1.25	1	2	1	2	1



MSc/Phy/3/CC13-B
MOOC available on SWAYAM portal

Credits: 4 **Max. Marks: 100**



MSc/Phy/3/SEC1-A – Laser & Spectroscopy-I

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: To impart knowledge in depth about lasers and laser based spectroscopy methods.

Course outcomes:
CO1: Understanding Einstein's postulates and laser field with unique properties not found in ordinary light.
CO2: Educate for optical resonators and generation of laser beam.
CO3: Understanding fundamental physical processes of the laser.
CO4: Laser spectroscopy methods applicable to characterize various materials for their potentiality indifferent technologies.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Basic postulates and laser beam characteristics: Einstein's coefficients and their relationships, Active medium, Cavity radiation and modes (one, two and three dimensions), Population inversion, Important properties of laser light: Coherence (experimental evidence for spatial and temporal conference), Monochromaticity, Directionality, Intensity, Brightness and Ultra short duration laser pulses.

Unit-II

Laser resonators and beam parameters: Gaussian (real) laser beam and its properties, Physical description of lowest order modes, Preliminary considerations of optical resonator, Energy stored in optical resonator, Types of resonators, Stability diagram, Different types of losses in optical resonators: diffraction and transmission losses.

Unit-III

Laser linewidth, optical gain and oscillation: Origin of broadening of spectral line (Line shape function), Homogeneous (natural and collisional) and Inhomogeneous (Doppler) broadening mechanisms, Threshold condition for laser oscillation, laser oscillation and amplification in a homogeneous broadened system and gain saturation.

Unit-IV

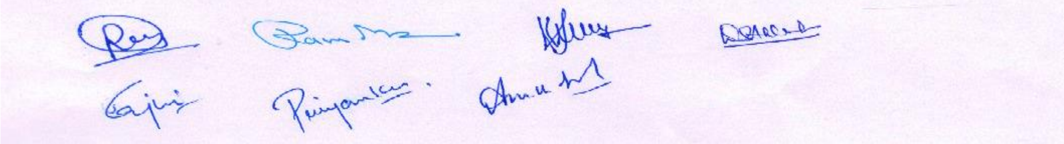
Optical detection and spectroscopy methods: Photodiode arrays and charged coupled device (CCD) arrays, Principle, design, construction and applications of spectrometer: UV-VIS, FTIR, Raman, Brillnon, Fabry-Perot.

Text/Reference Books:

1. Verdeyen, J.T. (1995) Laser Electronics: Pearson
2. Davis C. C. (2014) Lasers and Electro-Optics: Cambridge University Press.
3. Silfwast, W. T. (1998) Lasers Fundamentals: Cambridge University Press.
4. Ahlawat, D.S. (2017) Basic Concepts of Laser Physics: Mittal Publications, New Delhi.
5. Svelto, O. (1982) Principles of Lasers: Plenum Press, New York.
6. Ghatak, A. & Tayagrajan, K. (2011) Optical Electronics: Cambridge.
7. Ghatak, A. & Tayagrajan, K. (2005) Laser Theory & Applications: Macmillan, Delhi
8. Demtroder, W. (1996) Laser Spectroscopy : Springer.
9. Demtroder, W. (2015) Laser Spectroscopy 2 : Springer.
10. Laud, B.B. (2020) Lasers and Non-linear Optics: New Age International.
11. Nagabhushana S. & Sathyanarayana N. (2010) Laser and Optical Instrumentation: I.K. International.

Mapping matrix of COs, POs and PSOs of MSc/Phy/3/SEC1-A – Laser & Spectroscopy-I

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2.5	2.5	2.5	3	2.5	3	3	2.5	2.5	2.5
CO2	3	2.5	2.5	2.5	2	2.5	2.5	3	3	2.5	2	2.5
CO3	3	2	2.5	2	2	2.5	2.5	3	3	2.5	2	2.5
CO4	3	2.5	2	2.5	2.5	2	2.5	3	3	2.5	2.5	2.5
Average	3	2.5	2.37	2.37	2.25	2.5	2.5	3	3	2.5	2.25	2.5



MSc/Phy/3/SEC1-B– Computational Physics-I

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: In theoretical physics, one deals with the situations where the analytical solutions of the equations describing the physical models are not feasible. In such situations the numerical methods are employed for solving various linear and nonlinear algebraic equations, curve fitting techniques, ordinary differential equations, evaluating differentiation, integration and various types of errors etc. These numerical methods provide a powerful tools to describe the physical phenomenon quantitatively. On completing the course, the students will be able to understand the concepts involved in various numerical methods and to apply these methods in various physical situations using computer programming in FORTRAN.

Course Outcomes: After successful completion of the course on Computational Physics-I, a student will be benefited as:

CO1: The course will equip the student with FORTRAN programming and will enable to write Fortran programs to solve numerical computationally and to be aware about various types of applications.
CO2: Students would be able to recognize the various interpolation formulae, best fit curve, nature of a specific numerical problem and would develop the acumen for choosing an appropriate numerical technique to find its solution.
CO3: Students would acquire a vision for use of computer to solve various algebraic and ordinary differential equations of first and second order and play important role in research prospective. In addition to this one can find the eigenvalues and eigenvectors of matrices using polynomial and power methods.
CO4: After completing this course, students would be able to learn the numerical differentiation and integration by various methods and can understand different type of errors, their propagation, and to minimize errors while writing a program.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit I

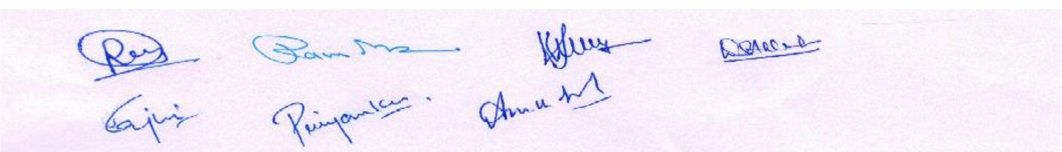
Computer Basics : Input Unit, Output Unit, Storage unit, Arithmetic logic unit, Control unit, Central processing unit , System concept, Basic idea of operating system, Assembler, Compiler, Linkers and Interpreters, Programming in Fortran-77 : Flow charts, Fortran constants and variables, Arithmetical and logical expressions, Input-output statements, DO, IF and GO TO statements, Arrays and subscripted variables, Function and subroutines. Computer programs for arranging numbers in ascending and descending order, Matrix addition and subtraction, Matrix multiplication

Unit II

Interpolation & Curve Fitting : Newton's formula for interpolation, Central difference interpolation - Gauss Central difference formula , Stirling formula, Bessel's formula, Lagrange's and Hermite's interpolation formula, Linear splines, Quadratic splines, Cubic splines, Surface fitting by cubic splines, Least square curve fitting : The principle of least square fitting, Linear regression, Polynomial regression, Fitting exponential and trigonometric functions.

Unit III

Algebraic and Ordinary Differential Equations: Bisection method, Method of false position, Newton-Raphson method, Gauss elimination method, Gauss Jordan elimination method, Jacobi method, Gauss seidel iterative method, Matrix eigenvalues and eigenvectors: Polynomial method, Power method, Taylor series method, Picard's method, Euler's method, Modified Euler's method, Second and fourth order Runge-Kutta method, Predicator and corrector method.



Unit IV

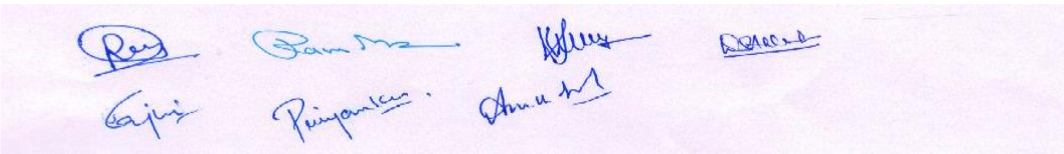
Numerical Differentiation, Integration & Errors : Taylor series method, Numerical differentiation by Newton's forward and backward difference formula, Stirling's formula, Cubic spline method, Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rule, Gaussian integration - Gaussian quadrature, Legendre-Gauss quadrature, Numerical double integration. Errors: Round off error, Truncation error, Machine error, Random error, Propagation of errors.

Text/Reference Books:

1. Sinha, P. K., & Sinha Priti (2011). Computer Fundamentals. New Delhi : BPB Publications
2. Xavier,C. (2012). FORTRAN 77 and Numerical Methods. New Delhi : New Age International Publishers
3. Lipschutz, S., & Arthur P.O.E. (1982). Theory and problems of Programming with FORTRAN. Singapur : Schaum's outline Series Mc-Graw Hill Book Company
4. Salaria, R.S.(2011). Computer Oriented Numerical Method Delhi : Khanna Book Publishing.
5. Desai, R. C. (1989). FORTRAN Programming and Numerical MethodsNew Delhi: Tata McGraw Hill Education Private Limited.
6. Singh, N. (2017). Computational methods For Physics & Mathematics. New Delhi : Narosa Publishing House
7. Sastry, S. S. (2013). Introductory Methods of Numerical Analysis . New Delhi : PHI Learning Private Limited.
8. Patil, P.B. & Verma, U.P. (2013). Numerical Computational Methods New Delhi: Narosa Publishing House
9. Balagurusamy, E.(2014). Numerical Methods New Delhi: McGraw Hill. Education (India) Private Limited
10. Mittal, V.K., Verma, R.C. & Gupta, S.C (2018). Computational Physics. New Delhi: Ane Books Pvt. Ltd.

Mapping matrix of COs, POs and PSOs of MSc/Phy/3/SEC1-B– Computational Physics-I

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	3	3	3	3	3	3	3	3	3
CO2	2	2	2	2	2	2	3	2	2	2	2	2
CO3	3	3	2	2	2	2	3	2	3	2	2	3
CO4	3	3	2	3	3	2	3	3	3	3	3	3
Average	**2.75**	**2.5**	**2.25**	**2.5**	**2.5**	**2.25**	**3**	**2.5**	**2.75**	**2.5**	**2.5**	**2.75**



MSc/Phy/3/DSC3-A– Materials Science-I

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: Crystal defects, semiconductor, dielectric and magnetic materials and their properties are discussed in detail. This course will give an in depth knowledge of materials and imperfections, semiconductor, dielectric, optical and magnetic properties.

Course Outcomes:
CO1: Study of defects present in the crystal will help the students to understand how properties of material can be modulated by adding impurities to the crystals/semiconductors
CO2: Semiconductors are the basis of micro-technology. After studying this course, students will be able to understand the electronic and optical properties of semiconductors.
CO3: Students will gain ample knowledge about dielectric materials and their properties and applications.
CO4: Students will be able to differentiate between diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic (ferrite) materials and their properties.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I
Crystal Imperfections: Point defects: Vacancy, Substitutional, Interstitial, Schottky and Frenkel defects; Line defects/Dislocations: Slip planes and slip directions, Edge and screw dislocations, Burger's vector and circuit, Energy of dislocation; Planar defects: Grain boundaries, Tilt and twist boundaries, twin interfaces, Stacking faults in close packed structures (fcc and hcp).

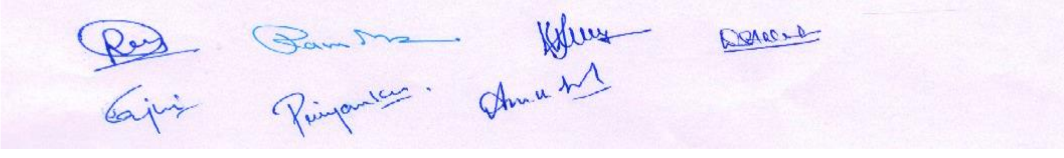
Unit-II
Semiconductors: Energy bands, Direct and indirect band gap, Motion of electrons in an energy band, Holes, Effective mass and its physical interpretation, Hall effect, Cyclotron resonance, Hot electrons and Gunn effect, Optical absorption, transmission and reflection, Refractive index, Colour, Photoconductivity, Photoluminescence.

Unit-III
Dielectrics: Polarization, Dielectric constant, Complex permittivity, Dielectric loss factor, Local field, Clausius-Mossotti relation, Electronic, Ionic & Dipolar Polarizabilities, Classification of dielectrics, Frequency dependence of dielectric constant. Ferroelectrics: Piezo-, Pyro- and Ferro-electricity, Transition temperature, Classification and general properties of ferroelectric materials, Polarization catastrophe, Landau theory of first and second order phase transitions, Ferroelectric domains, Antiferroelectricity.

Unit-IV
Magnetism: Larmor frequency, Diamagnetism, Magnetic susceptibility of a diamagnetic material, Langevin's diamagnetism equation, Paramagnetism, Curie constant, Ferromagnetism, Curie temperature, Curie-Weiss law, Exchange interactions, Ferromagnetic domains, Antiferromagnetism, Magnetic susceptibility of an antiferromagnetic material, Ferrimagnetism and Ferrites.

Text/Reference Books:

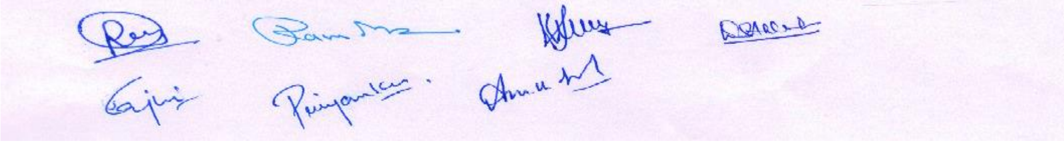
1. Kittel, C. (2012). Introduction to Solid State Physics. New Delhi: Wiley.
2. Ashcroft, N. W. & Mermin, N. D. (2003). Solid State Physics. Boston: Cengage.
3. Ibach, H. & Luth, H. (2009). Solid State Physics: An introduction to Principles of Materials Science. New York: Springer.



4. Omar, M. A. (2002). Elements of Solid State Physics. Noida (U.P.): Pearson Education India.
5. Wahab, M. A. (2015). Solid State Physics. New Delhi: Narosa.
6. Rajnikant, (2011). Applied Solid State Physics. New Delhi: Wiley.
7. Anderson, J. C., Leaver, K. D., Alexander, J. M. & Rawlings, R. D. (1990). Materials Science. New York: Springer.

Mapping matrix of COs, POs and PSOs of MSc/Phy/3/DSC3-A– Materials Science-I

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1	3	2	1	1	2	1	3	1	2	2
CO2	3	2	2	2	1	2	2	1	2	2	2	2
CO3	3	2	2	2	2	2	1	1	1	2	2	2
CO4	3	2	2	2	2	2	2	1	1	2	2	2
Average	2.75	1.75	2.25	2	1.5	1.75	1.75	1	1.75	1.75	2	2



MSc/Phy/3/DSC3-B– Advanced Electronics-I

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: The aim of this course is to train students to a host of important electronic device being used in vital practical applications. Amplifiers, the basic building block of analog electronics, is included so that students can grasp the basics of amplifiers. This course familiarizes about the microprocessor programming and their applications. Basic concepts of modulation will help the student to understand various applications in analog circuits as amplitude, frequency and phase modulations. Optoelectronic modulators are emphasized in this course so that students can easily understand the basic physics behind the concept. The overall course is designed in such a manner that the student after studying this will have strong basic knowledge to design power electronic systems and optical communication system easily.

Course Outcomes: After successful completion of the course, the students will be able to:
CO1: understand the basics of amplifiers with applications
CO2: understand the structure of microprocessor and their important applications.
CO3: realize the role and importance of different modulation and demodulation processes in modern electronic and optical communication system.
CO4: the concepts of ray and wave theory will be helpful to clear doubts about optical communication system. Students will easily understand the concept of optical fibres, their advantages, fabrication and losses.

***Note for the Paper Setter:** The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit I

Frequency Response of Amplifier: The amplifier pass band, Midrange response with a CE cascade, The high frequency equivalent circuit: Miller effect, The high frequency response, The RC coupled CE amplifier, The frequency response of the RC amplifier, Gain frequency plots of amplifier response, Bandwidth of cascaded amplifier, Band width criteria for the transistor, Gain bandwidth product, Amplifier noise figure, Noise in amplifier.

Unit-II

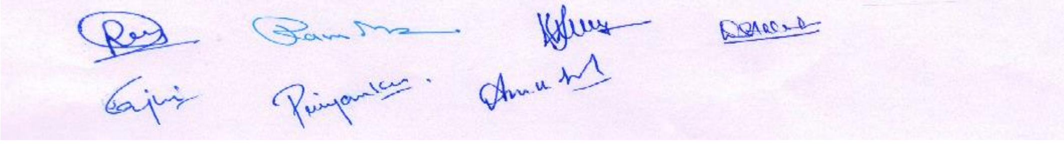
Microprocessor: Microcomputer systems and hardware, Microprocessor architecture and Microprocessor system, Instruction and timing diagram, Introduction to 8085 basic instructions (arithmetic operation, logic operation, branch operation) 16bit arithmetic instructions, Arithmetic operation related to memory, Rotate and compare instructions, Stack and subroutines, Programming of 8085 using instructions, Introduction to microcontroller.

Unit III

Modulation &Demodulation Schemes: Introduction to Modulation, Need for Analog, Pulse & Digital modulation, Amplitude Modulation: Modulation index, Frequency spectrum and power in the AM wave, Generation of AM waves, Demodulation of AM waves, Frequency modulation, Generation of FM waves, Demodulation of FM waves, Phase modulation, Pulse modulation: Pulse amplitude modulation, Pulse width modulation, Pulse position modulation, Pulse code modulation, Concept of optoelectronic modulators: electro and acousto-optic modulators.

Unit-IV

Optical Communication System: Advantages of Optical Communication, It's essential components, Ray theory of propagation: Total internal reflection, Numerical aperture, Acceptance angle/cone, Wave condition for propagation of light, Types of optical fibers: Multimode step index fibers, Multimode graded index fibers, Single mode fibers, Materials and Preparation of optical fibers: Liquid and Vapor-Phase deposition techniques, Attenuations in optical fibers: Material absorption losses, Scattering losses, Bending losses, Dispersion in fibers.

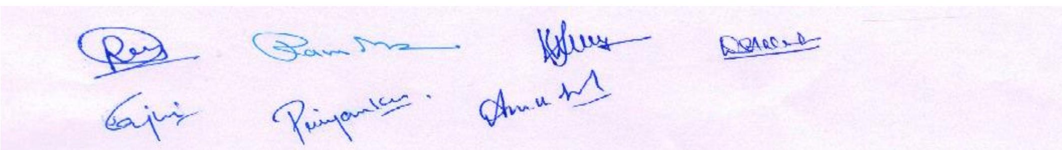


Text/Reference Books:

1. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall
2. Millman, J. & Halkias, C. C. (2017). Integrated Electronics. India: Mc Graw Hill
3. Millman, J. & Grabel (2017) Microelectronics. India: Mc Graw Hill Edu.
4. Keisser, G. (2017) Optical Fiber Communication. India: Mc Graw Hill Edu.
5. Ghatak, A. & Tyagrajan, K. (2017) Introduction to Fiber Optics. India: Cambridge University press.
6. Senior, J.M. (2014) Optical Fiber Communication- Principle and Practicals . India: Pearson Edu.
7. Jafer, D. (2005) Fiber Optics Communication and Technology. US: Pearson Pub.
8. Tomasi, W. (2013) Advanced Electronic Communication System. Inida: Pearson Pub.
9. Malvino, A.P. (2017) Digital Computer Electronics .India: Mc Graw Hill Edu.
10. Muller & Kamins (2003) Device Electronics for Integrated Circuit. New York: Wiley Pub.
11. S Gaonkar, S. (2013) Microprocessor Architecture Prog. & Appls. India: Pearson Pub.
12. Hall, D.V. (2017) Microprocessor and Interfacing. Europe: Mc Graw Hill Edu.
13. Jain, R.P. (2009) Modern Digital Electronics. India: Mc Graw Hill Edu.

Mapping matrix of COs, POs and PSOs MSc/Phy/3/DSC3-B– Advanced Electronics-I

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	2	2	2	2	3	2	3
CO2	2	3	2	2	1	2	2	2	2	3	2	2
CO3	2	3	2	2	2	2	2	2	2	3	2	2
CO4	3	3	2	2	2	2	2	2	2	3	2	3
Average	2.5	3	2	2	1.75	2	2	2	2	3	2	2.5



MSc/Phy/3/SEC2-A – Physics Lab–V (A) (Laser & Spectroscopy-I)

Credits: 4	**Max. Marks: 100**
Lectures: 60	**Final Term Exam.: 70**
Duration of Exam.: 3 Hrs.	**Internal Assessment: 30**

Objective: Gain practical experience about laser beam parameters, spectroscopy methods and applications in various fields. The major objective of this course is to expose practically about laser and optics through standard set of experiments and motivate the students to apply these concepts in real physical world.

Course Outcomes: Provides practical experience about various experimental laser based techniques to characterize laser beams and material properties.

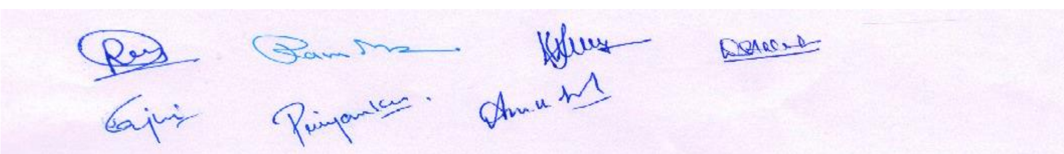
CO1: Calibration of experimental setups and evaluate physical parameters using experimental observations.
CO2: Having a basic understanding of the subject related lab concepts & contemporary issues.
CO3: Develop problem solving ability especially in optics, material science, engineering and related technology.
CO4: Analyze the characteristics of spectrometers, solar cells, LED's, lasers and optical fiber.

Experiments:

1. To determine the wavelength of Diode/He-Ne laser
   (a) using transmission grating.
   (b) using reflection grating.
   (c) with a mesh.
2. To determine the size of tiny particle/lycopodium powder
   (a) using cw laser beam.
   (b) using laser diffraction method.
3. To determine distance of an object by triangularization method using He-Ne/diode laser.
4. To determine refractive index of a given sample
   (a) using Abbe refractometer.
   (b) using He-Ne/diode laser.
5. To determine the diameter of human hair/thin wire
   (a) using a He-Ne/diode laser.
   (b) using engraved metal mm-scale/vernier calipers.
6. To calculate the efficiency and fill factors of a variety of solar cells.
7. To study the various optoelectronic devices.
8. Study of laser power attenuation in optical fibers.
9. To determine wavelength of light source (mercury prominent line) using spectrometer diffraction grating.
10. To study bending of light.
11. To find wavelength of laser light using Michelson interferometer.
12. To determine the numerical aperture and acceptance angle of a given optical fiber.
13. Laser beam divergence and spot size determination.
14. Brewster's angle determination.
15. Determine wavelength of a monochromatic source of light or any other experiment using Fresnel biprism.

Text/Reference Books:

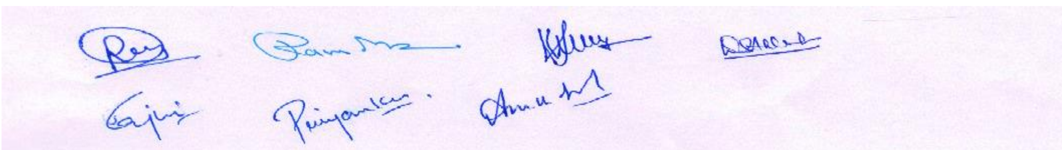
1. Nagabhushana, S., & Sathyanarayana N. (2013). Lasers and optical instrumentation. New Delhi: I.K. International.
2. Ghatak, A. (2017). Optics. New Delhi: Mc-Graw Hill Education India.
3. Davis, C. C. (2014). Lasers and Electro-optics: Cambridge University Press.



4. Singh, S. P. (2017). Advanced Practical Physics vol.I. Meerut: Pragati Parkashan.
5. Singh, S. P. (2019). Advanced Practical Physics Vol.II. Meerut: Pragati Parkashan.
6. Prakash, G. (2012). Experimental Physics. New Delhi: Studium Press India.
7. Sirohi, R.S. (1991). A Course of Experiments with He -Ne Laser. New Delhi: New Age International.
8. Sirohi, R.S. (2001). Wave Optics and Its Applications. Hyderabad: Orient Longman.

Mapping matrix of COs, POs and PSOs of MSc/Phy/3/SEC2-A – Physics Lab–V(A) (Laser & Spectroscopy-I)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2.5	2	2.5	2.5	2.5	2.5	3	3	2.5	1.5	2.5
CO2	3	2.5	2	2.5	2	2.5	2.5	3	3	2.5	1.5	2.5
CO3	3	2.5	2	2.5	2.5	2.5	2.5	3	3	2.5	1.5	2.5
CO4	3	2.5	2	2.5	2.5	2.5	2.5	3	3	2.5	1.5	2.5
Average	3	2.5	2	2.5	2.37	2.5	2.5	3	3	2.5	1.5	2.5



MSc/Phy/3/SEC2-B –Physics Lab–V (B) (Computational Physics-I)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

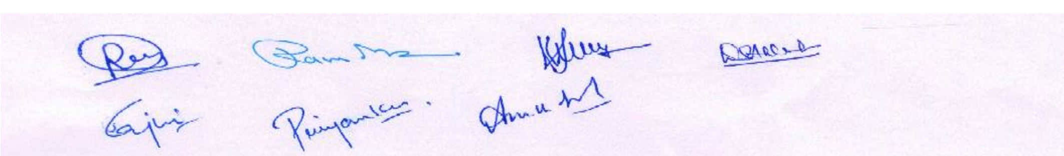
Note: Students have to perform atleast ten programs in all.

Course Objective: There are some topics in physics whose analytical solutions are very complex and suffer accuracy. Such phenomena can be described by various mathematical models and can be solved by various numerical methods. In these situations the numerical methods for solving various linear and nonlinear algebraic equations, ordinary differential equations, evaluating differentiation, integration etc. provide a powerful tools to describe the physical phenomenon quantitatively using computer programming in FORTRAN. The course will equip the student with FORTRAN programming and will enable then to write FORTRAN programs to solve numerical computationally and to be aware about various types of errors in numerical computation.

Course Outcomes: After successful completion of the course on Computational Physics Lab -I, a student will be able to:
CO1: Understand the working of various FORTRAN statements and implement algorithms in developing FORTRAN programs.
CO2: Solve numerical problems involving interpolation and/or extrapolation using different methods. Find roots of algebraic equations and ordinary differential equations using various iterative methods.
CO3: Fit a given data set with a best fit curve using principle of least square fitting and learn about fitting of different non-linear functions. Solve a set of simultaneous linear algebraic and ordinary differential equations numerically.
CO4: Find numerically the eigenvalues and eigenvectors of matrices using polynomial and power Methods, calculate the numerical differentiation and integration by various methods. Such techniques enhances computational skills in context of higher studies in Physics

List of Programs:

1. To find the root of an algebraic equation using bisection/ false position/ Newton-Raphson method correct to four decimal places.
2. Find the solutions of the system of equations using Gauss elimination/ Gauss Jordan elimination method.
3. To find the largest eigenvalue and corresponding eigenvector of a square matrix using power method.
4. Program to compute the interpolation value at a specified point from a given set of data points using Lagrange interpolation formula.
5. Program to construct the Newton interpolation polynomial from a given set of data points and then compute the interpolation value at a specified value.
6. Program to solve a system of linear equations by using Jacobi iterative method.
7. Program to solve a system of linear equations by using Gauss-Seidel iterative method.
8. Compute the interpolation value at a specified value from a given set of data points using natural cubic spline interpolation.
9. To fit a straight line/ polynomial curve from the given set of data points by the method of least squares
10. To find the numerical differentiation of a given function by Taylor series.
11. To find the numerical integration of a given function by Trapezoidal / Simpson's rule.
12. To find the numerical integration of a given function by Gaussian integration.
13. To find the numerical double integration of a given function
14. Simulation of the given first order differential equation using Euler's method / 2^{nd} order Runge-Kutta method/4^{th} order Runge-Kutta method.
15. Simulation of the given second order differential equation using 4^{th} order Runge-Kutta method/ Euler's method.

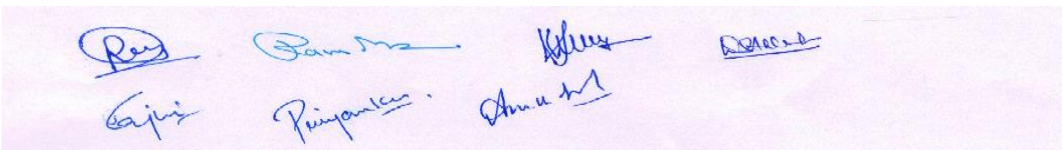


Text/Reference Books:

1. Dechaumphai, P. & Wansophark, N.(2011). Numerical Methods in Engineering. New Delhi: Alpha Science International.
2. Xavier,C.(2012). FORTRAN 77 and Numerical Methods. New Delhi : New Age International Publishers
3. Lipschutz, S., & Arthur P.O.E. (1982). Theory and problems of Programming with FORTRAN. Singapur : Schaum's outline Series Mc-Graw Hill Book Company
4. Salaria, R.S.(2011). Computer Oriented Numerical Method Delhi: Khanna Book Publishing.
5. Desai, R. C. (1989). FORTRAN Programming and Numerical Methods New Delhi: Tata McGraw Hill Education Private Limited.
6. Singh, N. (2017). Computational methods For Physics & Mathematics. New Delhi : Narosa Publishing House
7. Sastry, S. S. (2013). Introductory Methods of Numerical Analysis. New Delhi: PHI Learning Private Limited.
8. Patil, P.B. & Verma, U.P. (2013). Numerical Computational Methods New Delhi: Narosa Publishing House
9. Balagurusamy, E. (2014). Numerical Methods New Delhi: McGraw Hill. Education (India) Private Limited
10. Mittal, V.K., Verma, R.C. & Gupta, S.C (2018). Computational Physics. New Delhi: Ane Books Pvt. Ltd.

Mapping matrix of COs, POs and PSOs of MSc/Phy/3/SEC2-B –Physics Lab–V (B) (Computational Physics-I)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	3	3	2	3	3	3	3
CO2	3	3	2	3	2	2	3	2	3	3	2	3
CO3	3	3	2	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	2	2	3	3
Average	3	2.75	2.5	3	2.25	2.75	3	2.5	2.75	2.75	2.75	3



MSc/Phy/3/DSC4-A–Physics Lab–VI (A) (Materials Science-I)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

Objective: The objective of this lab course is to equip the students with the practical knowledge of the devices and effects observed in solids.

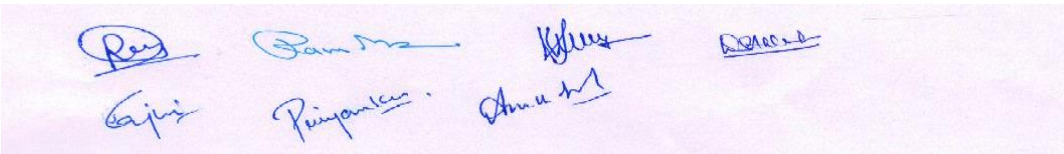
Course outcomes:
CO1: By practically performing the experiments students will be able to better understand the theoretical concepts of materials.
CO2: Students will be able to critically analyse the parameters that may affect the properties of materials.
CO3: Design and develop analogue systems to study the properties of any material / system.
CO4: Concept building by performing the experiment and deriving relationship between variables using observed data.

Experiments:

1. To determine the Dielectric constant for given samples.
2. To study temperature variation of resistivity of a semiconductor and to obtain energy gap using Four probe method.
3. To determine the carrier concentration, mobility & Hall coefficient using Hall effect experiment.
4. To determine the area of the B-H curve, saturation of magnetization, coercivity, retentivity of a given magnetic material.
5. To determine the velocity of sound waves in a liquid using ultrasonic interferometer.
6. To determine the Fermi energy of copper.
7. Determination of compressibility of a given liquid by using ultrasonic diffraction grating method.
8. To determine the quantized energy state of an atom by using Frank –Hertz experiment.
9. Measurement of susceptibility of Ferric Chloride ($FeCl_3$)/ Manganese Sulphate ($MnSO_4$) paramagnetic solution.
10. To determine the refractive index of glass material by Brewster angle measurement.
11. To study the magnetic susceptibility of a sample using Guy balance method.
12. The aim of the experiment is to verify Newton's Law of Cooling of different materials and different liquids. To draw the cooling curve.
13. To verify the relation between thermo emf of a thermocouple and temperature difference between two hot junctions.
14. To find the thermal conductivity of a material by the two slabs guarded hot plate method. To find the thermal resistance of the sample.
15. To determine the coefficient of thermal conductivity of a bad conductor using Lee's disc apparatus.

Text/References Books:

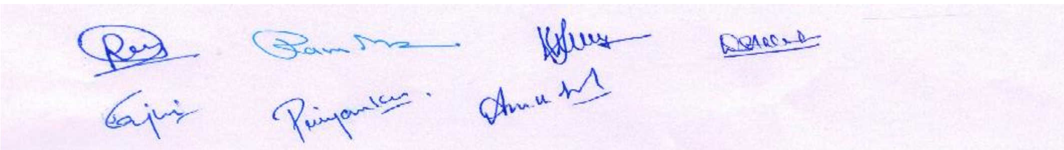
1. Zemansky, M. W. & Dittman, R. (1981). Heat and Thermodynamics. New York: Tata Mc Graw Hill.
2. Kittel, C. & Kroemer, H. (1980). Thermal Physics. United States: W. H. Freeman.
3. Pillai, S. O. (2020). Solid State Physics. New Delhi: New Age International Pvt. Ltd. Poynting, J. H. (2015). A text Book of Physics. Palala press.
4. Kittel, C. (2012). Introduction to Solid State Physics. New Delhi: Wiley.



5. Ashcroft, N. W. & Mermin, N. D. (2003). Solid State Physics. Boston: Cengage.
6. Ibach, H. & Luth, H. (2009). Solid State Physics: An introduction to Principles of Materials Science. New York: Springer.
7. Omar, M. A. (2002). Elements of Solid State Physics. Noida (U.P.): Pearson Education India.
8. Wahab, M. A. (2015). Solid State Physics. New Delhi: Narosa.
9. Rajnikant, (2011). Applied Solid State Physics. New Delhi: Wiley.
10. Anderson, J. C., Leaver, K. D., Alexander, J. M. & Rawlings, R. D. (1990). Materials Science. New York: Springer.

Mapping matrix of COs, POs and PSOs of MSc/Phy/3/DSC4-A–Physics Lab–VI(A) (Materials Science-I)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	2	1	2	2	2	2	1
CO2	2	2	3	3	2	2	1	2	3	2	2	2
CO3	2	2	2	2	2	2	1	3	2	3	3	2
CO4	2	2	2	3	2	2	1	2	2	2	3	2
Average	2.25	2.25	2.5	2.75	2	2	1	2.25	2.25	2.25	2.5	1.75



MSc/Phy/3/DSC4-B– Physics Lab-VI (B) (Advanced Electronics-I)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

Objective: The course on Physics Lab. (Advanced Electronics-I) familiarizes the students with electronics circuits of optoelectronics devices and will provide a hand on experience on modulation, demodulation. This course will provide a knowledge of characteristics of different amplifiers and various programmes on microprocessor kit.

Course Outcomes:

After completion of experimental work, students will be able to:

CO1: understand the characteristics of optoelectronics devices and frequency response of the amplifiers.

CO2: learn the characteristics of amplifiers, along with applications in various electronic devices.

CO3: design different types of circuits related to modulation and demodulation processes.

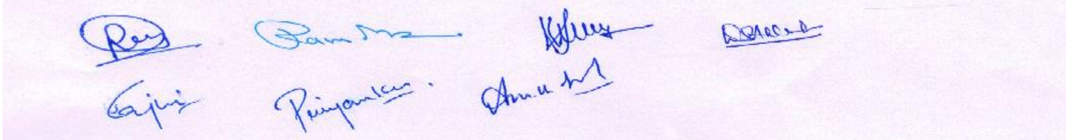
CO4: perform the microprocessor programming on microprocessor kit and applications in day to day life.

Experiments:

1. To study the characteristics of LED and Laser Diode using fiber optics trainer kit.
2. To determine the numerical aperture of monomode/multimode optical fiber.
3. Study of loss attenuation in optical fibers.
4. Study of pulse width modulation and demodulation.
5. Demonstration and realization of amplitude modulation & demodulation.
6. Demonstration and realization of frequency modulation & demodulation.
7. To study characteristics of Fiber optic photo-detectors.
8. Design and evaluation of a Laser diode linear Intensity Modulation system.
9. To plot the low and high frequency response of two stage RC coupled amplifier.
10. To study the mid frequency response of RC coupled amplifier.
11. Design and demonstrate the various programmes on 8085 microprocessor kit.
12. To design the different circuits of electronics on bread board.

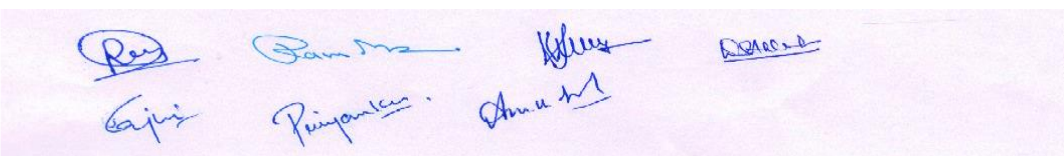
Text/References Books:

1. Sukhija, M.S. & Nagsarkar, T.K. (2016) Circuits and Networks. Oxford : Oxford University Pres
2. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall
3. Millman, J. & Halkias, C. C. (2017). Integrated Electronics. India: Mc Graw Hill Edu.
4. Millman, J. & Grabel (2017) Microelectronics. India: Mc Graw Hill Edu.
5. Keisser, G. (2017) Optical Fiber Communication: Mc Graw Hill Edu.
6. Ghatak, A. & Tyagrajan, K. (2017) Introduction to Fiber Optics. India: Cambridge University press.
7. Senior, J.M. (2014) Optical Fiber Communication- Principle and Practicals .India: Pearson Edu.
8. Jafer, D. (2005) Fiber Optics Communication and Technology. US: Pearson Pub.
9. Tomasi, W. (2013) Advanced Electronic Communication System. Inida:Pearson Pub.)
10. Malvino, A.P. (2017) Digital Computer Electronics .India: Mc Graw Hill Edu.
11. Muller & Kamins (2003) Device Electronics for Integrated Circuit. New York: Wiley Pub.
12. Gaonkar, S. (2013) Microprocessor Architecture Prog. &Appls. India: Pearson Publication Pub.
13. Hall, D.V. (2017) Microprocessor and Interfacing. Europe: Mc Graw Hill Edu.
14. Jain, R.P. (2009) Modern Digital Electronics. India: Mc Graw Hill Edu.



Mapping matrix of COs, POs and PSOs of MSc/Phy/3/DSC4-B– Physics Lab-VI (B) (Advanced Electronics-I)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	2	2	3	2	3
CO2	2	2	2	2	2	2	2	2	2	3	2	2
CO3	2	2	2	2	2	2	1	2	2	3	2	2
CO4	3	2	2	2	2	2	2	1	2	3	2	3
Average	2.5	2	2	2	2	2	1.75	1.75	2	3	2	2.5



MSc/Phy/4/CC14– Cardinal Principals of Academic Integrity and Research Ethics

Credits: 2	**Max. Marks: 50**
Lectures: 30	**Final Term Exam.: 30**
Duration of Exam.: 2 Hrs.	**Internal Assessment: 20**

Objective: The objective of the course is to apprise/aware the students about the Academic Integrity, Plagiarism (prevention and detection) and UGC regulations; as well as to follow Research and Publications ethics and best practices

Course outcomes: At the end of the course, the students will know:
CO1: Academic Integrity, Plagiarism (prevention and detection) and UGC regulations
CO2: Research and Publications ethics and best practices

Note for the paper setter: *The question paper will consist of five questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each unit. The candidates are required to attempt two more questions selecting at least one from each unit.*

Unit I

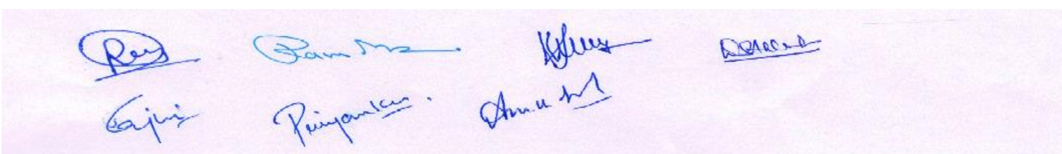
Academic Integrity: Introduction, Academic Integrity Values- Honesty and Trust, Fairness and Respect, Responsibility and Courage, Violations of Academic Integrity-types and consequences, Plagiarism - definition, Plagiarism arising out of misrepresentation-contract cheating, collusion, copying and pasting, recycling, Avoiding Plagiarism through referencing and writing skills, UGC Policy for Academic Integrity and prevention, Some Plagiarism detection tools

Unit II

Research and Publication ethics: Scientific misconducts- Falsifications, Fabrication and Plagiarism (FPP), Publication ethics- definition, introduction and importance, Best practices/standard setting initiatives and guidelines-COPE, WAME etc., Violation of publication ethics, authorship and contributor-ship, Identification of publications misconduct, complains and appeals, Conflicts of Interest, Predatory publisher and journals,

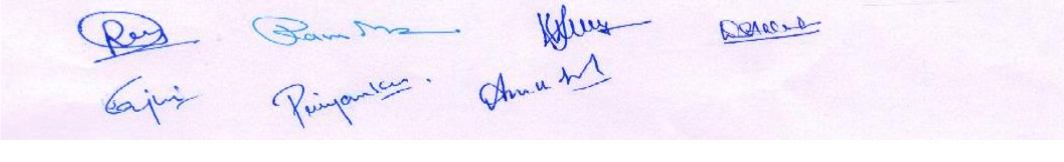
Text/References Books/Papers:

1. MacIntyre A (1967) A short History of Ethics, London
2. Chaddah P (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized. ISBN: 978-9387480865
3. National Academy of Sciences, National Academy of Engineering and Institute of Medicine (2009) On being a Scientist: A guide to Responsible Conduct in research: Third Edition. National Academics press.
4. Resnik D. B. (2011) What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10.
5. Beall J (2012). Predatory publishers are corrupting open access, Nature, 489 (7415), 179.
6. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019). ISBN: 978-81-939482-1-7.
7. UGC regulations (2018) for Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutes.
8. Ulrike kestler, Academic Integrity, Kwantlen Polytechnic University.



Mapping matrix of COs, POs and PSOs of MSc/Phy/4/CC14–Cardinal Principals of Academic Integrity and Research Ethics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	2	2	1	3	2	2	2
CO2	3	2	2	1	3	2	2	1	3	2	2	2
Average	3	2	2	1	3	2	2	1	3	2	2	2



MSc/Phy/4/CC15– Statistical Mechanics

Credits: 4	**Max. Marks: 100**
Lectures: 60	**Final Term Exam.: 70**
Duration of Exam.: 3 Hrs.	**Internal Assessment: 30**

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

Course outcomes:
CO1: A student will be able to understand the basic concepts of thermodynamics and set a relation between thermodynamics and statistics.
CO2: A fair knowledge about the various ensembles and learn about the behavior of classical Ideal gas under various ensembles.
CO3: A student will acquire sound knowledge of M.B., B.E. and F.D. statistics and understand the phenomenon of Bose-Einstein condensation and black body radiations.
CO4: A student will have fair knowledge of Landau theory of phase transition, Ising model, Langevin theory of Brownian motion.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

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

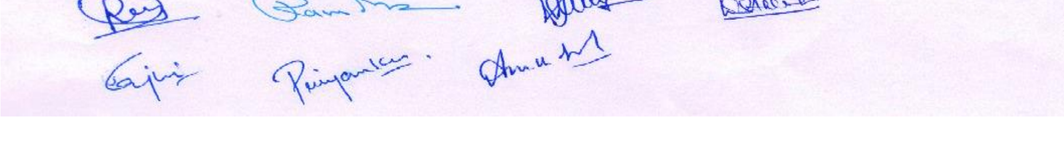
Unit-II
Phase space, Liouville's theorem, Concept of ensemble, Ensemble average, Microcanonical, canonical and grand canonical ensembles and partition functions, Thermodynamics of Classical ideal gas in Microcanonical, Canonical and Grand canonical ensembles, Energy and density fluctuations.

Unit-III
Density matrix, Statistics of indistinguishable particles, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Statistics of occupation numbers, Thermodynamic behavior of ideal Bose and Fermi gases, Bose-Einstein condensation, Laser cooling of atoms as an example of Bose condensate, Black body radiation and Planck's black body radiation formula.

Unit-IV
First and second order phase transitions, Critical exponents, Landau theory of phase transition, Diamagnetism, paramagnetism and ferromagnetism, Ising model, Thermodynamic fluctuations, Random walk and Brownian motion, Langevin theory of Brownian motion.

Text/Reference Books:

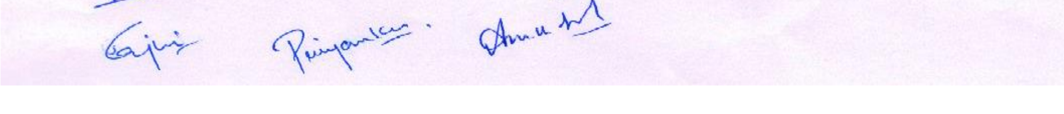
1. Pathria, R.K., Beale, D.(2021)Statistical Mechanics.Gurugram:Elsevier Pub.
2. Huang, K.(2008)Statistical Mechanics.India:Wiley Pub.
3. Agrawal, B.K., Eisner,M.(2020)Statistical Mechanics.India:New Age Int. Pub.
4. Sinha, S.K.(2005)Introduction to Statistical Mechanics .India:Narosa Pub. House.
5. Kittel,C.(2004)Elementary Statistical Mechanics.New York:Dover Pub. Inc.



6. Landau, L.D., Lifsitz, I.M.(2010) Statistical Physics.Oxford: Butterwoth Heinemann Pub.
7. Mandl, F. (2014): Statistical Physics, India: Wiley Pub.
8. Laud, B.B. (2020) Statistical Physics, India: New Age Int. Pvt. Ltd.
9. Kubo, R. (1990) Statistical Mechanics, Holland: Shokabo Pub. Co.
10. Reif, F.(2010) Statistics and Thermal Physics, Delhi: Sarat Books Distributors

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/CC15– Statistical Mechanics

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	1	2	1	2	1	1	1	3	2	3	2
CO2	2	1	2	2	1	1	1	1	3	1	2	1
CO3	3	1	2	2	1	1	1	1	2	2	2	2
CO4	2	2	2	2	1	1	1	1	2	1	2	1
Average	2.5	1.25	2	1.75	1.25	1	1	1	2.5	1.5	2.25	1.5



MSc/Phy/4/CC16-A – Radiation Physics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: To impart knowledge in depth about nuclear radiation, its detection, nuclear spectrometry and related aspects.

Course Outcome: Students will have understanding about:
CO1: nuclear radiation and its detection procedure, nuclear spectrometry.
CO2: applications of nuclear spectrometry.
CO3: nuclear radiation for diagnosis in medical field.
CO4: problems related to safety aspect of nuclear radiation.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Interactions of Nuclear Radiations : Origin and energy spectra, Brief discussion of interactions of gamma rays, Electron and heavy charged particles with matter, Different types of neutron sources, Interaction of neutron with matter, Neutron detectors.

Unit-II

Nuclear Radiation Detector : Gas filled detectors; Ionization chamber, Proportional counter and GM counter, Scintillation detector, semiconductor detector for X-rays, gamma rays and charged particle detection, Radiation exposure, Biological effects of radiation, radiation monitoring.

Unit-III

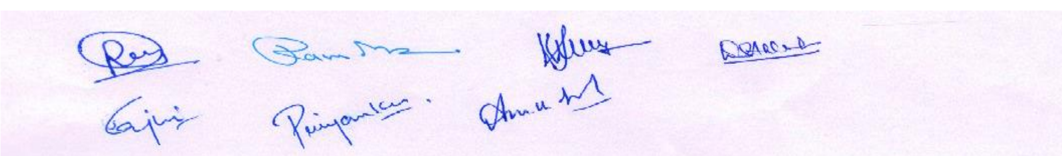
Nuclear Spectrometry and Applications: Analysis of nuclear spectrometric data, measurement of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, perturbed angular correlation, measurement of g-factor and hyperfine-fields. Safety aspects: Radiation dose unit, Safety limits, Dose calculations, Design consideration of simple shields.

Unit-IV

Nuclear Radiation in Biology and Medicine : Dosimetric units, Radiation dosimeter, Radioactive isotopes, Gamma camera, Positron emission tomography, Introductory idea of Single photon emission computed tomography, MRI, Boron neutron capture therapy, Ion beam in cancer therapy, Diagnostic nuclear medicine, Therapeutic nuclear medicine.

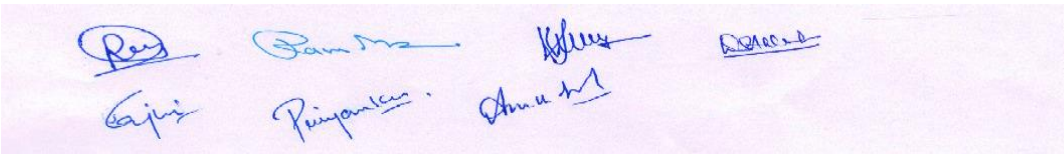
Text/Reference Books

1. J. Varma, R.C. Bhandari & D.R.S. Somayajulu (2017) : Fundamentals of Nuclear Physics (CBS Publishers)
2. G. F. Knoll (1989): Radiation Detection and Measurement (John Wiley & Sons)
3. R.M. Singuru (1987): Introduction to Experimental Nuclear Physics (Wiley Eastern Publications)
4. V. Muraleedhara (2009): Nuclear Radiation Detection, Measurement and Analysis (Narosa Publishing House)
5. Santanu,Ghosh (2011): An Introduction to Engineering Aspects of Nuclear Physics (I. K. International)
6. D.C. Tayal (2014): Nuclear Physics (Himalaya Publication)



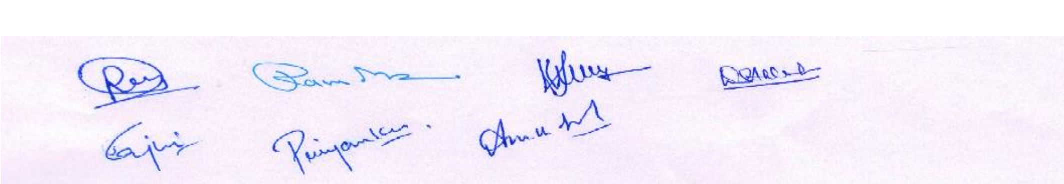
Mapping matrix of COs, POs and PSOs of MSc/Phy/4/CC16-A – Radiation Physics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	1.5	3
CO2	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	1.5	3
CO3	3	2.5	2.5	2.5	3	2.5	2.5	3	3	2.5	1.5	3
CO4	3	2.5	2.5	2.5	3	3	2.5	3	3	2.5	1.5	3
Average	3	2.5	2.5	2.5	2.75	2.62	2.5	2.7	3	3	1.5	3



MSc/Phy/4/CC16-B
MOOC available on SWAYAM portal

Credits: 4 **Max. Marks: 100**



MSc/Phy/4/SEC3-A– Laser & Spectroscopy-II

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objectives: In depth understanding about various laser systems in detail and effective use of lasers for different applications in any field along with motivation for advancement.

Course outcomes:
CO1: understanding about optical amplifier, oscillation, power output, and efficiency and laser rate equations.
CO2: working principle of some important laser systems with their pumping methods, energy levels and applications.
CO3: techniques to generate short and ultra-short high power laser pulses.
CO4: high sensitivity laser spectroscopy methods to explore optical properties of various materials for their potential use in technology.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Important processes and laser rate equations: Amplification in an inhomogeneously broadened system, Spacial and spectral hole burning, Lamb dip, Multi-mode oscillation, Efficiency of laser and its various factors, Rate equations for three and four level laser systems, Variation of laser power around threshold, Optimum output coupling.

Unit-II

Pumping and various laser systems**:** Optical and electrical pumping, Conversion efficiency, Excitation mechanisms, structure and important applications of laser systems: He-Ne, Ruby, Nd:YAG, Dye, CO_2, Argon Ion, Double Hetrostructure Semiconductor, Semiconductor Quantum well.

Unit-III

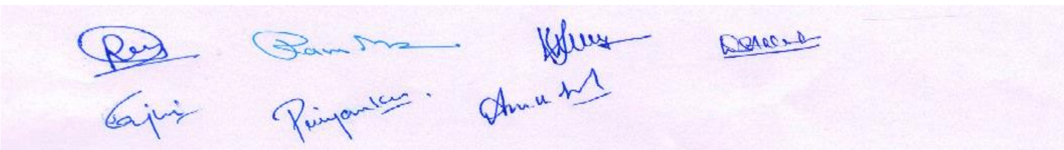
Short and ultrashort laser pulse generation: Index ellipsoid, Pockel and Kerr effects, Pockel effect in KDP crystal: Longitudinal and elementary idea of its transverse configuration, Magneto-optic and Acousto-optic effect, Theory of Q-switched laser, Theory of mode locking (active & passive), Methods for Q-switching and mode locking via passive and active methods in particular electro-optic effect.

Unit-IV

Non-linear optics and laser spectroscopy**:** Introduction to Maxwell's equations in a non-linear optical medium. Second harmonic generation, Principle, design, construction and applications: Laser Raman spectroscopy, High sensitivity methods of absorption spectroscopy; Frequency modulation and interactivity absorption (using single and multimode operation), Fluorescence excitation spectroscopy, Laser induced fluorescence.

Text/Reference Books:

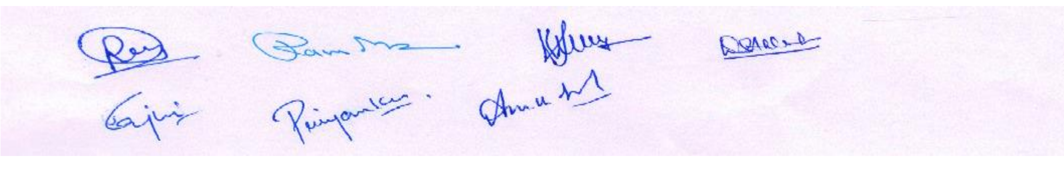
1. Verdeyen, J.T. (1995) Laser Electronics: Pearson
2. Davis C. C. (2014) Lasers and Electro-Optics: Cambridge University Press.
3. Silfwast, W. T. (1998) Lasers Fundamentals: Cambridge University Press.
4. Ahlawat, D.S. (2017) Basic Concepts of Laser Physics: Mittal Publications, New Delhi.
5. Svelto, O. (1982) Principles of Lasers: Plenum Press, New York.



6. Ghatak, A. & Tayagrajan, K. (2011) Optical Electronics: Cambridge.
7. Ghatak, A. & Tayagrajan, K. (2005) Laser Theory & Applications: Macmillan, Delhi
8. Demtroder, W. (1996) Laser Spectroscopy : Springer.
9. Demtroder, W. (2015) Laser Spectroscopy 2 : Springer.
10. Laud, B.B. (2020) Lasers and Non-linear Optics: New Age International.
11. Nagabhushana S. & Sathyanarayana N. (2010) Laser and Optical Instrumentation: I.K. International.

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/SEC3-A– Laser & Spectroscopy-II

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2.5	2.5	2.5	2	2.5	2.5	2.5	3	2.5	1.5	3
CO2	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	1.5	3
CO3	3	3	2.5	2.5	2.5	2.5	2.5	3	3	2.5	1.5	3
CO4	3	3	2.5	2.5	2.5	2.5	2.5	3	3	2.5	1.5	3
Average	3	2.75	2.5	2.5	2.37	2.5	2.5	2.87	3	2.5	1.5	3



MSc/Phy/4/SEC3-B– Computational Physics-II

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. **Internal Assessment: 30**

Objectives: As the physical models are represented by various algebraic, differential and integral equations which can be simulated on the computer by using FORTRAN and MATLAB etc. Using these software tools, the students would be familiar to various chaotic and nonlinear phenomena. Using the random numbers one can get the basic knowledge of radioactive phenomena and calculation of various integrals using Monte-Carlo method Further by learning the fundamental concepts involved in simulation techniques of simple physical phenomena like electronic circuits, quantum mechanics, wave and optics etc. one can get the flavour of simulation in Physics. After doing this the students will be empowered to learn the MATLAB and will be able to understand the complex physical processes using computer.

Course Outcomes: After successful completion of the course on Computational Physics-II, a student will be benefited as:

CO1: Students would be able to understand framework of linear and nonlinear systems, logistic systems and chaotic behaviour of given system and their simulation.
CO2: Students would be familiar with the framework of random numbers and their generation along with their applications in various physical phenomena. In addition to this student will know about the Monte Carlo method and its application to calculate the complex integrals, Brownian motion and noise distribution in Physics.
CO3: Students would be able to learn the simulation of various physical problems in wave, optics and electronic circuits.
CO4: Students would learn the simulation of various problems in quantum mechanics, the necessary basic knowledge of MATLAB. This will equip them to do theoretical analysis if their research work is experimental too.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit I

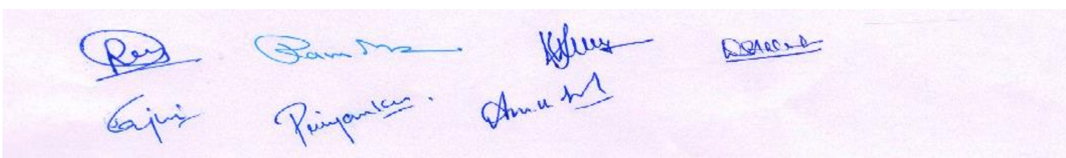
Nonlinear Dynamics and Chaos**:** Linear and nonlinear systems, Simple pendulum, Runge Kutta solution to the equation of motion. Potential energy of a dynamical system, Portrait in Phase space: Undamped motion, Damped motion, Driven and damped oscillator, Chaotic dynamics: Attractor, Chaotic attractor, Poincare section, Bifurcation and periodic doubling, Lyapunov exponents, Mapping, Logistic system, Chaotic pendulum**,**

Unit II

Random Phenomena Simulation**:** Randomness, Random number generators, Mid-square methods, Multiplicative congruential method, Mixed multiplicative congruential methods, Modeling radioactive decay, Hit and miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo integration, Monte-Carlo multidimensional integrations, Brownian Motion, Noise : Mean and standard deviation of a noise distribution, Form of Gaussian noise distribution.

Unit III

Simulation in Physics-I**:** Simulation of plane wave, Superposition of harmonic waves, Iinterference , Diffraction and Polarization of light, Simulation of charging and discharging of a capacitor, Current in LR, LC and LCR circuit, Computer model for LR, and LCR circuit driven by sine function, Motion of charged particle in uniform electric field, Motion of charged particle in uniform magnetic field.



Unit IV

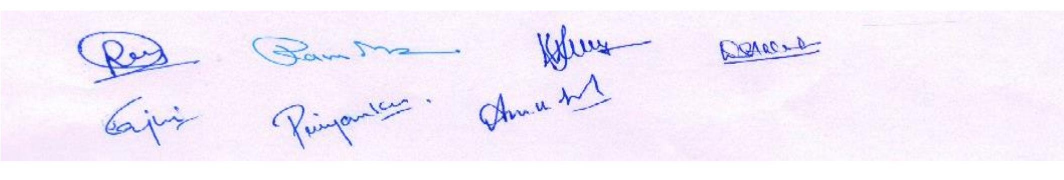
Simulation in Physics-II & MATLAB: Computer model for Rutherford scattering experiment, Simulation of electron orbit in H_2 ion, Formation of wave packet, Numerical solution of radial Schrodinger equation for Hydrogen atom using fourth order Runge-Kutta method (eigen value is given). Basics of MATLAB, Creating and working with arrays of numbers, creating and printing plots, Interacting computations: Matrices and vectors, Matrices and array operations, Built in functions, Saving and loading data, Programming in MATLAB: Script files, Function files and Language specific features.

Text/Reference Books:

1. Jong, M L De (1991). Introduction to Computation Physics. Boston : Addison – Wesley
2. Alligood K. T., Sauer Tim D. & Yorke, J. A (1997) : Chaos an introduction to dynamical systems. New Delhi :Springer
3. Verma, R. C., Ahluwalia P.K. & Sharma K.C. (2014). Computational Physics an Introduction. New Delhi :New Age International Publisher
4. Patil, P.B. & Verma, U.P. (2013). Numerical Computational Methods New Delhi : Narosa Publishing House
5. Singh, N.(2017). Computational methods For Physics & Mathematics. New Delhi : Narosa Publishing House
6. Pratap, R.(2010). Getting Started with MATLAB. New Delhi: Oxford University Press.
7. William J Palm III (2013). A concise introduction to MATLAB. New Delhi: McGraw Hill Education (India) Private Limited.
8. Koonin, S. E. (1998). Computational Physics. Boston : Addison –Wesley
9. Mackewon, P.K. & Newman, D.J. (1987). Computational Techniques in Physics (Bristol, England :A. Hilger)
10. Alder, B., Rotengen M. & Fernbach S. (1964): Methods in Computational Physics. New York: Academic Press

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/SEC3-B– Computational Physics-II

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	2	2	3	3	3	2	2	2
CO2	3	3	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	2	2	2	2	3	2	2	2	3	3
Average	2.75	2.75	2.25	2.75	2.5	2.5	3	2.75	2.75	2.5	2.75	2.75



MSc/Phy/4/DSC5-A – Materials Science-II

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: The objective of this course is to provide the students basic knowledge of nanoscale materials and their properties. This course will also discuss the synthesis and characterization techniques of nanomaterials.

Course Outcomes:
CO1: The learner will be able to understand how on reducing the size of a material to nanoscale, can change the electronic energy states and hence properties of the materials.
CO2: The learner will have an in depth knowledge of the characteristic change in properties of nanomaterials.
CO3: The learner will have ample knowledge about the various top down and bottom up techniques for synthesis of nanomaterials.
CO4: Learner will be aware about the various characterization tools for nanomaterials.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Free electron theory (qualitative idea) and its features, Idea of band structure, Metals, insulators and semiconductors, Density of state in bands, Variation of density of states with energy, Variation of density of state and band gap with size of crystal, Quantum size effect. Electron confinement in infinitely deep square well, confinement in one and two dimensional well.

Unit-II

Idea of quantum well structure, Quantum wires and dots. Determination of particle size, Increase in width of XRD peaks of nano-particles, Shift in photoluminescence peaks, Variation in Raman spectra of nano-materials, Carbon Nanotubes: Synthesis, Structure, Properties and Applications.

Unit-III

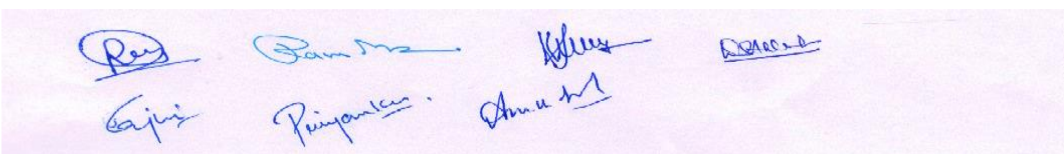
Different methods of preparation of Nanostructured materials: Brief idea of some important physical and chemical techniques, Ball milling, Pulsed laser deposition, Ion beam deposition, Chemical vapour deposition, Sol-gel, Co-precipitation, Electro-chemical deposition.

Unit-IV

Different methods of characterization of Nanostructured materials: X-ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, UV-visible spectroscopy, Photoluminescence (PL).

Text/Reference Books:

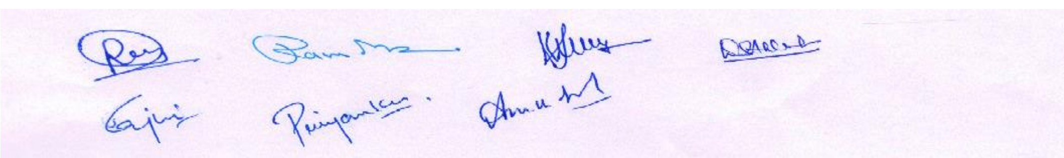
1. Cao, G. (2011). Nanostructures & Nanomaterials. Singapore: World scientific publishing.
2. Poole, C. P. & Qwens, F. J. (2003). Introduction to Nanotechnology. New Delhi: Wiley-Interscience.
3. Hornyak, G. L., Tibbals, H. F., Dutta, J. & Moore, J. H. (2008) Introduction to Nanoscience & Nanotechnology. Florida: CRC press.



4. Wilson, M. et al. (2002). Nanotechnology. Florida: CRC press.
5. Jain, K. P. (1997). Physics of Semiconductor Nano Structures. New Delhi: Narosa.
6. Davies, J. H. (1997). Physics of Low Dimensional Semiconductors. Cambridge: Cambridge University Press.
7. Fendler, J. H. (Ed.). (1998). Nanoparticles and Nanostructured Films. Germany: Wiley-VCH.
8. Harrison, P. (2016). Quantum Wells, Wires and Dots. New York: Wiley.
9. Edelstein, A. S. & Cammarata, R. C. (1998). Nanomaterials: Synthesis, Properties & Applications. Florida: CRC press.
10. Dresselhaus, M. S., Dressclhaus, G. & Avoris, Ph. (2001).CNT- Carbon Nanotubes: Synthesis, Structure, Properties and Applications. New York: Springer.

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/DSC5-A–Materials Science-II

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	1	2	2	1	1	2	1	2	2
CO2	2	3	3	2	2	2	1	1	2	2	2	2
CO3	3	2	2	2	2	1	2	2	2	2	2	1
CO4	3	3	3	2	2	1	2	2	2	2	2	2
Average	2.5	2.5	2.5	1.75	2	1.5	1.5	1.5	2	1.75	2	1.75



MSc/Phy/4/DSC5-B – Advanced Electronics-II

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objectives:
The aim of this course is to train the students to a host of important power amplifiers, wave generators, regulators, analog and digital systems, optical fiber Types & Fabrication Techniques, optoelectronic devices. The students will also be exposed to various optoelectronic devices like LED, diode lasers, Photodiode, Photo transistor, solar cells and optical amplifiers. The course is designed in a manner such that the student after studying this will have strong basic knowledge to design optoelectronic systems and integrated system easily.

Course Outcomes: After successful completion of the course, the students will be able to:

CO1: understand the basics of power amplifiers, oscillators, waregulators and realize the process of A/D conversion and D/A conversion.
CO2: Students would be able to appreciate the functioning and applications of various optoelectronic devices.
CO3: Students get familiarity with optical sources specially LEDs and Laser diodes used in modern optical communication system. This kind of specialization is expected to provide a larger scope for research in the various related and interdisciplinary areas.
CO4: They will realize the principle and working of optical receivers, solar cells, photodiodes, and optical amplifiers and also able to analyze the functioning of various communication devices that will be helpful to seek their carrier in advance research.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit I

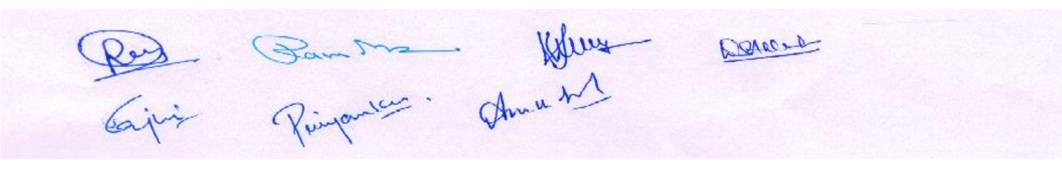
Power amplifiers and regulators: Power amplifiers: class A large signal amplifiers, second and higher order harmonic distortions, the transformer coupled power amplifier, impedance matching, efficiency, push-pull amplifiers, class-B amplifiers, complementary stages, cross over distortions, class-AB operation,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

Unit II

Analog and Digital Systems: Active filters, First order low pass and high pass butterworth filter, Second order low pass and high pass butterworth filter, Oscillators- Oscillator principle, frequency stability, Phase shift and Wein bridge oscillator, Square wave and triangular wave generator, Comparators, Digital to analog (D/A) converter- ladder and weighted resistor types, Analog to digital(A/D) converter-counter type, Successive approximation, Parallel comparator.

Unit-III

Optoelectronic Devices-I: Requirements of optical sources in communication, Concept of homojunction and heterojunctions structures, LEDs: Principle and working, Concept of Surface emitting and Edge emitting LEDs, Superluminescent LEDs, LED Characteristics: Optical output power and efficiency, Optical Source limitations, Diode Lasers: Principle and Characteristics, Gain guided and Index guided, Distributed feedback Lasers & VCSEL lasers.



Unit-IV

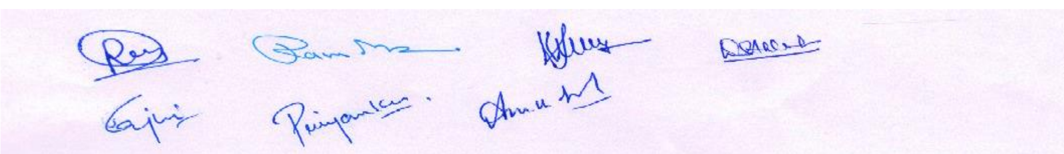
Optoelectronic Devices-II: Basic need of optical detectors, Block diagram of receiver unit, General Parameters, Types of Photo detectors, P-N, P-i-N and Avalanche photodiodes, Noises in detectors, Photo transistors, Solar cell: working & characteristics, Optical Amplifiers: Principle, system applications, Optical gain in Febry Perot and Travelling wave amplifiers, Rare earth doped fiber amplifiers (EDFA), concept of Raman fiber amplifiers.

Text/References Books:

1. Millman, J. & Halkias, C. C. (2017). Integrated Electronics. India: Mc Graw Hill Edu.
2. Senior, J.M.(2010)Optical Fiber Communication- Principle and Practicals.India: Pearson Edu.
3. Jafer, D.(2005)Fiber Optics Communication and Technology. US: Pearson Pub.
4. Sze, S.M. (2021) Physics of Semiconductors.New York : Wiley Interscience Pub.
5. Kothari, D.P.(2017) Basic Electronics.India: Mc Graw Hill Edu.
6. Millman, J. & Grabel (2017) Microelectronics. India: Mc Graw Hill Edu.
7. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall
8. Jain, R.P.(2009)Modern Digital Electronics. India: Mc Graw Hill Edu.
9. Keisser, G.(2017)Optical Fiber Communication.: Mc Graw Hill Edu.
10. Ghatak, A. & Tyagrajan, K. (2017) Introduction to Fiber Optics. India: Cambridge University press.
11. Parker, M.A. (2005) Physics of Optoelectronics. Florida: CRC Press.
12. Maini, A.K. (2007) Digital Electronics: Principles, Devices and Applications .New York: Wiley Pub.
13. Saggio, G.(2014)Principal of Analog Electronics. Florida: CRC Press.

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/DSC5-B – Advanced Electronics-II

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	2	3	2	3
CO2	2	3	2	2	3	2	2	2	2	3	2	2
CO3	2	2	2	2	3	1	2	2	2	3	2	2
CO4	3	3	2	2	3	2	2	2	2	3	2	3
Average	2.5	2.5	2	2	3	1.75	2	2	2	3	2	2.5



MSc/Phy/4/SEC4-A–Physics Lab–VII (A) (Laser & Spectroscopy-II)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

Objectives: To create in-depth knowledge of various laser applications by experimentation. The primary objective is to educate the students about various laser based applications. Experiencing in experimental field on optical parameters and correlate with the corresponding theory.

Course outcomes: Provides practical experience about various experimental laser based techniques to characterize laser beams and material properties.

CO1: Evaluate practically by measurement skills using experimental observations.

CO2: Design and develop various types of experimental systems to analyse properties of materials and optical fibers.

CO3: Adopting group working competency by working in teams on various experimental methods.

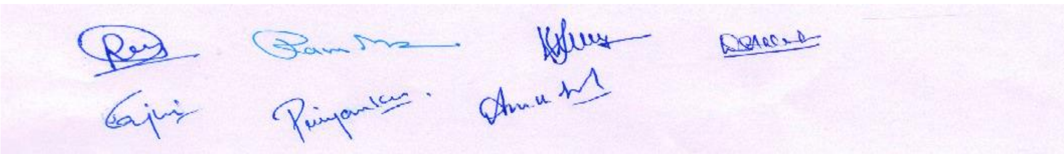
CO4: Having experimentation, computational approach, and innovative skills & data analysis ability.

Experiments:

1. To determine laser beam parameters using a He- Ne/diode laser source.
2. To study the characteristics of LED and Laser diode.
3. To study characteristics of Fiber optic photo-detectors.
4. Design and evaluation of a
   (a) Laser diode linear Intensity Modulation system.
   (b) Laser diode digital IM system.
5. To study various characteristics of PN junction: Reverse saturation current and material constant. To determine the temperature coefficient of junction and energy band gap.
6. Determination of applied magnetic field and resonance frequency (or g-factor) of a given sample using Electron spin resonance spectrometer.
7. To determine the value of forbidden energy gap of a diode and LED.
8. To verify inverse square law of radiation using photodiode.
9. Demonstration of spatial coherence of laser beam/ wavelength of sodium or white light using diffraction grating.
10. To study the Fraunhofer diffraction pattern
    (a) of a circular aperture and to measure its diameter.
    (b) anddetermine the slit width.
11. To determine the refractive index of a thin glass plate using Michelson interferometer.
12. Verification of Malus law / polarization characteristics of laser light.
13. Find out the value of Planck's constant
    (a) using LED.
    (b) using Photocell.
14. With the help of Abbe refractometer,
    (a) determine the polarizability of the given liquid samples at a given temperature.
    (b) study the variation of refractive index with
        (i) temperature of the liquid sample (ii) wavelength of the light source
15. To determine the thickness of a thin glass transparent plate using Michelsons interferometer.

Text/Reference Books:

1. Nagabhushana, S., & Sathyanarayana N. (2013). Lasers and optical instrumentation. New Delhi: I.K. International.
2. Ghatak, A. (2017). Optics. New Delhi: Mc-Graw Hill Education India.
3. Davis, C. C. (2014). Lasers and Electro-optics. Cambridge: Cambridge University Press.
4. Singh, S. P. (2017). Advanced Practical Physics Vol.I. Meerut: Pragati Parkashan.
5. Singh, S. P. (2019). Advanced Practical Physics Vol.II. Meerut: Pragati Parkashan.



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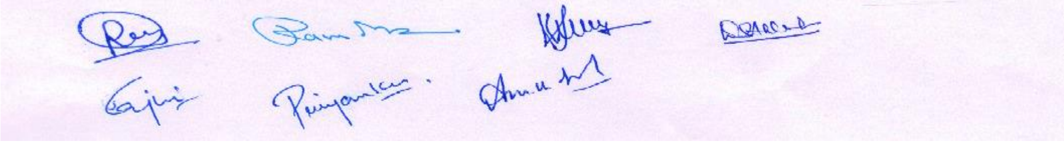
7. Sirohi, R.S. (1991). A Course of Experiments with He -Ne Laser. New Delhi: New Age International.
8. Sirohi, R.S. (2001). Wave Optics and Its Applications. Hyderabad: Orient Longman.

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/SEC4-A–Physics Lab–VII (A) (Laser & Spectroscopy-II)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1.5	2.5	2.5	2.5	2.5	3	3	2.5	1.5	2.5
CO2	3	2.5	1.5	2.5	2.5	2.5	2.5	3	3	2.5	1.5	2.5
CO3	3	2.5	1.5	2.5	2	2.5	2.5	3	3	2.5	1.5	2.5
CO4	3	2.5	1.5	2.5	2.5	2.5	2.5	3	3	2.5	1.5	2.5
Average	3	2.62	1.5	2.5	2.37	2.5	2.5	3	3	2.5	1.5	2.5



MSc/Phy/4/SEC4-B–Physics Lab–VII (B) (Computational Physics-II)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

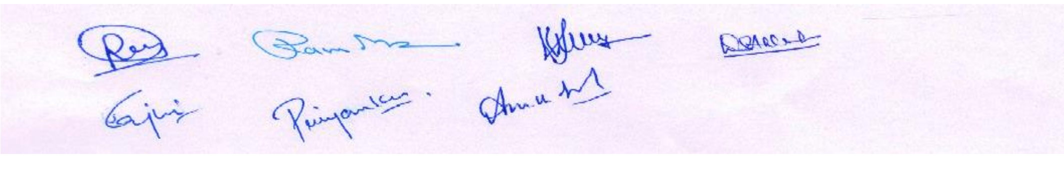
Note: Students have to perform ten programs in all.

Course Objective: In theoretical physics, one comes across very frequently with the physical models which are represented by various algebraic, differential and integral equations which can be simulated on the computer to get the better results by using FORTRAN and MATLAB etc. Further by learning the fundamental concepts involved in simulation techniques of simple physical phenomena like wave, optics, simple electronic circuits and quantum mechanics etc, one can get the flavour of simulation in Physics. After doing this the students will be empowered to understand the simulation of complex physical processes using computer.

Course Outcomes: After successful completion of the course on Computational Physics Lab-II, a student will be benefited as:
CO1: The course will equip the student with FORTRAN programming and will enable then to write FORTRAN programs to solve numerical computationally. The Students would be able to simulate the various physical problems and acquire a vision for use of computer in research prospective.
CO2: Students would be able to recognize the nature of a specific numerical problem and would develop the acumen for choosing an appropriate numerical technique to find its solution.
CO3: Students would develop understanding for programming concepts and would learn the Practical implementation of programming languages for carrying simulation of various physical problems in wave, optics, electronic circuits, quantum mechanics and others.
CO4: Students would gain the necessary basic knowledge of application of MATLAB for problem solving which is useful in research also.

Experiments:

1. Simulation of charging/ discharging of a capacitor.
2. To study the growth of current in LR/ LCR circuit.
3. To study the LR, and LCR circuit driven by sine function.
4. To study the motion of one-dimensional simple harmonic/anharmonic/damped harmonic oscillator.
5. To study the Monte-Carlo simulation of nuclear radioactivity
6. Simulation of the logistic equation $x_{n+1} = ax_n(1 - x_n)$ with the help of logistic map.
7. Program Monte -Carlo evaluation of integrals.
8. Program on random number generation by using mid square/ mixed multiplicative congruential method.
9. Program on Monte-Carlo simulation of Brownian motion.
10. Program to compute formation of wave packet.
11. Program on numerical solution of radial Schrodinger equation for Hydrogen atom using 4th order Runge-Kutta method
12. Program to compute interference pattern using Young's double slit experiment.
13. Program to compute diffraction pattern from single slit.
14. Program to compute polarization of light.
15. Programs on various numerical methods by MATLAB.

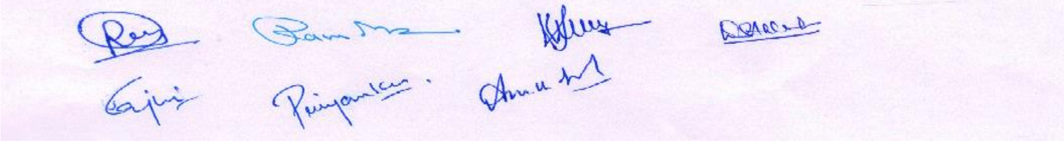


Text/Reference Books:

1. Jong, M L De (1991). Introduction to Computation Physics. Boston : Addison – Wesley
2. Alligood, K. T., Sauer, Tim D. & Yorke, J. A (1997) : Chaos an introduction to dynamical systems. New Delhi :Springer
3. Verma, R. C., Ahluwalia, P.K. & Sharma, K.C. (2014). Computational Physics an Introduction. New Delhi: New Age International Publisher.
4. Patil, P.B. & Verma, U.P. (2013). Numerical Computational Methods New Delhi: Narosa Publishing House
5. Singh, N. (2017). Computational methods For Physics & Mathematics. New Delhi: Narosa Publishing House
6. Pratap, R. (2010). Getting Started with MATLAB. New Delhi: Oxford University Press.
7. William, J. Palm III (2013). A concise introduction to MATLAB. New Delhi: McGraw Hill Education (India) Private Limited
8. Koonin, S. E. (1998). Computational Physics. Boston : Addison –Wesley
9. Mackewon, P.K. & Newman, D.J. (1987). Computational Techniques in Physics (Bristol, England :A. Hilger)
10. Alder, B., Rotengen M. & Fernbach S. (1964): Methods in Computational Physics. New York: Academic Press

Mapping matrix of COs, POs and PSOs MSc/Phy/4/SEC4-B–Physics Lab–VII (B) (Computational Physics-II)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	3	3	2	3	3	3	3
CO2	3	3	2	3	2	2	3	2	3	3	2	3
CO3	3	3	2	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	2	2	3	3
Average	3	2.75	2.5	3	2.25	2.75	3	2.5	2.75	2.75	2.75	3



MSc/Phy/4/DSC6-A–Physics Lab–VIII (A) (Materials Science-II)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

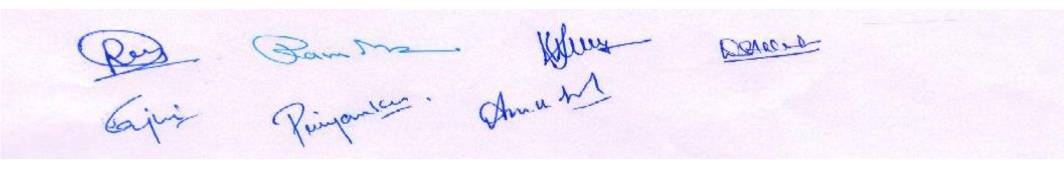
Objective: This course will provide by and large knowledge of various solid state devices/ effects and their properties.

Course Outcomes:
CO1: This course will equip the students with the practical knowledge of the devices and effects observed in solids.
CO2: Students will be able to understand how analogue to a system are designed to study a system.
CO3: Students will be able to better understand the properties of solids like heat capacity, refractive index, magnetic susceptibility etc.
CO4: Performing the experiments like photoelectric effects and black body radiation will help the students to understand the dual nature of matter.

Experiments:
1. To determine the Boltzmann's constant of a given sample using the Silicon diode.
2. To study of heat capacity of a given Sample
3. To determine the magnetic susceptibility using Quinck tube apparatus
4. To study the dispersion relation for monoatomic and diatomic lattices.
5. To determine the Curie temperature for a given Ferrite sample.
6. To determine the ionization potential of Argon with the help of Frank-Hertz tube.
7. To study the variation of magnetic field due to circular coil using Stewart and Gee's apparatus.
8. To determine the magneto-resistance of a semiconductor.
9. To determine the refractive index of a given liquid using Abbe's refractometer.
10. To understand the phenomenon Photoelectric effect as a whole.
    a. To draw kinetic energy of photoelectrons as a function of frequency of incident radiation.
    b. To determine the Planck's constant from kinetic energy versus frequency graph.
    c. To plot a graph connecting photocurrent and applied potential.
    d. To determine the stopping potential from the photocurrent versus applied potential graph.
11. To compare heat transfer between different material surface and the black body surface by radiation.
12. To find the emissivity of different material surface.
13. To study the phase change of a substance from liquid to solid by plotting the cooling curve.
14. To determine the melting point of the given substance and to find out the transition time.
15. To experimentally demonstrate the concept of Millikan's oil drop experiment. To find the terminal velocity of the drop. To find the charge on a drop.

Text/Reference Books:

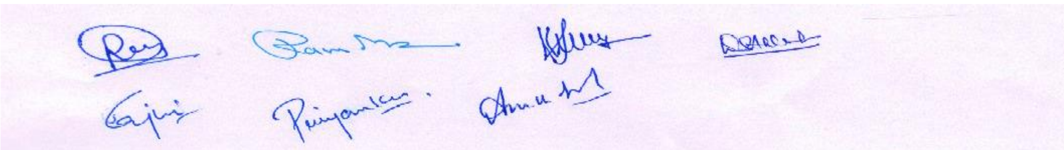
1. Pillai, S. O. (2020). Solid State Physics. New Delhi: New Age International Pvt. Ltd.
2. Beiser, A. (2017). Concept of Modern Physics. New Delhi: Mc Graw Hill Education.
3. Siegel, R., Menguc, M. P. & Howell, J. (2015). Thermal Radiation and heat transfer. Florida: CRC press.
4. Kraftmakher, Y. (2014). Experiments and Demonstrations in Physics. Oxford: Oxford University Press.
5. Kittel, C. (2012). Introduction to Solid State Physics. New Delhi: Wiley.
6. Ashcroft, N. W. & Mermin, N. D. (2003). Solid State Physics. Boston: Cengage.



7. Ibach, H. & Luth, H. (2009). Solid State Physics: An introduction to Principles of Materials Science. New York: Springer.
8. Omar, M. A. (2002). Elements of Solid State Physics. Noida (U.P.): Pearson Education India.
9. Wahab, M. A. (2015). Solid State Physics. New Delhi: Narosa.
10. Rajnikant, (2011). Applied Solid State Physics. New Delhi: Wiley.
11. Anderson, J. C., Leaver, K. D., Alexander, J. M. & Rawlings, R. D. (1990). Materials Science. New York: Springer.

Mapping matrix of COs, POs and PSOs MSc/Phy/4/DSC6-A–Physics Lab–VIII (A) (Materials Science-II)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	3	2	2	1
CO2	2	3	3	3	2	2	1	2	3	3	3	2
CO3	3	2	3	2	2	2	1	2	2	2	2	1
CO4	3	3	3	3	2	2	1	2	2	2	2	2
Average	2.5	2.25	2.75	2.5	2	2	1	1.75	2.5	2.25	2.25	1.5



MSc/Phy/4/DSC6-B–Physics Lab-VIII (B) (Advanced Electronics-II)

Credits: 4 (Practical) **Max. Marks: 100**
Teaching per week: 8 Hrs. **Duration of Exam.: 4 Hrs.**

Objectives: The course on Physics Lab. (Advanced Electronics-II) deals with characteristics of optoelectronics devices, analog to digital (A/D), digital to analog (D/A) converters, also this course will provide knowledge of applications of zener diode, transistors.

Course Outcomes: After completion of experimental work, students will be able

CO1: to acquire a vision for use of amplifiers and optoelectronics devices in daily life.

CO2: to exposed about the working and importance analog to digital (A/D) & digital to analog (D/A) converters in our daily life.

CO3: to understand the characteristics of zener diode and applications.

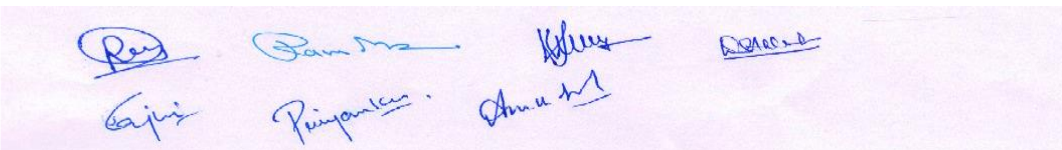
CO4: to design the various electronics circuits using different ICs.

Experiments:

1. To study the Class A and Class B Amplifiers.
2. To determine the response of silicon solar cell and the effect of prolonged irradiation and to calculate the efficiency and fill factors of a variety of solar cells.
3. To determine the value of forbidden energy gap of a diode and LED
4. To study the Polarizatton of light.
5. To study the characteristics of LED and Laser diode.
6. To Design and evaluation of a Laser diode digital IM system.
7. To learn the Laser free space communication.
8. To study various characteristics of pn junction:
   a) Reverse saturation current and material constant.
   b) To determine the temperature coefficient of junction and energy band gap.
9. To study the analog to digital (A/D) & digital to analog (D/A) converters.
10. To study the Wein bridge oscillator.
11. To study the square wave generator.
12. To determine the Planck's constant using Photocell.
13. To study the different optoelectronic devices.
14. To study the regulated power supply using (a) zener diode only (b) Zener diode with series transistor (c) Zener diode with shunt transistor.
15. To study the triangular wave generator.

Text/References Books:

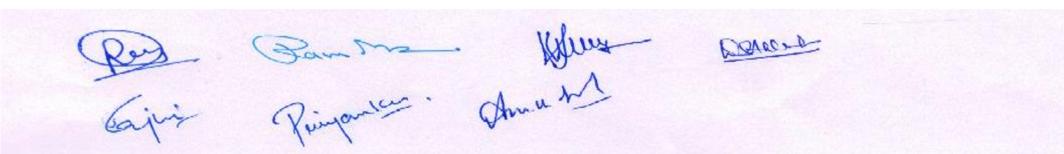
1. Jafer, D. (2005) Fiber Optics Communication and Technology. US: Pearson Pub.
2. Millman, J. & Halkias, C. C. (2017). Integrated Electronics. India: Mc Graw Hill Edu.
3. Senior, J.M. (2010) Optical Fiber Communication- Principle and Practicals. India: Pearson Edu.
4. Sze, S.M. (2021) Physics of Semiconductors. New York: Wiley Interscience Pub.
5. Kothari, D.P. (2017) Basic Electronics. India: Mc Graw Hill Edu.
6. Millman, J. & Grabel (2017) Microelectronics. India: Mc Graw Hill Edu.
7. Ryder, J.D. (2016) Electronics Fundamental & Applications. India: Prentice-Hall.
8. Jain, R.P. (2009) Modern Digital Electronics. India: Mc Graw Hill Edu.
9. Keisser, G. (2017) Optical Fiber Communication: Mc Graw Hill Edu.
10. Ghatak, A. & Tyagrajan, K. (2017) Introduction to Fiber Optics. India: Cambridge University press.



11. Parker, M.A. (2005) Physics of Optoelectronics. Florida: CRC Press.
12. Maini, A.K. (2007)Digital Electronics: Principles, Devices and Applications .New York: Wiley Pub.
13. Saggio, G.(2014)Principal of Analog Electronics. Florida: CRC Press
14. Sukhija, M.S. & Nagsarkar, T.K. (2016) Circuits and Networks. Oxford: Oxford University Press.

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/DSC6-B–Physics Lab-VIII (B) (Advanced Electronics-II)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	2	2	2	2	2	2	3	2	3
CO2	2	2	2	2	2	2	2	2	2	3	2	3
CO3	2	2	2	2	2	2	2	2	2	3	2	3
CO4	3	2	2	2	2	2	2	1	2	3	2	3
Average	2.5	2	2	2	2	2	2	1.75	2	3	2	3



MSc/Phy/4/CC14– Seminar

Credits: 1 **Max. Marks: 25**

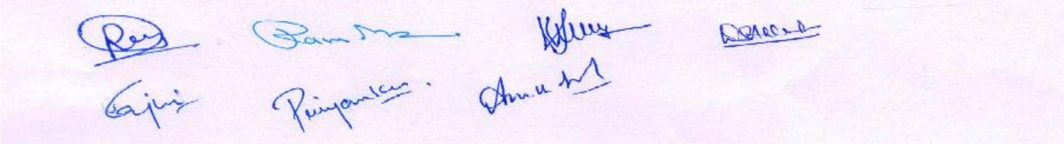
Objective: To improve oral and written communication skills. Exploring creative avenues of expression. Removing hesitation of speaking on a topic before audience. Development of critical thinking and confidence level.

Course Outcome:

CO1: Students would be able to create, revise and present ideas in spoken and written forms. Acquired listening, questioning and critical thinking skills. Demonstrate ability to defend and support ideas/claims with appropriate evidence. Students gained experience for how to organize and deliver/disseminate knowledge before audience.

Mapping matrix of COs, POs and PSOs of MSc/Phy/4/CC14– Seminar

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2.5	3	2.5	2	2.5	2.5	2.5	3	2.5	3	2.5
Average	3	2.5	3	2.5	2	2.5	2.5	2.5	3	2.5	3	2.5



MSc/Phy/9/OEC1–Environmental Physics

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objective: To enhance the understanding of energy and its types, thermal aspects of energy generation and radioactivity in detail. This course will provide knowledge about nuclear reactors.

Course outcomes:
CO1: Structure and thermodynamics of the atmosphere develop a keen interest in weather formation and its change (or science behind the nature).
CO2: Students get aware of climate change issues.
CO3: Gain a basic knowledge of energy transformations and heat engines.
OC4: Understand how electricity can be generated from nuclear reactions. Become aware of biological effects of nuclear radiations.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Structure and thermodynamics of the atmosphere; Troposhere, Stratosphere, Mesophere, Ionoshpere, Exosphere; Temperature, pressure and density variations with height; Composition of air.

Unit-II

Radiation, radiant energy; Solar and Terrestrial radiation; Rayleigh and Mie scattering; Ultraviolet (UV) radiation, Infrared (IR) radiation, Ozone depletion problem; Green House Effect, Global warming.

Unit-III

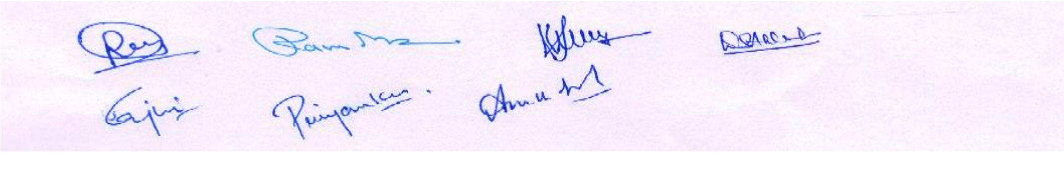
Concept of heat, energy and work, Energy transformation, Thermodynamic state of a system, Laws of thermodynamics, Isothermal and adiabatic processes; Carnot cycle, Heat pump and refrigerator; Entropy and disorder.

Unit-IV

Radioactivity; Characteristics of radioactive radiations; Radioisotopes and application; Units of radiation dose, Biological effects of nuclear radiation and safety measure; Age of earth-radioactive dating; Nuclear energy, Nuclear reactor.

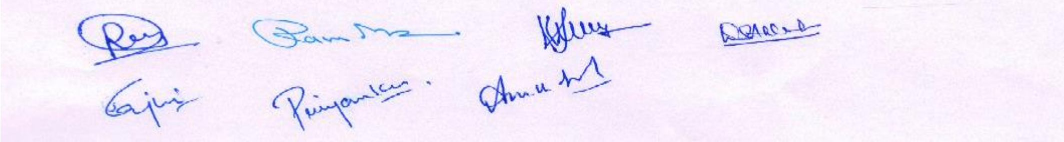
Text/Reference Books:

1. Lutgens, F. K., & Tarbuck, E. J. (2018). The atmosphere: An Introduction to Meteorology. London: Pearson.
2. Salby, M.L. (1996). Fundamentals of Atmospheric Physics. Cambridge: Academic Press.
3. Santra, S. C. (2011). Environmental Science. New Delhi: New Central Book Agency.
4. Boeker, E., & Groundelle R. V. (2011). Environmental Physics. New Jersey: John Wiley.
5. Manna, A. (2011). Heat and Thermodynamics. Noida: Pearson Education India.
6. Ghoshal, S. N. (1994). Nuclear Physics. New Delhi: Sultan Chand & Sons.



Mapping matrix of COs, POs and PSOs MSc/Phy/9/OEC1–Environmental Physics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	3	2	3	3	2	3	3
CO2	2	2	2	1	3	2	3	2	2	2	2	3
CO3	3	2	2	2	2	2	3	2	3	2	3	2
CO4	2	2	3	1	3	3	2	3	3	2	3	3
Average	2.5	2	2.5	1.5	2.75	2.5	2.5	2.5	2.75	2	2.75	2.75



MSc/Phy/9/OEC2– Physics in Everyday Life

Credits: 4 | **Max. Marks: 100**
Lectures: 60 | **Final Term Exam.: 70**
Duration of Exam.: 3 Hrs. | **Internal Assessment: 30**

Objectives: This course intends to provide knowledge of physics behind every day phenomena. In addition, it will also enhance knowledge on solar energy.

Course outcomes: After successful completion of the course, the students will be able to:
CO1: Will learn about the role of science in human body.
CO2: Get aware of renewable sources of energy.
CO3: Knowledge about laser applications gets enhanced.
CO4 Understand how physics is used in sports.

Note for the Paper Setter: *The question paper will consists of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit-I

Human Body: The eyes as an optical instrument, Vision defects; Rayleigh criterion and resolving power of an eye; Sound waves and hearing, Sound intensity, Decibel scale, Physics of the Cardiovascular system (The Cardiac Cycle).

Unit-II

Energy: Solar energy; solar cells, its types and applications; Wind energy, Hydroelectric energy, Ocean energy, Geothermal energy, Biomass energy.

Unit-III

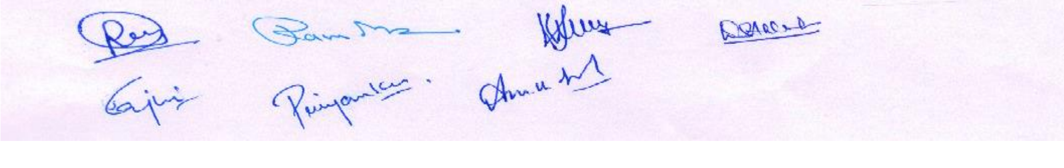
Lasers: Laser (characteristics and working) and types of lasers (He-Ne, semiconductor, Nd:YAG), Industry applications (cutting, drilling, welding and material processing), Medical applications.

Unit-IV

Sports and Technology: The sweet spot, Dynamics of rotating objects, Running, Jumping and pole vaulting, Motion of a spinning ball; Global Positioning System, Satellite Communication, Weather forecasting, Magnetic Resonance Imaging (MRI).

Text/Reference Books:

1. Spathopoulos, V. M. (2013). An Introduction to the Physics of sports. California: Createspace Independent Publication.
2. Singh, P., & Wani, T. A. (2011). Basic Environmental Physics. Meerut: Pragati Prakashan.
3. Santra, S. C. (2011). Environmental Science. New Delhi: New Central Book Agency.
4. Boeker, E., & Groundelle R. V. (2011). Environmental Physics. New Jersey: John Wiley.
5. Silfvast, W. T. (2008). Laser fundamentals. Cambridge: Cambridge University Press.
6. Herman, I. P. (1994). Physics of the Human Body. New York: Springer.



Mapping matrix of COs, POs and PSOs of MSc/Phy/9/OEC2– Physics in Everyday Life

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	3	2	2	3	2
CO2	2	2	3	1	3	3	3	2	2	2	3	2
CO3	2	2	2	1	3	2	3	3	3	2	2	2
CO4	3	2	3	2	2	3	3	2	2	2	3	2
Average	2.5	2	2.5	1.5	2.5	2.5	2.75	2.5	2.25	2	2.75	2