Dolphin (PG) Institute of Biomedical & Natural Sciences
Dehradun, Uflarakhand-248007

(An Autonomous Institute)

NAAC Accredited A+ (2nd cycle)

(Affiliated with H.N.B. Garhwal University, Srinagar, Srinagar Garhwal)

Ordinance & Syllabus

of

M.Sc. PHYSICS

Two Year (4 Semester Programme)

Based upon NEP-2020 and Curriculum frame work for
Post Graduate Programme-2024

Effective from

Academic Session

2024-2025

Department of Physics

Approved by BOS- 2/08/2024
Approved by Academic council- 5/08/2024

Acknowledgement

At the outset, I would like to thank our, Principal Prof. Shailja Pant for her guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all my colleagues in the Department of Physics for the long and arduous work they have put in during the compiling of the restructured syllabus.

Dr. Aasheesh Raturi

(Chairperson, Board of Studies in Physics)

Board of Studies in Physics

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Aasheesh Raturi	Chairperson	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
All Faculty Members of the Department			
1	Dr. Abhilasha	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
2	Dr. Jagdish Prasad Purohit	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
3	Mr. Vipul Garg	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
Subject Expert nominated by Vice-Chancellor			
1	Prof. Hemwati Nandan	Nominated Member	Department of Physics, HNB Garhwal University, Srinagar Garhwal
Subject experts			
1	Prof. Sumita Shrivastava	Nominated Member	Principal, Government PG College, Nainbag, Tehri Garhwal
2	Dr. Prashant Rawat	Nominated Member	Department of Physics, UPES, Dehradun
Representative from Industry/corporate sectors			
1	Dr. G.S. Rautela	Nominated Member	Science city Advisor, (UCOST) Government of Uttarakhand
	Alumnus		
1	Mr. Shantunu Ashima Gaur	Nominated Member	Teaching fellow and Resource person, Teach for India, New Delhi

Vision, Mission and Core Values of the Institute

Vision

Lead the youth on a journey of knowledge and innovation, along with cultivating a sense of responsibility, perseverance, integrity and fellowship to fortify society on a global scale.

Mission

1. Steadfastly delivering holistic and ethical development of students with education.
2. Focusing on learning inside the classroom, and beyond, by nurturing qualities of leadership, teamwork, self-agency and ingenuity in all the lives we touch.

Core Values

With encouragement and enthusiasm in each tireless, dedicated step into a future that embodies the institute's novel motto of "**Honours Beyond Education**".

Vision and Mission of the Department

Our vision is to foster an innovative and collaborative environment within the department that advances educational physics. We aim to achieve the same through active participation in curriculum development ad applying innovative methods in teaching & learning process of physics education, as well as promoting lifelong learning approach.

Our mission is to accelerate scientific knowledge within society by promoting scientific literacy and addressing the scientific needs of the community. We are dedicated to prepare our students to achieve a high degree of proficiency in their fields while also fostering their development as responsible and compassionate individuals.

About the Subject

Physics is the natural science that studies the matter, its motion and behavior through space and time, and the related entities of energy and force. Physics is one of the most fundamental scientific disciplines and its main goal is to understand the behaviour of universe and its characteristics. Physics uses the scientific method to help uncover the basic principles governing light and matter, and to discover the implications of those laws. It assumes that there are rules by which the universe functions, and that those laws can be at least partially understood by humans. It is also commonly believed that those laws could be used to predict everything about the universe's future if complete information was available about the present state of all light and matter. On inclusion of Astronomy and astro physics, the Physics became one of the oldest academic disciplines. Physicists find inspiration not just within the confines of physics but also from a wide array of other areas of human exploration and reflection. Keeping all these things in mind the Post Graduate physics program has been designed to allow students to develop logical thinking, reasoning, intellectual thinking and providing most exciting and rewarding jobs in the future.

About the Programme (Nature, extent and aims)

M.Sc. Physics is a two-year regular programme. There are four semesters in this programme. Each semester is of fifteen weeks duration. Teaching and learning process of M.Sc. Physics involves theory and practical classes along with seminar presentation and research project work. The curriculum will be taught through formal lectures with the aid of power-point presentations, audio and video tools and other teaching aids can be used as and when required. Emphasis will be given to laboratory work and visit to National laboratories to give hands on experience to students. Students will encourage to do semester long project in their own institutes as well as in reputed institutes of National level.

Aims of the Programme are as follows

1. Understand the underlying Physics in respective specializations, and, be able to teach and guide successfully

2. Introduce advanced ideas and techniques that are applicable in respective fields.

3. Provide the students with a broad spectrum of Physics Courses

4. Emphasize the role of Physics in other disciplines such as (Chemical Sciences, Mathematical Sciences, Life Sciences and their applied areas)

5. Develop the ability of the students to observe, perform, analyse and report an experiment

6. Develop the ability of the students to deal with physical models and formulas mathematically

7. Equip the students with different practical, intellectual and transferable skills.

8. Strengthen the student knowledge of Physics and its applications in real world.

9. Provide the student with mathematical and computational tools and models to be used in solving professional problems

10. Improve the student's inter disciplinary skills.

11. To develop human resources with a solid foundation in theoretical and experimental aspects of respective specializations as a preparation for career in academia and industry.

Possible career pathways

Upon successful completion of the course, the students receive M.Sc. Degree in the Physics. The postgraduate of Department of Physics is expected to opt different paths seeking sphere of knowledge and domain of professional work that can fulfil their dreams. Students will be able to demonstrate their knowledge in advance branches of Physics. This will establish a platform over which students can pursue higher studies.

The possible career paths for postgraduate in M.Sc. Physics are

1. Teaching Assignments
2. Scientific Assignments
3. Instruments development
4. Research and Development in Industries
5. Simulation Techniques Development in Science
6. Role in Renewable Energy Resources
7. University/Institute Administrative Assignments
8. Technician in Lasers, Accelerators, Detectors and Electronics
9. Astronomer
10. Medical Device Designer
11. Radiologist

PROGRAMME OUTCOMES

PO-1: **Complex problem-solving:** Physics Post graduates will have the ability to apply their knowledge of physics to analyse and resolve problems in various settings, using appropriate mathematical tools, experimental methods, and computational techniques

PO-2: ***Critical thinking:*** Physics Post graduates will be able to analyze and evaluate information, identify and define problems, develop and implement solutions, and make evidence-based decisions

PO-3: ***Creativity***: Physics Post graduates will able to design solutions and circuits for complex scientific problems and execute them by considering the environmental, societal and public safety aspects appropriately

PO-4: ***Communication Skills:*** Physics Post graduates will demonstrate written and oral communication skills in communicating physics-related topics and the ability to write dissertations, reports, make effective presentations and documentation.

PO-5: ***Analytical reasoning/thinking*** Physics Post graduates will have the ability to Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools.

PO-6: ***Research-related skills***: Physics Post graduates graduates will get academic exposure through the various Internships offered by reputed National Research Institutes during their PG tenure. They will be able to utilize the fourth semester through their involvement in dissertation and research work under careful guidance of reputed faculties and may get the flavor of the current trend of research.

PO-7: ***Coordinating/collaborating with others***: Physics Post graduates will be able to collaborate effectively with others, including peers, colleagues, and interdisciplinary teams, to achieve common goals.

PO-8: ***Leadership readiness/qualities:*** Physics Post graduates will have an ability to develop the quality of leadership which will help them to be a part of any organization as well as create a positive energy in their work field to achieve any assigned target.

PO-9: ***Learning how to learn skills:*** Physics Post graduates will have a curiosity-driven and self-directed approach to learning, as well as the ability to ask insightful questions and explore new areas of knowledge

PO-10: ***Digital and technological skills*** Physics Post graduates will should be able to demonstrate the capability to use ICT in a variety of learning and work situations and can access the relevant information sources, and use appropriate computational software for analysis of data.

PO-11: ***Multicultural competence and inclusive spirit:*** Physics Post Graduates will have acquisition of knowledge of the values and beliefs of multiple cultures and a global perspective to honour diversity

PO-12: ***Value inculcation:*** Physics Post graduates will be aware of the global and national issues related to science and technology, as well as their roles and responsibilities as Indian and global citizens as well.

PO-13: Autonomy, responsibility, and accountability: Physics post graduates will able to apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification and can work independently, and identify appropriate resources required for a task

PO-14: ***Environmental awareness and action:*** Physics graduates should have a strong ethical and environmental awareness and the ability to analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.

PO-15: ***Community engagement and service:*** The Physics Post graduates should be able to demonstrate the capability to participate in community-engaged services and activities for promoting the well-being of society through the scientific approach.

PO-16: ***Empathy:*** The Physics Post graduates will be able to demonstrate the ability to give regard to points of view of another individual or group, and to identify and understand other people's emotions.

PROGRAMME SPECIFIC OUTCOMES (PSO)

The students shall be able to realize the following specific outcomes by the end of program:

PSO-1Academic competence:

(i) Develop and demonstrate an understanding of the concepts related to Classical mechanics, Mathematical Physics, Atomic and Molecular Physics, Electrodynamics, Advance quantum mechanics, Condensed matter Physics, Solid State Physics, Statistical Mechanics, astronomy and astrophysics. Associate the fundamental concepts in physics and interpret information.

(ii) Demonstrate independent thinking and scientific temper. Categorize, calculate and solve problems using concepts of physics

PSO-2. Personal and Professional Competence:

(i) Carry out laboratory-oriented numerical calculations and be capable in data visualization and interpretation. Perform, demonstrate and analyse experimental work with suitable techniques in physics to study the classical phenomenon of nature, scientific instruments, material process, electrical and electronics applications in the industry.

(ii) Carry out the calculations in classical mechanics, quantum mechanics mathematical methods and solids with advance techniques using computations and analyze experimental results and interpret graphs. Formulation of ideas, scientific writing and authentic reporting, effective presentation and communication skills through group discussion.

PSO-3. Research Competence:

(i) Apply the concept of physics to understand the dynamics of natural phenomenon and Integrate core concepts studied in materials science, electronics, and quantum mechanics and astronomy experimentations and projects.

(ii) Integrate and explore techniques of synthesis, characterization of different materials and techniques of astronomical data analysis. Cultivate concepts of measurement techniques in physics and relate physics concepts in day-to-day life. Identify and interpret research literature, formulate ideas, write reports and review articles related to all subjects in physics.

PSO-4. Entrepreneurial and Social competence:

Enhance and empower the students with their self-reliance capabilities through the understanding of advance techniques, use of programming language, material processing, mathematical and classical concepts, advancement of electronics ideas with reference to advance techniques with their industrial applications.

(i) Employ experimental skills in industrial applications and execute social competence including effective use of physics-based knowledge to meet global competencies in technological world

(ii) Develop scientific temperament and social awareness through internships and science popularization. Awareness of ethical issues: emphasis on academic and research ethics.

Structure of PG programme

Minimum credits requirement = 80 Cr

2-Year Master of Science (M.Sc.) with Coursework & Research in 2nd year(3rd and 4th Semesters) and only Course work in 2nd Year (3rd and 4th Semesters)						
Semester	**Courses**	**Course Code**	**Theory**		**Practical**	
			H	**Cr**	***H***	***Cr***
Sem I	Classical Mechanics	**PHYS/CC/101**	4	4	0	0
	Mathematical Physics	**PHYS/CC/102**	4	4	0	0
	Electrodynamics & Astrophysics	**PHYS/CC/103**	4	4	0	0
	Electronics	**PHYS/CC/104**	4	4	0	0
	Laboratory Course-I	**PHYS/CC/105**	0	0	4	2
	Laboratory Course-II	**PHYS/CC/106**	0	0	4	2
Total Credits= 20						
Sem II	Atomic and Molecular Physics	**PHYS/CC/107**	4	4	0	0
	Solid State Physics	**PHYS/CC/108**	4	4	0	0
	Statistical Mechanics	**PHYS/CC/109**	4	4	0	0
	Quantum Mechanics-I	**PHYS/CC/110**	4	4	0	0
	Laboratory Course-I	**PHYS/CC/111**	0	0	4	2
	Laboratory Course-II	**PHYS/CC/112**	0	0	4	2
	Skill development course from the DIBNS pool or Course from NPTEL/SWAYM		Audit Course			
	Total Credits= 20					
Sem III	Quantum Mechanics-II	**PHYS/CC/201**	4	4	0	0
	Nuclear Physics	**PHYS/CC/202**	4	4	0	0
	Computational Physics	**PHYS/CC/203**	4	4	0	0
	Laboratory Course -I	**PHYS/CC/204**	0	0	4	2
	Seminar/ Presentation	**PHYS/CC/205**	0	0	4	2
	Discipline Centric Elective Courses (Choose any one)					
	Electronics-I	**PHYS/DCEC/201**	4	4	0	0
	Condensed Matter Physics-I	**PHYS/DCEC/202**	4	4	0	0
	Laser Physics-I	**PHYS/DCEC/203**	4	4	0	0
	Astronomy and Astrophysics-I	**PHYS/DCEC/204**	4	4	0	0
	Course from NPTEL/SWAYM		Audit Course			

Total Credits= 20						
Sem IV	Research Project/Dissertation	**PHYS/PROJ/200**				20
	Total Credits= 20					
	For only Course work students					
	Particle Physics	**PHYS/CC/206**	4	4	0	0
	Physics of Nanomaterials	**PHYS/CC/207**	4	4	0	0
	General Theory of Relativity	**PHYS/CC/208**	4	4	0	0
	Laboratory Course -I	**PHYS/CC/209**	0	0	4	2
	Seminar/ Presentation	**PHYS/CC/210**	0	0	4	2
Discipline Centric Elective Courses (Choose any one)						
Sem IV	Electronics-II	**PHYS/DCEC/205**	4	4	0	0
	Condensed Matter Physics-II	**PHYS/DCEC/206**	4	4	0	0
	Laser Physics-II	**PHYS/DCEC/207**	4	4	0	0
	Astronomy and Astrophysics-II	**PHYS/DCEC/208**	4	4	0	0
Total Credits =20						

Note:

The Department may offer more than one discipline centric elective courses (DCECs) depending on specialization and strength of faculty members, and the number of students have to opt one of them for semester III. If class strength is less than 10, then that particular subject will not be offered.

In semester IV, the students have to opt one discipline centric elective core-based course from options offered by the Department depending on the specialization and strength of the faculty.

OR

Student may opt for full semester long dissertation work on the campus or outside the campus in some Laboratories/Institutes/Universities of National Importance.

For carrying out the dissertation work outside the campus, student will have to produce an invitation/acceptance letter from external supervisor by the end of Semester III.

Student may complete the dissertation project under the guidance of a supervisor on Dolphin Institute campus.

Student who will pursue the project outside Dolphin Institute will have one internal supervisor and one external supervisor.

Internal supervisor will periodically interact with student and external supervisor. He/She will be responsible for internal assessment of the candidate from time to time. Student will be allowed to work with external supervisor at other outside institutions only after completing all the documentation process at Dolphin Institute. Students have to follow the timeline strictly issued by Department from time to time.

Department will have no financial obligation if student carries out the dissertation work outside Dolphin Institute.

The **Audit courses are the compulsory courses and** aim to enhance the overall educational experience of PG students at the Dolphin Institute. By providing the option to take online courses, the department encourages students to explore additional learning opportunities outside the regular curriculum.

MOOCS/SWAYAM/NPTEL

SWAYAM (Study Webs of Active learning for Young Aspiring Minds) is an online portal to provide best teaching-learning experience. SWAYAM is an initiative of Govt of India to promote access for open-learning. Any Students can register to this portal for online courses. SWAYAM is an instrument for a self-actualization providing opportunities for life-long learning. Dolphin PG Institute has taken a step forward towards establishing an SWAYAM- NPTEL local Chapter under the National Programme on Technology Enhanced Learning (NPTEL). The primary aim of this Chapter is to facilitate our students in acquiring knowledge through enriched NPTEL video lectures and obtaining NPTEL certificates for the courses they undertake. This initiative also aims to enhance our students' employability in the industry or prepare them for further higher education in various fields. Dr. Aasheesh Raturi, faculty member of the Physics department, has been appointed as the Single Point of Contact (SPOC) for the NPTEL DIBNS Local Chapter and officially recognized by IITM. The responsibilities of the SPOC is to identify mentors from different departments who will encourage students to enrol in relevant NPTEL courses, oversee their progress on a weekly basis, motivate them to complete assignments, register for NPTEL exams, and guide them towards successfully completing the NPTEL courses.

For more details: hflps://onlinecourses.nptel.ac.in/

Detailed Syllabus for Semesters I & II

Course Name	CLASSICAL MECHANICS	L	T	P	C
Course Code	PHYS/CC/101	3	1	0	4

Course Objectives

This course aims to develop the idea of theoretical understanding of motion of a group of particles involving a wide range of length and energy scales. And to develop an understanding of Lagrangian and Hamiltonian formulation which allow for simplified treatments of many complex problems in classical mechanics and provides the foundation for the modern understanding of dynamics. By the end, students will be able to analyze and apply classical mechanics principles to various physical systems.

Course Outcomes

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

CO1 Students will apply the Lagrangian formulation to analyze particle mechanics, handle constraints, solve Euler-Lagrange equations, and address conservation laws.

CO2 Students will apply Hamilton's equations of motion to analyze physical systems, derive Hamiltonian formulations, and solve relativistic and practical problems.

CO3 Students will perform canonical transformations, apply Poisson and Lagrange brackets, utilize Hamilton-Jacobi theory, solve the Hamilton-Jacobi equation, and analyze action-angle variables.

CO4 Students will analyse and solve rigid body motion problems using orthogonal transformations, Euler's angles, inertia tensor, Euler equations, and dynamics of torque-free motion.

CO5 Students will analyse small oscillations by solving eigenvalue equations, understanding free vibrations and normal coordinates, and applying these concepts to systems like triatomic molecules.

Course Contents

Unit I : Lagrangian Formulation and Central Force Problem 16Hr.

Mechanics of one and many particle systems, Virtual work, Constraints: holonomic and non-holonomic, D'Alembert's Principle and Euler-Lagrange Equations of motion, velocity dependent potentials, simple applications of Lagrangian formulation. Hamilton's Principle, Calculus of Variations, Derivation of Lagrange's equation from Hamilton's principle. Conservation theorems and Symmetry Properties, Noether's theorem.

Unit II: Hamilton's Equations of Motion: 10Hr.

Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, simple applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Hamiltonian Formulation of Relativistic Mechanics, Derivation of Hamilton's canonical equation from Hamilton's variational principle.

Unit III Canonical Transformation and Hamilton-Jacobi Theory: 12 Hr.

Canonical transformation, integral invariant of Poincare, Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson bracket formulation. Infinitesimal contact transformation and generators of symmetry, Liouville's theorem. Hamilton-Jacobi equation and its application. Action angle variable: adiabatic invariance of action variable, the Kepler problemin action angle variables

Unit IV Rigid Body Motion: 12 Hr.

Independent co-ordinates of rigid body, Orthogonal transformation, Euler's Angles and Euler's theorems, Infinitesimal rotation, Rate of change of vector, Coriolis force, Angular momentum and kinetic energy of a rigid body, The inertia tensor, Principal axis transformation, Euler equations of motion, Torque free motion of rigid body, Motion of a symmetrical top.

Unit V Small Oscillations: 10 Hr.

Eigenvalue equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule. Hamilton's Equations: Legendre Transformations, Hamilton's equations of motion, Cyclic-co- ordinates, Hamilton's equations from variational principle.

Unit No	Reference Material
1	***Suggested Readings:*** 1. N C Rama and P S Joag: Classical Mechanics (Tata Mc Graw Hil, 1991) 2. H Goldstein: Classical Mechanics (Addition Wesley, 1980) 3. Classical Mechanics,David J.Morins 4. Classical Mechanics ,J.C. Upadhyaya(Himalaya Publishing House) **Suggested Digital Platforms/Web Links** 1. https://swayam.gov.in/explorer?category=Physics 2. https://archive.nptel.ac.in/courses/115/106/115106123/
2	***Suggested Readings:*** 1. V.D. Bargerand M.G. Olsson, Classical Mechanics, McGraw-Hill, New York,(1973). 2. N.C. Rana and P.J .Joag, Classical Mechanics, Tata McGraw Hill, New Delhi(2004) 3. H. Goldstein, Classical Mechanics, Narosa, New Delhi (1992) **Suggested Digital Platforms/Web Links** 1. https://swayam.gov.in/explorer?category=Physics 2. https://archive.nptel.ac.in/courses/115/106/115106123/
3	***Suggested Readings:*** 1. V. B. Bhatia, Classical Mechanics Classical Mechanics: With Introduction to Nonlinear Oscillations and Chaos, Narosa Pub. House, New Delhi (2001). 2. J. C. Upadhyay, Classical Mechanics, Himalaya Publishing House, Mumbai (2016). 3. G. Aruldhas, Classical Mechanics, 8th Ed., PHI Learning Private Limited, New Delhi (2017) **Suggested Digital Platforms/Web Links:** 1. https://youtu.be/pt28ZeliXhI 2. https://youtu.be/52r6EJJ29a
4	***Suggested Readings:*** 1. G. Aruldhas, Classical Mechanics, 8th Ed., PHI Learning Private Limited, New Delhi (2017) 2. N.C. Rana and P.J .Joag, Classical Mechanics, Tata McGraw Hill, New Delhi(2004) 3. H. Goldstein, Classical Mechanics, Narosa, New Delhi (1992) **Suggested Digital Platforms/Web Links** *1. https://www.youtube.com/watch?v=nGfVTNfNwnk&list=PLOSWwFV98rfKXq2KBphJz95rao7q8PpwT* *2. https://www.youtube.com/watch?v=rk0rp2Jpidc&list=PLyqSpQzTE6M_d9f-9fKxUQYR1qI5YEnSz*
5	***Suggested Readings:*** 1. V. B. Bhatia, Classical Mechanics Classical Mechanics: With Introduction to Nonlinear Oscillations and Chaos, Narosa Pub. House, New Delhi (2001). 2. J. C. Upadhyay, Classical Mechanics, Himalaya Publishing House, Mumbai (2016).

	3. N.C. Rana and P.J .Joag, Classical Mechanics, Tata McGraw Hill, New Delhi(2004) **Suggested Digital Platforms/Web Links** 1. *https://www.youtube.com/watch?v=rk0rp2Jpidc&list=PLyqSpQzTE6M_d9f-9fKxUQYR1qI5YEnSz* 2. *https://www.youtube.com/watch?v=HzcJIgsjQrQ*

Modes of Evaluation:

Components	Lab	Theory	
	Continuous Evaluation	IA (internal assessment)	End Semester
Weight%	-----	40	60

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Course Name	MATHEMATICAL PHYSICS	L	T	P	C
Course Code	PHYS/CC/102	3	1	0	4

Course Objectives

Equip students with a comprehensive understanding of mathematical tools and techniques essential for solving problems in physics, including differential equations, transforms, group theory, and tensor analysis, and apply these methods to model and analyze physical phenomena across various domains of science and engineering.

Course Outcomes

On completion of this course, the students will be able to

CO1- Students will be able to solve and apply special differential equations, such as Legendre, Hermite, Laguerre, and Bessel equations, and effectively use Beta and Gamma functions to model and analyze problems in mathematical physics and engineering

CO2- Students will be able to apply Laplace and Fourier transforms to solve differential equations, analyze and process signals, and understand the properties and applications of Fourier series, Fourier integrals, and transform techniques for practical engineering and scientific problem.

CO3-Students will be adept at applying group theory concepts to analyze and classify groups, subgroups, and their properties, as well as to utilize representation theory, including reducible and irreducible representations, Schur's Lemmas, orthogonality theorem, and characters, to solve problems in abstract algebra and applied fields

CO4- Students will be able to analyze and solve complex-variable problems by applying concepts such as analytic functions, Cauchy's integral theorem and formula, Taylor and Laurent series, residue theory, and contour integration to evaluate complex integrals and understand the behavior of complex functions.".

CO5- Students will be proficient in matrix and tensor operations, including calculating the inverse and trace of matrices, understanding unitary and orthogonal matrices, finding eigenvalues and eigenvectors, performing matrix diagonalization, and applying concepts of coordinate transformation and tensor operations such as addition, multiplication, and contraction, to solve problems in linear algebra and multidimensional systems."

Course Contents

Unit I Differential Equations: 10 Hr.

Special equations of Mathematical Physics, Legendre and Associated Legendre equations. Hermite equation, Lagueree equation, Bessel's equation. Beta and Gamma functions.

Unit II Fourier and Laplace Transform 8 Hr.

Laplace Transforms - Properties of Laplace transform, differential equation method of finding Laplace transform, Inverse Laplace transform. Fourier Transforms – Fourier Series, properties of Fourier Series, Fourier integral, Fourier transform of derivatives, Applications of Fourier transform.

Unit III Group Theory: 15 Hr.

Definition, Classification of groups, subgroup, cyclic group, isomorphism and homomorphism, classes, vector spaces, representation theory of finite groups, Reducible and Ir-reducible representations, Schur's Lemmas and orthogonality theorem, Characters of representations.

Unit IV Complex Variable: 12 Hr.

Function of complex variable, Analytic functions, Cauchy's integral theorem and Cauchy's integral formula, Taylor and Laurent's expressions, theorem of residues, Contour integration.

Unit V Matrix and Tensors: 15 Hr.

Inverse and Trace of Matrix, Unitary Matrices, Orthogonality, Eigen values-Eigen vectors and Diagonalisation of matrices, Coordinate transformation, Covariant and contravariant Tensors, addition, multiplication and contrition of tensors, Associated tensors.

Units No	*Reference Material*
1	***Suggested Readings*** 1. G Arfken: Mathematical Methods for Physicist (Academic Press) 2. Pipes and Harvil: Mathematical Methods for Engineers and Physicist 3. C Harper: Introduction to Mathematical Physics (Prentice Hall of India) 4. A W Joshi: Element of Group Theory for Physicists (Wiley Eastern) 5. Mathematical Physics, B.S.Rajput ,Pragati Prakashan. ***Suggested Digital Platforms/Web Links*** 1. *https://www.youtube.com/watch?v=f5WNaV4nwiQ&list=PLyqSpQzTE6M-w1m48vyVvnoU7siWv14XX*
2	***Suggested Readings*** 1. Mathematical Physics, H.K.Dass,Dr.Rama Verma,S.Chand Company Pvt.Ltd. 2. Mathematical Physics, B.S.Rajput ,Pragati Prakashan 3. Satya Prakash, Mathematical Physics, 6th Ed., Sultan Chand & Sons. 4. B. S. Rajput, Mathematical Physics, 28th Ed., Pragati Prakashan. ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/watch?v=f5WNaV4nwiQ&list=PLyqSpQzTE6M-w1m48vyVvnoU7siWv14XX 2. *https://www.youtube.com/watch?v=mhHdA9vsjSo*
3	***Suggested Readings*** 1. Text Book Algebra, A.R.Vasishtha,Rakesh Dangwal,Vipin Kumar Ravi (Krishna Prakashan Ltd.) 2. Mathematical Physics (17th Edition), B.S.Rajput, Pragati Prakashan, Meerut. 3. Mathematical Physics, H.K. Das, S.Chand Publications ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/watch?v=f5WNaV4nwiQ&list=PLyqSpQzTE6M-w1m48vyVvnoU7siWv14XX 2. https://www.edx.org/course/subject/physics
4	***Suggested Readings*** 1. 1.Mathematical Physics, H.K.Dass,Dr.Rama Verma,S.Chand Company Pvt.Ltd. 2. 2.Mathematical Physics, B.S.Rajput ,Pragati Prakashan ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/watch?v=f5WNaV4nwiQ&list=PLyqSpQzTE6M-w1m48vyVvnoU7siWv14XX 2. *https://www.youtube.com/watch?v=BOx8LRyr8mU*
5	***Suggested Readings*** 1. 1.Mathematical Physics, H.K.Dass,Dr.Rama Verma,S.Chand Company Pvt.Ltd. 2. 2.Mathematical Physics, B.S.Rajput ,Pragati Prakashan ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/watch?v=f5WNaV4nwiQ&list=PLyqSpQzTE6M-w1m48vyVvnoU7siWv14XX 2. https://www.youtube.com/watch?v=-iOcBqxTkx0

Modes of Evaluation:

Components	Lab	Theory	
	Continuous Evaluation	IA (internal assessment)	End Semester
Weight%	-----	40	60

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Course Name	Electrodynamics and Astrophysics	L	T	P	C
Course Code	PHYS/CC/103	3	1	0	4

Course objective:

The objective of the Electrodynamics and Astrophysics course is to provide students with an integrated understanding of the fundamental principles of electromagnetism and their application application. Students will explore Maxwell's equations, electromagnetic wave propagation, and the interaction of radiation with matter and. Students will understand how astronomers over millennia have come to understand mysteries of the universe using laws of geometry and physics. They will also be introduced to the Indian contribution to astronomy in the modern times, instruments and techniques to measure astronomical parameters, the different layers of the Sun and an overview of our Milky Way galaxy.

Course Outcomes

CO-1 Students will demonstrate a thorough understanding of classical electrodynamics, including Maxwell's equations, electromagnetic waves, and their interactions with matter.

CO-2 Students will gain a comprehensive understanding of the fundamental principles governing radiation from moving charges and the derivation of electromagnetic radiation fields from accelerating charges.

CO-3 Students will be able to integrate historical perspectives of astronomy with contemporary scientific understanding and will acquire a solid understanding of the different types of celestial objects and celestial coordinate system.

CO-4 Students will be able to identify and describe different types of astronomical instruments, such as refractors, reflectors, interferometers, and space-based observatories, and understand their specific applications, advantages, and limitations.

CO-5 Students will gain a detailed understanding of different types of stars, including main-sequence stars, giants, supergiants, white dwarfs, and neutron stars, as well as their physical properties, classification, and the mechanisms driving their evolution.

Course Contents

Unit I Maxwell's equations and Electromagnetic waves: 10 Hr.

Maxwell's equations and their physical significance. Equation of continuity and relaxation time, Vector and scalar potentials, Lorend and Coulomb gauge, electromagnetic energy and Poynting's theorem, electromagnetic wave equations in free space, their plane wave solutions. Concept of Retarded potentials, Lienard Wiechert potentials, Multipole expansion of EM fields, Electric dipole radiations, field due to oscillating electric dipole, magnetic dipole radiations, electric quadrupole radiation

Unit II Radiations from moving charges: 10Hr.

Fields produced by moving charges, radiations from an accelerated charged particle at low velocities, radiations from a charged particles with co-linear velocity and acceleration, Radiations from an accelerated charged particle at low velocities in circular orbits-Larmor formula, Radiations from an accelerated charged particle at relativistic velocities in circular orbits relativistic generalization of Larmor Formula.

Unit III Introduction to Astronomy and Aspects of the sky: 15Hr.

The roots of astronomy in India, and contribution to astronomy in the modern times. Concept of Celestial Coordinates and spherical astronomy. Astronomical telescopes. The early years of solar system, the solar system today. Study of Planets: Classification of the Planets, Orbits, Laws of planetary motion, Physical features, surface features, Internal Structure, Atmosphere, Satellites and Rings. Minor Bodies in Solar System: Asteroids, Meteors and Meteorites: Discovery of minor planets (Asteroids), their orbits and physical nature. Origin of the minor planets. Meteors and Meteorites. Observation of meteor showers and sporadic meteors. Orbits of sporadic meteoroids and meteor showers. Meteorites, its types and composition. Meteorite craters. Comets-Discovery and designation. Periodic comets. Physical nature. Spectra. Brightness variation. Gas production rates, dust and ion tails. Nature of dust particles and origin of comets.

Unit – IV Astronomical Instruments: 10Hr.

Observing through the atmosphere (scintillation, seeing, atmospheric windows and extinction); basic definitions for telescopes (magnification, light gathering power, limiting magnitude, resolving power, diffraction limit); optical telescope (Galilean, Newtonian, Cassegrain); basic overview of Hubble space telescope, James Web space telescope, Fermi gamma ray space telescope, radio astronomy (overview of GMRT).

Unit IV Stellar System: 15Hr.

Sun As a Star: History of Sun, Sun's interior, the photosphere, the solar atmosphere (chromosphere & corona). Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Distances of stars from the trigonometric. secular. and moving cluster parallaxes. Stellar motions. Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magitudes and distance modulus. color index. The Hertzberg- Russell Diagram:The colour, Brightness or luminosity, the population of star. Elementary idea of Binary & Variable Stars. Nuclear fission, Nuclear fusion, condition for nuclear reaction in stars.Types of galaxies, Structure and features of the Milky Way Galaxy.

Reference Material

<table>
<tr><td>Unit No</td><td></td></tr>
<tr><td>1</td><td>Suggested Readings:
1. The Feynman Lectures on Physics, Vol. II: Mainly Electromagnetism and Matter, Richard Feynman, Robert B. Leighton, Matthew Sands (Pearson Education India, 2012)
2. D.J. Griffiths: Introduction to Electrodyanamics (Prentices Hall, 2002)
3. J.R. Reid, F.J. Milford & R.W. Christy: Foundation of E.M. Theory
4. Landau and Lifshid: The Classical theory of Fields (Pergman Press)
5. Panofsky and Philips: Electricity and Magnetism
Suggested Digital Platforms/Web Links
1. https://swayam.gov.in/explorer?category=Physics
2. https://nptel.ac.in/course.html</td></tr>
<tr><td>2</td><td>Suggested Readings:
1. J.D.Jackson: Classical Electrodynamics (Wiley Eastern)
2. S.P. Puri: Classical Electrodynamics (Tata McGraw Hill, 1990)
3. Field and Wave Electromagnetics, 2nd edition, David K. Cheng (Pearson Education India, 2014)
4. Introduction To Electromagnetic Theory, 1st edition, Ram Kripal (Booksclinic Publishing, 2021)
5. Jordan and Balman: Electromagnetic Waves and Radiation system
Suggested Digital Platforms/Web Links
1. https://swayam.gov.in/explorer?category=Physics
2. https://nptel.ac.in/course.html</td></tr>
<tr><td>3</td><td>Suggested Readings:
1. Marc L. Kutner: Astronomy: A Physical Perspecttive (Cambridge University Press)
2. Shu, F.H.: The Physical Universe An Introduction to Astronomy
3. Robert H. Baker : Astronomy
4. McCusky: Introduction to Celestial Mechanics
5. S.N. Sen : A History of Indian Astronomy
Suggested Digital Platforms/Web Links
1. hflps://ncert.nic.in/textbook/pdf/keks105.pdf
2. hflps://archive.nptel.ac.in/courses/121/104/121104006/</td></tr>
<tr><td>4</td><td>Suggested Readings:
1. The Essentials of Astronomy (Colombia University Press) L Mod. & A.Duveen:
2. The Physical Universe: An Introduction to Astronomy, F. H. Shu, University Science Books
3. Telescopes and techniques, C. R. Kitchin, Springer New York, NY</td></tr>
</table>

	4. An introduction to astrophysics, B. Basu, Prentice Hall of India Private Limited **Suggested Digital Platforms/Web Links** ***1.*** **hflps://www.youtube.com/watch?v=6T62HuRVUlY**
5	*Suggested Readings:* 1. L Mod. & A.Duveen: The Essentials of Astronomy (Colombia University Press) 2. Willian K. Hartmann: Moons & Planets 3. I Morison: Introduction to Astronomy and Cosmology 4. A.W.Joshi & N.Rana: Our solar system 5. Jayant Naralikar: The Structure of Universe 6. K.D. Abhyankar : Astrophysics (Stars & Galaxies) **Suggested Digital Platforms/Web Links** **1. hflps://www.youtube.com/watch?v=tWxLNyYZjvs** 2. https://swayam.gov.in/explorer?category=Physics 3. https://nptel.ac.in/course.html

Modes of Evaluation:

Components	**Lab**	**Theory**	
		Continuous Evaluation	**End Semester**
Weight%	**-----**	**40**	**60**

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Course Name	ELECTRONICS	L	T	P	C
Course Code	PHY/CC/104	3	1	0	4

Course Objectives

This course aims to provide to understand the concepts of P and N type semiconductors and Classify various types of power amplifiers-series. The student able to understand the concept of Feedback in amplifiers and ptoelectronics,concept of n-p-n and p-n-p transistors, amplifiers and feedback amplifiers by using transistors. To learn about oscillators, operational amplifiers and their applications. By the end, students will be able to analyze and apply electronics principles to various physical systems.

Course Outcomes

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

CO1 Gain expertise in designing and analysing reactive networks, filters, and attenuators.

CO2 Develop the ability to design and troubleshoot various power amplifier circuits with an understanding of their performance metrics.

CO3 Understand the principles and effects of feedback in amplifiers and oscillators, and apply this knowledge to practical circuit design.

CO4 Utilize operational amplifiers in a variety of applications, demonstrating proficiency in designing and implementing circuits with real-world applications.

CO5 Acquire knowledge of optical fiber technologies and optical sources, and apply this understanding to practical optoelectronic systems.

Course Content:

Unit I

Passive Networks: **13 Hr**

Synthesis of two terminal reactive networks – Driving point impedance and admittance, Foster's reactance theorems, properties of poles and zeros of reactance function, canonic networks. Four-terminal two-port network – parameters for symmetrical and unsymmetrical networks; image, iterative and characteristic impedances; propagation function; lattice network; Bisection theorem and its application. L-C filters-LPF, HPF, BPF and BRF type constant-k prototype filters; m-derived filters (principle only). Attenuators -T-type, Pi-type, Bridged-T type lattice attenuators.

Unit II

Power amplifiers : **10 Hr.**

Types of power amplifiers-series fed class A: amplifier-series fed transformer coupled class B: push pull circuits-harmonic distortion in amplifiers-class C and D amplifiers-design considerations.

Unit III

Feedback in amplifiers: **10 Hr.**

Feedback principle-effect of feedback on stability-nonlinear distortion input and output impedance-bandwidth-different types of feedback. Criteria for oscillation-phase shift, Wein bridge, crystal oscillator-frequency stability, astable, monostable and bistable multivibrators, Schmitt trigger-bootstrap-sweep circuits.

Unit IV

Operational amplifiers: **12 Hr.**

Differential amplifier-ideal and real op—amp-input and output impedance- frequency response-applications: amplifiers, mathematical operations, active filters, waveform generators-analog computations-comparators-S and H circuit-voltage regulator.

Unit V

Optoelectronics: **15 Hr.**

Optical fibres: graded index step index fibres-refractive index profiles-propagation of optical beams in fibres-mode characteristics and cut off conditions-losses in fibrwes-signal distortion group delay-material and wave guide dispersion. Optical sources: Light emitting diodes-LED structure-internal quantum efficiency-injection laser diode-comparison of LED and ILD. Optical detectors: PN junction photo diodes-PN photo detectors-avalanche photo diode-performance comparison.

Reference Materials:

Units No	*Reference Material*
1	***Suggested Readings*** 1. Network Analysis- M.E. Van Valkenburg 2. J D Ryder, Networks line and fields. 3. Ryder: Electronics-fundamentals and applications(PHI) ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/watch?v=0pFF1oAYgQI&list=PLMZ8LHWk_2jibW8IHkGcZmY36V-wrWv0S 2. *https://www.youtube.com/watch?v=5ka_14DkoYQ*
2	***Suggested Readings*** 1. Microelectronic Circuits - Adel S. Sedra and Kenneth C. Smith 2. Principles of Electronics,V.K.Metha,Rohit Mehta(S.Chand &Company) 3. Hand Book of Electronics,Dr.S.L.Gupta ,Dr.V.Kumar(Pragati Prakashan) ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/watch?v=KUDGGsyh1Hs&list=PLbMVogVj5nJQdGDSx243YPnNeLMBrhNE8 2. https://www.youtube.com/watch?v=ZbvWe9xBu3Q&list=PLp6ek2hDcoND7i5-DAD9mPmYF1Wg6ROdO
3	***Suggested Readings*** 1. Electronic Principles -Albert Malvino and David J. Bates 2. Keiser : Optical fibre communications (McGraw Hill) 3. Agarwal: Nonlinear fibre optics(AP) ***Suggested Digital Platforms/Web Links*** 1. *https://www.youtube.com/watch?v=1zgSM4objBU&list=PLq-Gm0yRYwTiwwgz9qTmK0eLAhOvyhCkb*
4	***Suggested Readings*** 1. Bolested – Electronic devices and circuit theory 2. Ryder – Electronic -fundamentals and applications (PHI) 3. Keiser : Optical fibre communications (McGraw Hill) 4. Agarwal : Nonlinear fibre optics(AP) ***Suggested Digital Platforms/Web Links*** 1. *https://www.youtube.com/playlist?list=PLV76hMzCsklduUWLIg4ZAKWxwqwcdBMfJ* 2. *https://www.youtube.com/watch?v=1zgSM4objBU&list=PLq-Gm0yRYwTiwwgz9qTmK0eLAhOvyhCkb*
5	***Suggested Readings*** 1. Principles of Electronics,V.K.Metha,Rohit Mehta(S.Chand &Company) 2. Hand Book of Electronics,Dr.S.L.Gupta ,Dr.V.Kumar(Pragati

	Prakashan) *Suggested Digital Platforms/Web Links* 1. https://www.youtube.com/watch?v=PVnftOMxl6w&list=PLyAZSyX8Qy5Asu5owBT4L6vd3yQgWel_8

Modes of Evaluation:

Components	Lab	Theory	
	Continuous Evaluation	IA (internal assessment)	End Semester
Weight%	-----	40	60

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Course Name	Laboratory Course- I	L	T	P	C
Course Code	PHYS/CC/105	0	0	2	2

Course Objectives

This course aims to enhance the problem-solving ability and to help the students to gain in-depth technical knowledge In electronics and to gain experience in the practical, hands-on aspects of Electronics, thereby adapt to work in teams. To identify the working principles of several devices based upon electronics, calculation of physical parameters such as voltage, current, RC circuits and error. By the end, students will be able to analyse and apply principles of electronics to various physical systems.

Course Outcomes

On completion of this course, the students will be able to

CO1 Develop knowledge of different measurement instruments as well as error calculation with them.

CO2 Compute the several physical parameters involved in the principles of electronics.

CO3 Analyze the working of different LCR, RC, and circuits and calculation of different circuit parameters.

CO4 Develop technical knowledge of Scilab. Understand the types of amplifiers.

Course Contents: **60 Hr**

Unit - I

P1. **Study of LCR Circuit:**
Investigate the behaviour of a series and parallel LCR circuit, focusing on resonance, impedance, and phase relationships. Measure and analyse the resonance frequency, bandwidth, and quality factor.

P2. **Transistorized LCR Bridge:**
Explore the principles and operation of a transistorized LCR bridge for measuring inductance, capacitance, and resistance. Understand the balancing conditions and determine the unknown component values accurately.

P3. **Study of UJT (Unijunction Transistor):**
Examine the characteristics and operation of a UJT, observing its switching behavior and negative resistance region. Understand its applications in relaxation oscillators and triggering circuits.

P4. **Study of MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor):**
Analyse the characteristics of MOSFETs, including transfer and output characteristics. Understand the enhancement and depletion modes of operation and their applications in amplifiers and switching circuits.

P5. **Study of NPN and PNP Transistor Characteristics:**
Investigate the input and output characteristics of NPN and PNP transistors. Understand the current gain (β) and analyse the differences in behaviour between the two types of transistors.

P6. **Study of DIAC (Diode for Alternating Current):**
Explore the V-I characteristics of a DIAC, focusing on its symmetrical breakover voltage properties. Understand its role in triggering TRIACs in AC switching applications.

P7. **Study of TRIAC (Triode for Alternating Current):**
Examine the operation and V-I characteristics of a TRIAC, including its bidirectional conduction properties. Analyse its use in AC power control applications such as dimmers and motor speed controllers.

Unit II

P8. **Study of FET (Field-Effect Transistor):**
Study the characteristics of JFETs or MOSFETs, focusing on their high input impedance and voltage-controlled behaviour. Understand their applications in amplifiers and analogue switches.

P9. **R.C. Coupled Amplifier:**
Analyse the frequency response and gain of an RC-coupled amplifier. Understand the coupling mechanism and its impact on signal amplification and bandwidth.

P10. **T.C. Coupled Amplifier (Transformer Coupled Amplifier):**
Investigate the characteristics and performance of a transformer-coupled amplifier. Study its efficiency, frequency response, and applications in impedance matching and signal amplification.

P11. **Study of Feedback Amplifier:**
Explore the effects of negative and positive feedback on amplifier stability, gain, and bandwidth. Understand different feedback topologies and their applications in electronic circuits.

P12. **Study of Hartley Oscillator:**
Construct and analyse a Hartley oscillator, focusing on its frequency determination using inductors and capacitors. Understand its application in RF signal generation.

P13. **Study of Colpitts Oscillator:**
Study the design and operation of a Colpitts oscillator, focusing on its frequency stability and the role of capacitive feedback. Understand its use in high-frequency applications.

P14. **Study of Wien Bridge Oscillator:**
Analyse the Wien bridge oscillator circuit, focusing on its frequency stability and low distortion output. Understand its applications in audio frequency generation and function generators.

P15. **Design and Study of Different Network Theorems:**
Verify and apply network theorems such as Thevenin's, Norton's, Superposition, and Maximum Power Transfer. Understand their practical applications in simplifying complex circuits and analysing electrical networks.
Seminar: Two seminars for each student are compulsory

Note: At least 10 Experiments are to be performed.
Modes of Evaluation:

Components	**Theory**	**Lab**	
	Continuous Evaluation	**IA (internal assessment)**	**End Semester**
Weight%	**-----**	**40**	**60**

Course Name	Laboratory course - II	L	T	P	C
Course Code	PHYS/CC/106	0	0	2	2

Course Objectives

This course uses Stellarium software or Virtual Laboratory to familiarise students with the night sky, enabling them to identify astronomical objects and constellations at different times.

Course Outcomes

On completion of this course, the students will be able to

CO1 Night Sky Familiarity: Students will create night sky maps using Stellarium and identify astronomical objects, correlating them with naked eye observations.

CO2 Constellation Identification: Students will identify and recognize constellations at different times using Stellarium.

CO3 Understanding Retrograde Motion: Students will comprehend and identify the retrograde motion of planets relative to background stars.

CO4 Solar Spectrum and Star Classification: Students will analyse the solar spectrum, identify spectral lines, compute column densities of hydrogen and calcium, and classify stars based on their spectra.

Course Contents: **60 Hr**

P1 To become familiar with night sky

To become familiar with the astronomical objects visible to naked eye in the night sky using the software Stellarium. You will create a night sky map at different times. In the map you will identify astronomical objects such as planets, stars, nebula, milky way etc. You will then correlate the objects in the map with the directly observable night sky with naked eye.

P2 Becoming Familiar with Constellations

To become familiar with the Constellations in the night sky using the software Stellarium. You will learn to identify the constellations at different times (10 PM and 12 midnight) in the night.

P3 Retrograde motion of Planets

To identify the retrograde motion of Planets with respect to the Background stars.

P4 Study of solar spectrum

To study the solar spectrum and identify some of the prominent spectral lines in the spectrum. You will also use the spectra to compute the column density of Hydrogen and Calcium atoms in the Solar atmosphere.

P5 Spectral classification of stars

To get familiar with the spectra of different stars

Reference books:

1. Practical Physics,Anchal Srivastava,R.K.Shukla(New Age International pubblishers)
2. Practical Physics,Harnam Singh,Dr.P.S. Hemne(S.Chand &Company Pvt.Ltd.)
3. VirtualAstronomy/Astrophysics Laboratory https://va-iitk.vlabs.ac.in/?page=objectives

Modes of Evaluation:

Components	Theory	Lab	
	Continuous Evaluation	IA (internal assessment)	End Semester
Weight%	-----	40	60

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Course Name	ATOMIC AND MOLECULAR PHYSICS	L	T	P	C
Course Code	PHYS CC107	3	1	0	4

Course Objectives:

The course aims to provide an in-depth understanding of atomic and molecular spectroscopy, including the fine structure of hydrogen and alkali atom spectra, electron spin-orbit interaction, and various coupling schemes. It covers central field approximations, Hartree's self-consistent field theory, and the Thomas-Fermi statistical model. Students will explore spectroscopic effects like the Zeeman and Stark effects, and Lamb shift. Additionally, the course delves into molecular spectroscopy, including rotational and vibrational spectra, the Raman effect, and molecular orbital theory

Course Outcomes:

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

CO1- Explain the fine structure of hydrogen lines and alkali atom spectra. Apply L-S and J-J coupling schemes and Hund's rule.

CO2- Utilize central field approximation and Hartree's self-consistent field theory. Apply the Thomas-Fermi model and Pauli's exclusion principle.

CO3- Analyse Zeeman, Paschen-Back, and Stark effects. Explain hyperfine structure, line broadening, and the Lamb shift.

CO4- Interpret rotational and vibrational spectra. Explain the Raman effect and calculate dissociation energy.

CO5- Apply molecular orbital theory and the Born-Oppenheimer approximation. Analyse electronic spectra using Fortrat parabola, Deslandres table, and Franck-Condon principle.

Course Contents:

Unit 1: Atomic Spectroscopy and Fine Structure **15 Hr**

Fine structure of Hydrogen lines, Alkali atom spectra, Penetrating and non-penetrating orbits, Electron spin-orbit interaction, L-S and J-J coupling schemes, Hund's rule, Spectra of two valence electron atoms (Helium, Magnesium), Selection rules for atomic transitions, Multielectron spectra

Unit 2: Central Field and Quantum Models **8 Hr**

Central field approximation, Hartree's self-consistent field theory, Thomas-Fermi statistical model, Pauli's exclusion principle and determination of ground state

Unit 3: Spectroscopic Effects and Line Widths **7 hr**

Zeeman effect, Paschen-Back effect, Hyperfine structure, Stark effect, Width of spectral lines, Lamb shift

Unit 4: Molecular Spectroscopy **15 Hr**

Rotational spectra of diatomic molecules, Non-rigid rotator, Vibrational spectra (anharmonic oscillator), Explanation of rotational-vibrational spectra in infrared. Molecular dissociation and calculation of dissociation energy, Raman effect and intensity alternation of the rotational bands, Applications of infrared and Raman spectroscopy

Unit 5: Molecular Theory and Electronic Spectra **15 Hr**

Born-Oppenheimer approximation, Molecular orbital theory, Heitler-London treatment of Hydrogen molecule ion and Hydrogen molecule, Electronic spectra of molecules, Fortrat parabola, Deslandres table, Vibrational structure of electronic bands, Intensities of electronic transitions, Franck-Condon principle, Condon parabola

Reference Materials:

Unit No	*Reference Material*
1	***Recommended Books:*** 1. Atomic Spectra- H.E white Cambridge University Press, Newyork, 1935) 2. Principle of Atomic Spectra - Shore and Menzel 3. Spectra of Diatomic Molecules- G. Herzberg 4. Quantum Physics, Robert Eisberg and Robert Resnik 5. Introduction to Solid States Physics, Charles, Kittle 7th Edition **Online Material:NPTEL/SWAYM** **hflps://www.youtube.com/watch?v=0zDZqjqGtl4** ***https://www.youtube.com/@atomicandmolecularphysics-8700***
2	***Recommended Books:*** 1. Quantum Mechanics by L.I. Schiff 2. Introduction to Quantum Mechanics by David J. Griffiths 3. Quantum Mechanics: Concepts and Applications by Nouredine Zettili 4. Quantum Mechanics by Satya Prakash 5. Principle of Atomic Spectra - Shore and Menzel **Online Material: NPTEL/SWAYM** ***https://www.youtube.com/@atomicandmolecularphysics-8700*** ***https://www.youtube.com/watch?v=SCmtEhGVhSM&list=PLupNYX6-k9ggRRmDqV9hxY1p4dC-QGrg7***
3	***Recommended Books:*** 1. Principles of Modern Physics by A.B. Arfken 2. Introduction to Quantum Mechanics by Linus Pauling and E. Bright Wilson 3. Quantum Mechanics and Path Integrals by Richard P. Feynman and Albert R. Hibbs 4. Modern Physics by R. Murugeshan and Kiruthiga Sivaprasath 5. Spectroscopy by B.P. Straughan and S. Walker (Note: This is an Indian edition of the original work) **Online Material: NPTEL/SWAYM** ***https://www.youtube.com/@atomicandmolecularphysics-8700*** ***https://www.youtube.com/watch?v=7jOSbtR8mTs&list=PLyqSpQzTE6M8eGML9tjCEgZjci5USazoW***
4	***Recommended Books:*** 1. Molecular Spectroscopy by Jeanne L. McHale 2. Molecular Spectra and Molecular Structure by Gerhard Herzberg 3. Fundamentals of Molecular Spectroscopy by C.N. Banwell and E.M. McCash 4. Molecular Spectroscopy by Aruldhas G. 5. Molecular Spectroscopy by Raj Kumar **Online Material: NPTEL/SWAYM** ***https://www.youtube.com/@atomicandmolecularphysics-8700***

5	***Recommended Books:*** 1. The Spectra and Dynamics of Diatomic Molecules by H.L. Bethke 2. Electronic and Photoelectron Spectroscopy: Fundamentals and Case Studies by Andrew M. Ellis, Miklos Feher, and Timothy G. Wright 3. The Theory of Atomic Spectra by E.U. Condon and G.H. Shortley 4. Molecular Physics by Suresh Chandra 5. Elements of Molecular Spectroscopy by K.P. Mukherjee **Online Material: NPTEL/SWAYM** *https://www.youtube.com/@atomicandmolecularphysics-8700*

Modes of Evaluation:

Components	Lab	Theory	
	Continuous Evaluation	IA (internal assessment)	End Semester
Weight%	-----	40	60

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Course Name	SOLID STATE PHYSICS	L	T	P	C
Course Code	PHYS/CC/108	3	1	0	4

Course Objectives

This course aims to provide a comprehensive understanding of crystal structures, including periodic arrays, lattice types, and crystal structures. Students will learn about reciprocal lattices, diffraction, Bragg's law, and structure factors. The course covers crystal binding, elastic constants, and lattice vibrations, including phonons and their properties. By the end, students will be equipped to analyse and interpret various crystallographic and lattice phenomena in solid-state physics.

Course Outcomes

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

CO1 - Describe periodic arrays of atoms and primitive lattice cells. Identify and classify fundamental lattice types and simple crystal structures.

CO2- Explain coordination numbers and specific crystal structures like Cesium chloride, HCP, diamond, and cubic ZnS. Understand various symmetry operations in crystal structures.

CO3- Apply Bragg's law and Laue equations to crystal diffraction. Analyse reciprocal lattices for SC, BCC, and FCC structures, and calculate structure factors.

CO4- Differentiate between ionic, covalent, and metallic crystals. Analyse elastic properties and determine elastic constants in crystal structure.

CO5- Explain lattice vibrations and phonons in crystals. Analyse vibrational modes, group velocity, and inelastic scattering of photons by phonons.

Course Contents

Unit-1: Basics of crystals: 8 Hr.

Atoms, Ions, and Molecules in Crystals, Primitive and Unit cells, Crystallographic Directions and Planes, Bravais lattices: Two Dimensional and Three Dimensional Bravais lattices, Miller Indices, Cubic (Isometric), Tetragonal, Orthorhombic Rhombohedral (Trigonal), Monoclinic, Triclinic, Hexagonal

Unit-2 Crystal Structure and symmetry operations: 8 Hr

Coordination number, Cesium chloride structure, Hexagonal Close Packed Structure, Diamond Structure, cubic Zinc Sulphide structure, Point Symmetry Elements (Centers, Axes, and Plans of Symmetry), Rotation Axes, Mirror Planes, Inversion Centers, Translation Symmetry, Glide Planes and Screw Axes

Unit 3: Reciprocal laflice: 15 Hr

Diffraction waves by crystals, Braggs law, Scattered wave amplitude, Laue equations, Brillouin zones, reciprocal lattice to SC lattice, B C C lattice, F C C lattice, structure factor of B C C structure, F C C lattice, atomic form factor.

Unit 4 Crystal Binding and Elastic Constants: 15 Hr

Ionic Crystal, Covalent Crystal, Metals, Hydrogen bonds, analysis of elastic springs, elastic compliance and stiffness constants, Elastic waves in cubic crystals, Experimental determination of elastic constants.

Unit 5: Laflice Vibrations: 14 Hr

Vibrations of crystals with monoatomic basis, First Brillouin zone, Group Velocity, Long wavelength limit, Two atoms per primitive basis, quantisation of elastic waves, Phonons, Phonon momentum, Inelastic scattering of photons by phonons.

Reference Materials

Unit No	***Reference Materials***
1	*Suggested Readings* 1. Solid State Physics - M.A. Wahab 2. *Introduction* to Solid State Physics-C Kittel 3. Solid State Physics –N W Ashcroft&N David Mermin 4. Peterson: Introduction to Solid State Physics ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/@solidstatephysics8564 **2.** https://www.youtube.com/watch?v=Ofzd2ZqFvjo&list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
2	*Suggested Readings* 1. Solid State Physics-Ajay Kumar Saxena 2. Solid State Physics - M.A. Wahab 3. Elements of Solid-State Physics - J.P. Srivastava 4. Introduction to Solid State Physics - Charles Kittel 5. Solid State Physics - Neil W. Ashcroft and N. David Mermin ***Suggested Digital Platforms/Web Links*** *1. https://www.youtube.com/watch?v=Ofzd2ZqFvjo&list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m*
3	*Suggested Readings* 1. Azaroff: Introduction to solids 2. Aschroft and Mermin: Solid-State Physics 3. Introduction to Solid State Physics- Charles Kittel 4. Solid State Physics - Neil W. Ashcroft and N. David Mermin ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/@solidstatephysics8564 *2.* https://www.youtube.com/watch?v=Ofzd2ZqFvjo&list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
4	*Suggested Readings* 1. Solid State Physics_ N W Ashcroft & N David Mermin 2. Solid State Physics- Ajay Kumar Saxena 3. Solid State Physics - M.A. Wahab 4. Elements of Solid-State Physics - J.P. Srivastava ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/@solidstatephysics8564 *2.* https://www.youtube.com/watch?v=Ofzd2ZqFvjo&list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
5	*Suggested Readings* 1. Peterson: Introduction to Solid State Physics 2. Verma and Srivastava: Crystallography for Solid-State Physics 3. Introduction to Solid State Physics- Charles Kittel 4. Solid State Physics- Neil W. Ashcroft and N. David Mermin ***Suggested Digital Platforms/Web Links*** *1.* https://www.youtube.com/@solidstatephysics8564

Modes of Evaluation:

Components	Lab	Theory	
	Continuous Evaluation	IA (internal assessment)	End Semester
Weight%	-----	40	60

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Course Name	STATISTICAL MECHANICS	L	T	P	C
Course Code	PHYS/CC/109	3	1	0	4

Course Objectives

This course aims to provide a thorough understanding of statistical mechanics and its applications. Students will explore fundamental postulates, classical and quantum statistics, and the behaviour of ideal and imperfect gases. The course covers phase space, ensembles, partition functions, thermodynamic properties, and black body radiation. By the end, students will be able to analyse and apply statistical mechanics principles to various physical systems.

Course Outcomes

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

CO1 - Understand phase space, eigenstates, and Liouville's theorem. Apply microcanonical, canonical, and grand canonical ensembles. Use Maxwell-Boltzmann, Gibbs distribution, and partition functions to determine thermodynamic properties.

CO2- Analyse degrees of freedom, Helmholtz and Gibbs free energy. Understand entropy, Gibbs paradox, and Sakur-Tetrode equation.

CO3- Distinguish between ideal and real gases. Apply Van der Waals equation and understand gas condensation, Fermi theory, and phase rule.

C04-Compare Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distributions. Analyse partition functions and quantum effects in gases and solids.

CO5- Explain Planck’s distribution, Rayleigh-Jeans formula, and Wein's laws. Understand black body radiation and the relationship between pressure and energy of photons.

Course Contents:

Unit 1: Basic Postulates: **15 Hr**

Phase space, relation between eigen states and phase space volume, Liouville's theorem, ensembles, microcanonical, canonical and grand canonical ensembles, Maxwell's Boldmnn's distribution and Gibb's formulation for canonical and grand canonical ensembles, partition function, their thermodynamic properties, laws of thermodynamics.

Unit 2: Application of classical distribution to the ideal gases: 8 Hr.

Degrees of freedom, translational motion, Helmhold free energy, Gibb's free energy, entropy and thermodynamic properties, Gibb's paradox, Sakur-tetrode equation.

Unit 3: Imperfect gases: 10Hr.

Difference between ideal and real gas, imperfect gases, Vander Waal's equation, virial coefficients, condensation of gases, general properties of liquids, Fermi theory, liquid Helium, and phase rule.

Unit 4: Quantum Statistics: 15 Hr.

Drawbacks of M B distribution, Bose-Einstein's and Fermi-Dirac distribution, symmetric and antisymmetric particles, partition functions, non-degenerate, weakly degenerate and strongly degenerate cases, B.E. condensation, application to He, pressure-energy relationship, electronic specific heat of solids and paramagnetism.

Unit 5: Black Body Radiation: 12 Hr.

Planck's distribution, pressure and energy relationship of photons, black body radiation, Rayleigh Jean's formula, Wein's law, Wein's displacement formula, absorption and emission of radiation, Stefan's law, high-temperature measurements.

Reference Materials:

Units No	*Reference Material*
1	***Suggested Readings*** 1. Glasstone: Theoretical Chemistry 2. E.S. Raj Gopal: Statistical Mechanics and Properties of Matter 3. Statistical Mechanics - B.K. Agarwal and M. Eisner 4. A Textbook of Statistical Mechanics - M. Anil Kumar and S.P. Singh ***Suggested Digital Platforms/Web links*** 1. https://www.youtube.com/watch?v=XIXQ38JnF0k&list=PLCC901B3A9445042D 2. https://www.youtube.com/watch?v=xT5SWnbdgTo&list=PLyqSpQzTE6M-eaGGXZ2VJgcFk0d63VXqG
2	***Suggested Readings*** 1. Mayer And Mayer: Statistical Mechanics 2. Landau and Lifshid: Statistical Physics 3. Fundamentals of Statistical Mechanics - B.B. Laud 4. Introduction to Modern Statistical Mechanics - David Chandler 5. Statistical Thermodynamics - Andrew Maczek ***Suggested Digital Platforms/ Web links*** 1. https://www.youtube.com/watch?v=XIXQ38JnF0k&list=PLCC901B3A9445042D 2. https://www.youtube.com/watch?v=xT5SWnbdgTo&list=PLyqSpQzTE6M-eaGGXZ2VJgcFk0d63VXqG
3	***Suggested Readings*** 1. Pointon: Introduction to Statistical Physics 2. Huang: Statistical Mechanics 3. Concepts in Thermal Physics - S.C. Garg, R.M. Bansal, and C.K. Ghosh 4. Thermodynamics and an Introduction to Thermostatistics - Herbert B. Callen ***Suggested Digital Platforms/ Web links*** 1. https://www.youtube.com/watch?v=xT5SWnbdgTo&list=PLyqSpQzTE6M-eaGGXZ2VJgcFk0d63VXqG
4	***Suggested Readings*** 1. Statistical Mechanics - Satya Prakash and J.P. Agrawal 2. Huang: Statistical Mechanics 3. Wanier: Statistical Physics 4. Statistical Mechanics - Kerson Huang 5. Quantum Statistical Mechanics - Leo P. Kadanoff and Gordon Baym ***Suggested Digital Platforms/ Web links*** ***1.*** https://www.youtube.com/watch?v=XIXQ38JnF0k&list=PLCC901B3A9445042D

5	***Suggested Readings*** 1. Heat and Thermodynamics - M.W. Zemansky and R. Dittman (Indian edition available) 2. Radiative Processes in Astrophysics - George B. Rybicki and Alan P. Lightman 3. Thermal Physics - Charles Kittel and Herbert Kroemer 4. Landau and Lifshid: Statistical Physics 5. Pointon: Introduction to Statistical Physics ***Suggested Digital Platforms/ Web links*** 1. https://www.youtube.com/watch?v=XIXQ38JnF0k&list=PLCC901B3A9445042D 2. https://www.youtube.com/watch?v=xT5SWnbdgTo&list=PLyqSpQzTE6M-eaGGXZ2VJgcFk0d63VXqG

Modes of Evaluation:

Components	**Lab**	**Theory**	
	Continuous Evaluation	**IA (internal assessment)**	**End Semester**
Weight%	**-----**	**40**	**60**

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Course Name	QUANTUM MECHANICS	L	T	P	C
Course Code	PHYS/CC/110	3	1	0	4

Course Objectives

This course provides a comprehensive introduction to the fundamental principles and mathematical frameworks of quantum mechanics. Topics include the foundational postulates, wave mechanics, matrix formulation, and symmetry operations. Advanced concepts in angular momentum, perturbation theories, and quantum statistics are explored, with applications to physical systems such as potential wells, hydrogen atoms, and harmonic oscillators. Students will gain a deep understanding of quantum theory's theoretical and practical aspects, preparing them for advanced studies and research in physics.

Course Outcomes

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

CO1 - Understand the foundational principles of quantum mechanics, including the Schrödinger wave equation and its applications to potential steps, tunneling, the hydrogen atom, and particles in three-dimensional boxes.

CO2- Grasp the matrix formulation of quantum mechanics, vector representations of states, and Dirac notation, including transformations and commutation relations.

CO3- Comprehend the role of symmetry in quantum mechanics, unitary operators, angular momentum, and spin.

C04- Apply advanced concepts of angular momentum, including Clebsch-Gordon coefficients, Wigner-Eckart theorem, and symmetry operations.

CO5- Analyse quantum statistics, including Bose-Einstein and Fermi-Dirac distributions, and their applications to physical systems and phenomena such as B.E. condensation and electronic specific heat of solids.

Course Contents:

Unit 1: Introduction of Quantum Mechanics **12 Hr.**

A brief review of foundations of quantum mechanics, basic postulates of quantum mechanics, uncertainty relations, Schrodinger wave equation, expectation value and Ehrenfest theorem. Relationship between space and momentum representation. Applications: **One-dimensional** potential step, tunneling, Hydrogen atom, particle in a three-dimensional box.

Unit 2: Matrix Formulation of Quantum Mechanics **12 Hr.**

Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

Unit 3: Symmetry in Quantum Mechanics **11 Hr.**

Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigenvalue spectrum, angular momentum matrices of J +, J- , Jz, J2 Concept of spin, Pauli spin matrices. Addition of angular momenta.

Unit 4: Quantum Concepts and Applications **12 Hr.**

Clebsch-Gordon coefficients and their properties, recursion relations. Matrix elements for rotated state, irreducible tensor operator, Wigner-Eckart theorem. Rotation matrices and group aspects. Space inversion and time reversal: parity operator and anti-linear operator. Dynamical symmetry of harmonic oscillator. Applications: non-relativistic Hamiltonian for an electron with spin included. C. G. coefficients of addition for j =1/2, 1/2; 1/2, 1; 1, 1.

Unit 5: Quantum Statistics **13 Hr.**

Drawbacks of M B distribution, Bose-Einstein's and Fermi-Dirac distribution, symmetric and antisymmetric particles, partition functions, non-degenerate, weakly degenerate and strongly degenerate cases, B.E. condensation, application to He, pressure-energy relationship, electronic specific heat of solids and paramagnetism.

Reference Materials:

Units No	*Reference Material*
1	***Suggested Readings*** 1. Principles of Quantum Mechanics - R. Shankar 2. Introduction to Quantum Mechanics - David J. Griffiths 3. Quantum Mechanics: Concepts and Applications- Nouredine Zettili 4. L. I. Schiff, Quantum Mechanics (McGraw Hill). 5. V. K. Thankappan, Quantum Mechanics (Wiley Eastern). ***Suggested Digital Platforms/Web Links*** 1. *https://www.youtube.com/watch?v=pGerRhxNQJE&list=PLbMVogVj5nJTXGlgqyzpUqozrU55oRX-H* 2. *https://www.youtube.com/watch?v=TcmGYe39XG0&list=PL0F530F3BAF8C6FCC*
2	***Suggested Readings*** 1. Modern Quantum Mechanics - J. J. Sakurai and Jim Napolitano 2. Quantum Mechanics: A Modern Development - by Leslie E. Ballentine 3. Quantum Mechanics - Claude Cohen-Tannoudji, Bernard Diu, and Frank Laloë 4. P. M. Mathews and K. Venkatesan, A Text-Book of Quantum Mechanics (TMH) 5. 4. C. Cohen-Tannoudji, Bernard Diu, Franck Loloe, Quantum Mechanics Vols-I&II (John Wiley). ***Suggested Digital Platforms/Web Links*** 1. *https://www.youtube.com/watch?v=pGerRhxNQJE&list=PLbMVogVj5nJTXGlgqyzpUqozrU55oRX-H* 2. *https://www.youtube.com/watch?v=TcmGYe39XG0&list=PL0F530F3BAF8C6FCC*
3	***Suggested Readings*** 1. J. J. Sakurai, Modern Quantum Mechanics (Addison-Wesley). 2. A. K. Ghatakh and S. Lokanathan, Quantum Mechanics 3rd ed. (MacMillan). 3. Quantum Mechanics and Symmetry - Walter Greiner 4. Symmetry Principles in Quantum Physics - Philip L. Richards 5. Angular Momentum in Quantum Mechanics - Y. Aharonov and D. Bohm ***Suggested Digital Platforms/Web Links*** 1. *https://www.youtube.com/watch?v=pGerRhxNQJE&list=PLbMVogVj5nJTXGlgqyzpUqozrU55oRX-H*

	2. https://www.youtube.com/watch?v=TcmGYe39XG0&list=PL0F530F3BAF8C6FCC
4	***Suggested Readings*** 1. Group Theory and Quantum Mechanics- Michael Tinkham 2. Angular Momentum: An Illustrated Guide to Rotational Symmetry- Michael E. Peskin and Daniel V. Schroeder 3. The Quantum Theory of Angular Momentum - L. D. Landau and E. M. Lifshid 4. V. K. Thankappan, Quantum Mechanics (Wiley Eastern). 5. P. M. Mathews and K. Venkatesan, A Text-Book of Quantum Mechanics (TMH) ***Suggested Digital Platforms/Web Links*** **1.** https://www.youtube.com/watch?v=pGerRhxNQJE&list=PLbMVogVj5nJTXGlgqyzpUqozrU55oRX-H
5	***Suggested Readings*** 1. C. Cohen-Tannoudji, Bernard Diu, Franck Loloe, Quantum Mechanics Vols-I&II (John Wiley). 2. J. J. Sakurai, Modern Quantum Mechanics (Addison-Wesley). 3. A. K. Ghatakh and S. Lokanathan, Quantum Mechanics 3rd ed. (MacMillan). 4. Statistical Mechanics - R.K. Pathria and Paul D. Beale 5. Introduction to Modern Statistical Mechanics - David Chandler 6. Quantum Statistics of Particles - E. Fermi ***Suggested Digital Platforms/Web Links*** 1. https://www.youtube.com/watch?v=pGerRhxNQJE&list=PLbMVogVj5nJTXGlgqyzpUqozrU55oRX-H **2.** https://www.youtube.com/watch?v=TcmGYe39XG0&list=PL0F530F3BAF8C6FCC

Modes of Evaluation:

Components	**Lab**	**Theory**	
	Continuous Evaluation	**IA (internal assessment)**	**End Semester**
Weight%	**-----**	**40**	**60**

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Course Name	Laboratory Course-I	L	T	P	C
Course Code	PHYS/CC/111	0	0	2	2

Course Objectives

The objective of this laboratory course is to equip students with practical skills and knowledge through hands-on experiments in electronics, optics, and electromagnetism. Students will learn to use various instruments, conduct precise measurements, and analyse data, reinforcing their understanding of fundamental physical principles.

Course Outcomes

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

CO1 Master the use of Michelson and Fabry-Perot interferometers to measure light wavelengths and small distances.

CO2 Analysing interference patterns and applying metrology principles.

CO3 Gain expertise in using spectrophotometers, CROs, and ultrasonic detectors.

CO4 Determine physical constants and analyse material properties through hands-on experiments.

Course Contents: **60 Hr**

Unit I

P1. **Michelson Interferometer**:

Utilize the Michelson interferometer to measure wavelengths of light and small distances with high precision. Study the interference patterns and understand their applications in metrology.

P2. **Fabry-Perot Interferometer:**

Explore the principles of multiple beam interference using a Fabry-Perot interferometer. Determine the wavelength of light and the refractive index of materials.

P3. **Fresnel's Law:**

Verify Fresnel's laws of reflection and refraction by measuring the intensity of reflected and refracted light. Study the polarization effects and Brewster's angle.

P4**. Hall Effect:**

The Hall Effect describes the generation of a voltage difference (Hall voltage) across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current. It is used to measure magnetic field strength and charge carrier density in materials.

P**5. Electron Spin Resonance (ESR)**

Electron Spin Resonance (ESR) is a spectroscopic technique used to detect and study chemical species with unpaired electrons. It is based on the absorption of microwave radiation by these electrons in the presence of a magnetic field, revealing information about the electronic structure and environment of the species.

Unit II

P6. **Determination of Absorption Using UV:**

Measure the absorption coefficient of iodine vapor using a spectrophotometer. Understand the relationship between absorbance, concentration, and path length (Beer-Lambert Law).

P7. **B-H Curve:**
Plot the B-H curve for a ferromagnetic material. Understand magnetic hysteresis, coercivity, and retentivity, and determine the magnetic properties of the material.

P8. **Study of Cathode Ray Oscilloscope (CRO):**
Develop proficiency in using a CRO for visualizing and measuring electrical signals. Understand the working principles of CRO, including time base, triggering, and voltage measurement.

P9. **Velocity of Ultrasonic Waves**:
Measure the velocity of ultrasonic waves in different media. Understand the applications of ultrasonics in medical imaging and materials testing.

P10. **Linear Air Track:**
Conduct experiments on a linear air track to study the principles of kinematics and dynamics in a nearly frictionless environment. Measure acceleration, velocity, and conservation of momentum.

P11. **Determination of Planck's Constant:**
Experimentally determine Planck's constant using the photoelectric effect. Understand the quantum nature of light and the relationship between energy and frequency of photons.

Modes of Evaluation:

Components	**Theory**	**Lab**	
	Continuous Evaluation	**IA (internal assessment)**	**End Semester**
Weight%	**-----**	**40**	**60**

Course Name	Laboratory Course-II	L	T	P	C
Course Code	PHYS/CC/112	0	0	2	2

Course Objectives

This course aims to develop foundational programming skills in students through a series of practical assignments. Students will learn to implement algorithms for basic arithmetic operations, number comparisons, and mathematical computations such as finding roots of quadratic equations, factorials, GCD, LCM, and generating Fibonacci series. By the end of the course, students will be proficient in writing programs that solve real-world problems, enhancing their logical and computational thinking abilities.

Course Outcomes

CO1 Calculate cube volume. Perform basic arithmetic operations

CO2 Display the maximum of two numbers, and Identify largest and smallest of three numbers.

CO3 Find quadratic equation roots, Check if a year is a leap year.

CO4 Compute the factorial of a number, Check for Armstrong numbers.

CO5 Calculate GCD and LCM, and Generate Fibonacci series.

Course Contents: **60 Hr**

Unit I

P1. **Program to Calculate and Display the Volume of a Cube**
This program calculates the volume of a cube by taking the height, width, and depth as inputs from the user and then multiplying these values to find the volume.

P2. **Program for Arithmetic Operations**
This program takes two numbers as inputs and performs addition, subtraction, multiplication, and division, displaying the results of each operation.

P3. **Program to Display the Maximum Number**
This program inputs two numbers from the user and compares them, displaying the larger of the two numbers.

P4. **Program to Find the Largest and Smallest Among Three Numbers**
This program inputs three numbers, identifies the largest and smallest among them, and checks if these identified numbers are even or odd.

Unit II

P5. **Program to Find Roots of Quadratic Equation**
This program takes coefficients of a quadratic equation as inputs and calculates the roots using the quadratic formula, considering real and imaginary roots.

P6. **Program to Check Leap Year**
This program checks if a given year is a leap year by verifying if it is divisible by 4 and either divisible by 100 or 400.

P7. **Program to Find Factorial of a Number**
This program calculates the factorial of a given number by multiplying all positive integers up to that number.

P8. **Program to Check Armstrong Number**
This program checks if a given number is an Armstrong number, which means the sum of its own digits each raised to the power of the number of digits equals the number itself.

P9. **Program to Find GCD and LCM of Two Numbers**
This program calculates the greatest common divisor (GCD) and least common multiple (LCM) of two input numbers using mathematical algorithms.

P10. **Program to Generate Fibonacci Series**
This program generates the Fibonacci series up to a specified number, where each number is the sum of the two preceding ones, starting from 0 and 1.

Reference Books:

1. ***Practical Physics by Anchal Srivastava and RK Shukla***
2. ***"Programming in ANSI C" by E. Balagurusamy***

Modes of Evaluation:

Components	**Theory**	**Lab**	
	Continuous Evaluation	**IA (internal assessment)**	**End Semester**
Weight%	**-----**	**40**	**60**

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