ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF APPLIED & PURE SCIENCES

(RSAPS)

DEPARTMENT OF PHYSICS

COURSE STRUCTURE & SYLLABUS
(BASED ON NATIONAL EDUCATION POLICY 2020)
FOR

B.Sc. IN PHYSICS
(4 YEARS SINGLE MAJOR)

W.E.F
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Preamble

The National Education Policy (NEP) 2020 conceives a new vision for India's higher education system. It recognizes that higher education plays an extremely important role in promoting equity, human as well as societal well-being and in developing India as envisioned in its Constitution. It is desired that higher education will significantly contribute towards sustainable livelihoods and economic development of the nation as India moves towards becoming a knowledge economy and society.

If we focus on the 21st century requirements, the higher education framework of the nation must aim to develop good, thoughtful, well-rounded, and creative individuals and must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and twenty-first-century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education should be capable enough to enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to society. Overall, it should focus on preparing students for more meaningful and satisfying lives and work roles and enable economic independence.

Towards the attainment of holistic and multidisciplinary education, the flexible curricula of the University will include credit-based courses, projects in the areas of community engagement and service, environmental education, and value-based education. As part of holistic education, students will also be provided with opportunities for internships with local industries, businesses, artists, crafts people, and so on, as well as research internships with faculty and researchers at the university, so that students may actively engage with the practical aspects of their learning and thereby improve their employability.

The NEP 2020 curriculum of UG Physics courses is focused on developing a comprehensive understanding of the subject matter and to the need of the students to understand the basics of Physics, its applications, explaining the natural phenomenons and future perspective

The undergraduate curriculum is diverse and has varied subjects to be covered to meet the needs of the programs. As per the recommendations from the UGC, introduction of courses related to the Indian Knowledge System (IKS) is being incorporated in the curriculum structure which encompasses all of the systematized disciplines of knowledge which were developed to a high degree of sophistication in India from ancient times and all of the traditions and practises that the various communities of India—including the tribal communities—have evolved,

refined and preserved over generations, like for example Vedic Mathematics, Vedangas, Indian Astronomy, Fine Arts, Metallurgy, etc.

At RGU, we are committed that at the societal level, higher education will enable each student to develop themselves to be an enlightened, socially conscious, knowledgeable, and skilled citizen who can find and implement robust solutions to their own problems. For students at university, higher education is expected to form the basis for knowledge creation and innovation, thereby contributing to a more vibrant, socially engaged, cooperative community leading towards a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation."

1. Introduction

The National Education Policy (NEP) 2020 clearly indicates that higher education plays an extremely important role in promoting human as well as societal well-being in India. As envisioned in the 21st-century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. According to the new education policy, assessments of educational approaches in undergraduate education will integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) that will lead to positive learning outcomes. This will lead to develop creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning, and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. And more in-depth learning.

The NEP highlights that the following fundamental principles that have a direct bearing on the curricula would guide the education system at large, viz. i. Recognizing, identifying, and fostering the unique capabilities of each student to promote her/his holistic development.

ii. Flexibility, so that learners can select their learning trajectories and programmes, and thereby choose their own paths in life according to their talents and interests.

iii. Multidisciplinary and holistic education across the sciences, social sciences, arts, humanities, and sports for a multidisciplinary world.

iv. Emphasis on conceptual understanding rather than rote learning, critical thinking to encourage logical decision-making and innovation; ethics and human & constitutional values, and life skills such as communication, teamwork, leadership, and resilience.

v. Extensive use of technology in teaching and learning, removing language barriers,

increasing access for Divyang students, and educational planning and management.

vi. Respect for diversity and respect for the local context in all curricula, pedagogy, and policy.

vii. Equity and inclusion as the cornerstone of all educational decisions to ensure that all students can thrive in the education system and the institutional environment are responsive to differences to ensure that high-quality education is available for all.

viii. Rootedness and pride in India, and its rich, diverse, ancient, and modern culture, languages, knowledge systems, and traditions.

2. Approach to Curriculum Planning

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications such as a Bachelor's Degree (Hons) programme are earned and awarded on the basis of (a) demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and (b) academic standards expected of graduates of a programme of study.

The B.Sc. The Physics course curriculum and syllabus are framed on National Education Policy 2020. National Education Policy (NEP) 2020 for the B.Sc. degree in Physics offers a broad and balanced structural framework that includes all the current curricular needs. The course aims at mesmerizing the student to acquire knowledge, skills understanding, values, graduate attributes, and academic standards. Each course in the program is designed with clear instructional objectives which are mapped to the student's outcomes. An extensive range of advanced elective courses is available within the department and across the disciplines. Students awarded B.Sc. physics-based on this skills-based curriculum, will help them to make the right choice in their future endeavors.

3. Award of Degree in the said Programme

The bachelor's programme in Physics is a four year-degree course which is divided into 8 semesters as shown below. The certificate, diploma and degree that will be awarded in different stages are also mentioned in the table.

Sl. No	Year	Semester	Credits	Certificate/diploma/ degree/
1	1	I	20	UG Certificate in Physics
2		II	20	
3	2	III	20	UG Diploma in Physics
4		IV	20	
5		V	20	3-year UG Degree in Physics

6	3	VI	20	
7	4	VII	20	4-year UG Degree (Honours) in Physics OR 4-year UG Degree (Honours with Research) in Physics
8		VIII	20	
Grand Total Credits			**160**	

4. Graduate attributes

In general, learning of new and innovative things attracts the students who pursue the undergraduate program in science stream. The additional attributes which distinguish a student studying Physics are mentioned below.

Sl. No.	**Graduate Attribute**	**The Learning Outcomes Descriptors (The graduates should be able to demonstrate the capability to :)**
GA1	Disciplinary Knowledge	Ability to demonstrate comprehensive knowledge of physics and its sub fields, and its applications to one or more disciplines. The student should be knowledgeable enough to correlate the concerned theory with practical experiments.
GA 2	Creativity	Creativity is a valuable attribute for physics graduates as it enables them to approach problems from novel perspectives, propose innovative theories, design effective experiments, collaborate across disciplines, and communicate complex ideas. It drives scientific progress and contributes to the advancement of our understanding of the natural world.
GA 3	Complex problem solving	Problem-solving is an integral part of the physics syllabus. It is expected that the students will have the potential to think and inquire about relevant/appropriate questions, ability to define problems, formulate and test hypotheses, formulate physical arguments and proofs, draw conclusions; ability to present results
GA 4	Analytical & Critical thinking	The student should develop the skill of logical conclusions based on knowledge, facts, and observations. The students are expected to be equipped with the necessary analytical and critical thinking abilities.
GA 5	Communication Skills	Communication is important in any discipline. The physics discipline is not an exception. The student is expected to have the required skill to accumulate information and convey the same to the intended audience in an intelligent way in terms of oral presentation as well as a written documents.
GA 6	Digital and technological skills	By emphasizing on digital and technological skills throughout the Physics curriculum, graduates will not only be well-prepared for the evolving demands of the field, but also equipped to make meaningful contributions to research, industry, and technological advancements.
GA 7	Research-related skills	The students are expected to develop the skills for research and reviewing literature which enhance their project

		development skills, developing theories, testing hypotheses, generating ideas and integrating theoretical approaches
GA 8	Collaboration	Collaboration and communication are important in science . It allows us to work together, share ideas, and build upon each other's research. For researchers, it is even more important as it allows them to learn from more experienced researchers and grow in their skills without having to start from scratch. The students are expected to engage in different project works through collaboration
GA 9	Leadership readiness/qualities	Leadership quality is a very coveted characteristic for students, which, in turn, leads to a very effective class environment.
GA 10	Environmental awareness and action	This environmental statement is designed to be a focus for heightened environmental awareness, encouraging students to assess the environmental impacts arising from their activities and seeking ways to mitigate adverse impacts and improve environmental performance. The new strategy represents an increase in the societal, environmental, and economic benefits of physics. This will be achieved through partnerships with government, industry, and academia, as well as building on the foundations created over the last five years.

5. Programme Learning Outcomes (PLO) relating to UG degree programme in Physics

Students graduate with a degree B.Sc. (Physics) will be able to achieve the following:

PLO 1: Develop knowledge of Physics: Apply the basic knowledge of physics to the solution of advanced physics problems.

PLO 2: Develop Creativity skills: Development of creativity skills in physics not only enhances students' problem-solving skills but also prepares them to be innovative thinkers who can contribute to advancements in the field. This approach aligns with the evolving nature of physics and the ever-increasing need for imaginative solutions to complex challenges.

PLO 3: Conduct Investigations of Complex Problems: Uses research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PLO 4: Ability to solve critical problems: Identify, formulate, research literature, and analyze complex physics problems critically, reaching substantiated conclusions using the principles of physics.

PLO 5: Develop effective communication skills: Communicate effectively on physics related activities with the community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, also give and receive clear instructions.

PLO 6: Use of digital and technological skills: Make use of digital and technology in physics,

can prepare students not only for traditional physics careers but also for emerging fields where technology and physics intersect. This approach equips students to navigate the modern scientific landscape and make meaningful contributions to research and innovation.

PLO 7: Develop research, design & development skills: Design solutions for advanced physics problems and design system components or processes based on research that shows the hidden truth of nature.

PLO 8: Develop Scientific collaboration: Effective collaboration with established and renowned institutions throughout the nation and abroad can impact on the holistic benefit of society (health, safety, legal), cultural issues and the consequent responsibilities relevant to physics applications.

PLO 9: Ethics, Individual and Team Work: Apply ethical principles and commit to professional ethics and responsibilities and norms of the physics practice. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PLO 10: Environment and Sustainability: Understand the impact of the applied physics solutions in societal and environmental contexts, and demonstrate the knowledge for sustainable development.

6. Programme Specific Outcomes

PSO1: Building a critical understanding of the subject matters to conduct research and analyze complex problems in physics.

PSO2: Communicate the concept of physics in effective ways individually or as a team member.

PSO3: Apply the concept of physics to develop new and innovative ideas/solutions in physics and allied fields for the society and the environment at large.

7. Teaching Learning Process

Teaching and learning in this programme involves classroom lectures as well as tutorials.
It allows-

- the tutorials allow a closer interaction between the students and the teacher as each student gets individual attention.
- Written assignments and projects submitted by students
- project-based learning
- Group discussion
- Home assignments
- Quizzes and class tests
- PPT presentations, Seminars, interactive sessions
- Sociology-economic survey
- Co-curricular activity etc.
- Industrial Tour or Field visit

8. Assessment Methods

Methods	Weight-age
Theory	
Semester End Examination	70%
Continuous Evaluation: (Assignment, Class Test, Viva, Seminar, Quiz: Any Three)	15%
Mid-term examination	10%
Attendance	5%
Total	**100%**
Practical	
Semester End Examination	70%
Continuous Evaluation: (Skill Test, lab copy, viva, lab involvement: Any Three)	25%
Attendance	5%
Total	**100%**

9. Programme Structure (8 Semesters)

Semester wise and component wise distribution of credit (Four Year UGP - Single Major): **Physics**

Year	Semester	Component	Course code	No. of Courses	Course title	Level	Credit per Course	Total credit in the component
First Year	I	Major (Core)	PHY012M101	2	Mechanics	100	3	6
			PHY012M111		Physics Lab I		3	
		Minor	PHY012N101	1	Fundamentals of Physics		3	3
		Interdisciplinary	IDC-1	1	Introduction to Indian Knowledge System – I		3	3
		AEC1-Language (English/MIL/Regional Language)	CEN982A101 and BHS982A102	1	Communicative English and Behavioral Science-I		2	2
		SEC-(Chosen from a pool of courses)	PHY012S111	1	Physics Workshop Skills		3	3

		VAC- (chosen from a pool of courses)	VAC-1	1	From basket courses		3	3
				7				20
	II	Major (Core)	PHY012M201	2	Electricity and Magnetism	100	3	6
			PHY012M211		Physics Lab II			
		Minor	PHY012N211	1	General Physics Lab I		3	3
		Interdisciplinary	IDC-2	1	Introduction to Indian Knowledge System – II		3	3
		AEC1-Language (English MIL/Regional Language)	CEN982A201 and BHS982A202	1	Communicative English and Behavioral Science-II		2	2
		SEC-(Chosen from a pool of courses)	PHY012S211	1	Electrical Circuit and Network Skills		3	3
		VAC- (chosen from a pool of courses).	VAC-2	1	From basket courses		3	3
				7				20
Second Year	III	Major (Core)	PHY012M301	2	Ray and wave optics	200	4	8
			PHY012M302		Mathematical Physics-I			
		Minor	PHY012N301	1	Modern Physics		4	4
		Interdisciplinary	IDC-3	1	IKS related to the major field of specialization		3	3
		AEC1-Language (English MIL/Regional Language)	CEN982A301 and BHS982A302	1	Communicative English and Behavioral Science-III		2	2
		SEC - (Chosen from a pool of courses)	PHY012S311	1	Basic Instrumentation skills		3	3
				6				20
	IV	Major (Core)	PHY012M401	3	Thermal & Statistical Physics	200	4	12
			PHY012M402		Nuclear & Particle Physics		4	
			PHY012M411		Physics Lab III		4	

		Minor	PHY012N401	2	Atomic and Nuclear Physics		3	6
			PHY012N411		General Physics Lab II		3	
		AEC1-Language (English MIL/Regional Language)	CEN982A401 and BHS982A402	1	Communicative English and Behavioral Science-IV		2	2
				6				20
Third Year	V	Major (Core)	PHY012M501	3	Classical and Quantum Mechanics	300	4	12
			PHY012M502		Atomic & Molecular Physics			
			PHY012M503		Electrodynamics			
		Minor	PHY012N501	1	Fundamentals of Thermal Physics		4	4
		Internship	PHY012M521	1			4	4
				5				20
	VI	Major (Core)	PHY012M601	4	Electronics	300	4	16
			PHY012M602		Waves Oscillation & Sound		4	
			PHY012M603		Solid State and Mathematical Physics-II		4	
			PHY012M621		Minor Project		4	
		Minor	PHY012N601	1	Physical Optics		4	4
				5				20
Fourth Year	VII	Major (Core)	PHY012M701	4	Theory of relativity	400	4	16
			PHY012M702		Astronomy		4	
			PHY012M703		Mathematical Physics-III		4	
			PHY012M721		Major Project		4	
		Minor	PHY012N701	1	Basics of electronics		4	4
				5				20
	VIII	Major (Core)	PHY012M801	1	Methods of selected instruments used Physical Sciences	400	4	4

					Research			
		Research Methodology	PHY012 M802	1	Research Methodology		4	4
		Dissertation/Research Project	PHY012 M821	1			12	12
		For the students who are not eligible for the Dissertation/Research Project*						
		Or 400 level advanced course Core (in lieu of Dissertation/Research Project)	PHY012 M803	3	Fiber Optics and Basic of Laser	400	4	12*
			PHY012 M803		Plasma and space physics		4	
			PHY012 M803		Nanophysics		4	
				3 or 5				20

Detailed Syllabus

Level: Semester I

Course Level: C-101

Name of the Subject: Mechanics

Type of Course: Major

Subject Code: PHY012M101 **Scheme of Evaluation: Theory**

L-T-P-C: 3-1-0-3 **Total credits: 3**

Course Objectives:
This course begins with the review of Newton's Laws of Motion and ends with the Fictitious Forces and Special Theory of Relativity and to develop the understanding of Collisions in center of mass (CM) frame, Gravitation, Rotational Motion and Oscillations.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r Newton's laws of motion and applications.	**BT 1**
CO 2	**Understand** the concept of inertial reference frames and Galilean transformations, conservation of energy, momentum, angular moment, the analogy between transnational and rotational dynamics, variable mass system	**BT 2**
CO 3	**Apply** the concept of moment of inertia to the given axis of symmetry for different uniform mass distributions, the phenomena of collisions and the idea about center of mass and laboratory frames.	**BT 3**
CO 4	**Analyze** the concept of different types of elastic constants, energy in a strained body, bending moment, cantilevers, the concept of flow of liquids, simple harmonic motion, Centrifugal force and Coriolis forces, special theory of relativity.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Fundamentals of Dynamics:** Reference frames, Inertial frames, Galilean transformations, Review of Newton's Laws of Motion, Momentum of variable mass system: motion of rocket, Dynamics of a system of particles Center of mass, Principle of conservation of linear and angular momentum, Impulse. **Rotational Dynamics:** Angular momentum of a particle and system of particles. Torque. Moment of inertia, theorem of parallel and perpendicular axes. Calculation of Moment of Inertia for Rectangular, Cylindrical, and Spherical Bodies. Motion involving both translation and rotation.	**15**
II.	**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of energy. Elastic (1-D and 2-D) and inelastic collisions. **Elasticity:** Different types of elastic constants and relations among them. Energy in a strained body, bending of a beam, bending moment, cantilever, depression of a cantilever considering the weight of the beam.	**15**
	Flow of Liquids: Equation of continuity, Bernoulli's Theorem, Viscosity: Poiseullie's equation for flow of a liquid through narrow tube. Surface tension, relation between surface tension and surface energy.	

III.	**Oscillations:** Idea of SHM. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations.	**15**
IV.	**Motion of a particle under a central force field:** two-body problem, its reduction to one-body problem and its solution. Kepler's Laws. Gravitational Law and Field. **Non-Inertial Systems:** Non-inertial frames and fictitious forces. Uniformly rotating frame. Centrifugal force. Coriolis force. **Special Theory of Relativity:** Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity, Length contraction, Time dilation. Relativistic transformation of velocity, and acceleration. Mass of relativistic particles. Mass-energy Equivalence.	**15**
Total		**60**

Text Books:

1. *An Introduction to Mechanics*, Kleppner D. &Kolenkow R., Tata McGraw Hill (2007).
2. *Physics* – Resnick, Halliday & Walker 9/e, Wiley, Tata McGraw Hill (2010).

Reference Books:

1. Purcell E.M. *Mechanics*, (Ed): Vol. I, McGraw Hill.Berkely Physics Course,2nd*edition*(2017).
2. Feynmam R.P. et. al., *The Feynmam Lectures in Physics*, Vol.I, B.I. Publication (2012).

Additional Readings:

1. Resnick R. *Introduction to Special Relativity*, John Wiley and Sons (2005)
2. *Elements and properties of matter* - Mathur D.S., S. Chand Publication, 11th Edition (2016).

NPTEL LINK: https://nptel.ac.in/courses/115/106/115106123

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
60 hrs	O	30 hrs

Level: Semester I

Course Level: C-102

Name of the Subject: Physics Lab I

Type of Course: Major

Subject Code: PHY012M111 **Scheme of Evaluation: Practical**

L-T-P-C: 0-0-3-3 **Total credits: 3**

Course Objective:

To familiarize with different basic experiments of Physics and to understand the working of different devices like M I table, Kater's pendulum etc.

Course Outcome:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Find** different physical devices.	**BT 1**
CO 2	**Demonstrate** different mechanisms like Searle's apparatus, capillary tube etc.	**BT 2**
CO 3	**Apply** different methods in experiments.	**BT 3**
CO 4	**Analyze** different experimental results with error calculations.	**BT 4**

List of experiments:

1. To determine the Moment of Inertia of a given solid about its own axis by using M.I.Table
2. To determine the Young's Modulus of a Wire using Searle's Apparatus
3. To determine g by Kater's Pendulum.
4. To determine surface tension capillary tube method.
5. Measurement of excitation and ionization potential using the Frank and Hertz experiment.
6. Determination of refractive index of a transparent liquid by using a travelling microscope.
7. To find the density of the material of a wire by employing sonometer.
8. To determine the frequency of a tuning fork of Melde's experiment.
9. Determination of spring constant using static and dynamic method.
10. Analysis of elliptically polarized light using Babinet Compensator.

Text

1. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
2. *B.Sc. Practical Physics* P. R. Sashi Kumar, Prentice Hall India learning (2011).

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition (2012)

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
0	60 hrs	30 hrs

Level: Semester I

Course Level: M-101

Name of the Subject: Fundamentals of Physics

Type of Course: Minor

Subject Code: PHY012N101 **Scheme of Evaluation: Theory**

L-T-P-C: 3-1-0-3 **Total credits: 3**

Course Objective: To give some basic knowledge of mathematical physics, rotational motion, electricity, thermodynamics and modern physics

Course Outcome:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the nature of differential equations, laws of rotational motion, laws of thermodynamics	**BT 1**
CO 2	**Understand** a few primary concepts of mathematical physics, rotational motion, electricity, thermodynamics, and modern physics	**BT 2**
CO 3	**Apply** different laws of mathematical physics, electricity, rotational motion, and thermodynamics to solve different physics-related problems.	**BT 3**
CO 4	**Analyze** the effect of different mathematical operations on a physical parameter, importance of rotational axis, effects of electricity on different circuit elements and the effect of temperature in a thermodynamics system.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	Order and degree of differential equation, 1st order differential equation and solution, second order differential equation and solution, Complementary function, Particular integral, Gradient, Divergence, Curl and significance and related problems	**15**
II	Frame of reference, Newton's Laws of motion, Rotational motion, Angular velocity and momentum, couple, Torque, moment of inertia, Calculation of MI for rectangular block, disk, ring, earth etc.	**15**
III	Gauss theorem and its applications- Electric field due to point charge, infinite line of charge, spherical shell, solid sphere, Faraday's law of electromagnetic induction, Lenz law, Self and mutual inductance, Maxwell's equations and their significance.	**15**
IV	Zeroth law of Thermodynamics, concept of temperature, internal energy, First law of Thermodynamics, Second law of Thermodynamics, Carnot's cycle and theorem, Third law of Thermodynamics, Concept of modern Physics, Blackbody radiation, Rayleigh Jeans law, Wiens law, Planck's law, Photoelectric effect.	**15**
Total		**60**

Text:

1. *Mathematical Physics* by: Das H.K. S. Chand publishing (2018)
2. *Elements and properties of matter* - Mathur D.S., S. Chand Publication. (2018)

Reference Books:

1. Concept of Modern Physics; Beiser A., McGraw Hill Education; 6th Ed., 2002, New Delhi
2. Mathematical methods for physicists, Arfken and Weber Academic Press (2017)

Study material:

http://www.digimat.in/nptel/courses/video/115106086/L29.html;https://www.youtube.com/watch?v=Xr1E46TFBfc

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
60 hrs		30 hrs

Level: Semester I

Course Level: SEC-1

Name of the Subject: Physics Workshop Skills

Type of Course: SEC

Subject Code: PHY012S111 **Scheme of Evaluation: Practical**

L-T-P-C: 0-0-3-3 **Total credits: 3**

Course Objective:
To develop the foundation of physical laws and theory related to laboratory physics, and hands on skill of measurement instruments, optics, elasticity and electricity.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**recall** vernier scale, screw gauge, spherometer, spectrometer, prism optical bench, Young's modulus instrument.	**BT 1**
CO 2	**demonstrate** the logic and principles behind the measurement techniques.	**BT 2**
CO 3	**apply** the knowledge to measure small distances, diameter and radius of rods, Young's modulus, image distance and focal distances of lens, prism parameter etc.	**BT 3**
CO 4	**discover**skills to perform the experiments to solve real problems related to above mentioned apparatuses.	**BT 4**

List of experiments:

1. To determine the Young's Modulus of the material of the given rod by bending of beam.
2. Determination of Power of given lenses using an optical bench (i) Concave lens (ii) Convex lens.
3. Determination of Refractive Index of the material of a prism by spectrometer using minimum deviation method.
4. To use a prism shaped double refracting crystal to determine the refractive indices of the material corresponding to ordinary and extra-ordinary rays.
5. To determine the (a) Charge Sensitivity and (b) Current Sensitivity of a B.G.
6. Principles and applications of vernier scale, screw gauge, spherometer.

Text

1. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
2. *B.Sc. Practical Physics* P. R. Sashi Kumar,Prentice Hall India learning (2011).

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition(2012).

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning

0	60 hrs	30 hrs

Level: Semester II

Course Level: C-103

Name of the Subject: Electricity and Magnetism

Type of Course: Major

Subject Code: PHY012M201 **Scheme of Evaluation: Theory**

L-T-P-C: 3-1-0-3 **Total credits: 3**

Course Objective:

To develop the strong foundation for electricity and magnetism for application in practical fields and analytical concepts of electricity, basic laws of electricity, magnetism

Course Outcome:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Define the** phenomena of electrical fields and the properties for basic phenomena.	**BT 1**
CO 2	**Understand** the properties and importance of polarization, susceptibilities, and dielectric constants.	**BT 2**
CO 3	**Apply e**lectric and magnetic properties to different material and study the characteristic output.	**BT 3**
CO 4	**Analyze** different formulas and solve numerical of alternating current, Kirchhoff's law, LCR, RC, and RLC Circuits.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Electric Field and Electric Potential: Electric field**: Electric field: Electric field lines. Electric flux. Coulombs law, Gauss Law with applications to charge distributions with spherical, cylindrical, and planar symmetry. Electrostatic Potential. Electrostatic boundary conditions, Laplace's, and Poisson equations. The Uniqueness Theorem. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Capacitance of an isolated conductor.	**16**
II	**Dielectric Properties of Matter**: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, Cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss Law in dielectrics.	**14**
III	**Magnetic Field**: Magnetic force between current elements and the definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Ampere's Circuital Law and its application to (1) Solenoids and (2) Toroids. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. **Magnetic Properties of Matter**: Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. relation between B, H, M. Ferromagnetism.BH curve and hysteresis.	**15**
IV	**Electromagnetic Induction**: Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Poynting's theorem, Displacement current. Lorentz Force and motion of charged particles in electric and magnetic fields. **Electrical Circuits**: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (Resonance, Power Dissipation,	**15**

	Quality Factor, and Band Width). Parallel LCR Circuit. DC Circuits: Transient Response of Series *R-L* Circuit, *R-C* Circuit, *RLC* Circuit having DC Excitation, Transient Response of Parallel *RLC* Circuit having DC Excitation	
	Total	**60**

Texts:

1. *Electricity and magnetism D. C. Tayal*. Himalaya publishing house. New Delhi, 4 th Ed., 2019
2. *Electromagnetics* B.B. Laud. Wiley Eastern limited.

Reference Books:

1. Edward M. P. *Electricity and Magnetism* (McGraw-Hill Education,1991).
2. Griffiths D.J., *Introduction to Electrodynamics*, Pearson Education India Learning Pvt. Limited; 4th edition (2015).

Additional Readings

1. R.P. Feynman, *R.B. Leighton, M. Sands*, Feynman Lectures Vol.2, , 2008, Pearson Education
2. Arthur F. Kip, *Fundamentals of Electricity and Magnetism*, 2nd Edn.1981, Mc Graw Hill.

NPTEL LINK: https://archive.nptel.ac.in/courses/115/106/115106122

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
60 hrs		30 hrs

Level: Semester II

Course Level: C-104

Name of the Subject: Physics Lab II

Type of Course: Major

Subject Code: PHY012M211 **Scheme of Evaluation: Practical**

L-T-P-C: 0-0-3-3 **Total credits: 3**

Course Objective:

To familiarize the student with different basic experiments of Physics and to understand the working of different devices like lenses, biprism, Zener diode etc.

Course Outcome:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Find** different physical devices.	**BT 1**
CO 2	**Demonstrate** different mechanisms like statical method, Newtons' ring method etc.	**BT 2**
CO 3	**Apply** different methods in experiments.	**BT 3**
CO 4	**Analyze** different experimental results with error calculations.	**BT 4**

List of experiments:

1. To determine the radius of curvature of the lower surface of a plano-convex lens by using Newtons ring method.
2. To verify the Law of Malus for Plane Polarized Light.
3. To determine the wavelength of sodium light using Fresnel Biprism.
4. Determination of Rigidity of Modulus of the material of the given rod by Statical method.
5. To measure the Self Inductance of a Coil by Anderson's Bridge method.
6. To find the refractive index of a liquid with the help of a convex lens and a plane mirror.
7. To study the response curve of a Parallel LCR circuit and determine its (a) Anti-Resonant Frequency and (b) Quality Factor Q.
8. To measure the mechanical equivalent of heat by an electrical method.
9. To study absorption spectra of Iodine molecule and to determine its dissociation energy using spectrometer.
10. To study the Forward and Reverse characteristics of a Zener Diode and to study its use as a Voltage Regulator.
11. Study of Zeeman Effect and determination of e/m of electron.

Text

1. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
2. *B.Sc. Practical Physics* P. R. Sashi Kumar, Prentice Hall India learning (2011).

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition (2012)

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
0	60 hrs	30 hrs

Level: Semester II

Course Level: M-102

Name of the Subject: General Physics Lab I

Type of Course: Minor

Subject Code: PHY012N211 **Scheme of Evaluation: Practical**

L-T-P-C: 0-0-3-3 **Total credits: 3**

Course Objective:
To familiarize with a few basic experiments of Physics and to understand the working of different devices like Post Office Box, Searle's apparatus etc.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Operate different physical devices.	**BT 1**
CO 2	Work with different mechanisms, like torsional oscillation method, electrical method, etc.	**BT 2**
CO 3	Apply different methods in experiments.	**BT 3**
CO 4	Analyze different experimental results with error calculations.	**BT 4**

LIST OF EXPERIMENTS

1. Determination of Resistance of a Galvanometer using Post Office Box.
2. Determination of E.C.E. of copper by using an ammeter and a copper voltmeter.
3. Determination of Young's modulus of the material of a given wire Searle's apparatus.
4. Determination of the value of acceleration due to gravity by using the given bar Pendulum.
5. Determination of the moment of inertia of the given body about an axis passing through its center of gravity by torsional oscillation method.
6. Determine earth's horizontal intensity.
7. To measure the mechanical equivalent of heat by an electrical method.
8. Determination of viscosity.

Text

1. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
2. *B.Sc. Practical Physics* P. R. Sashi Kumar,Prentice Hall India learning (2011).

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition (2012)

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
0	60 hrs	30 hrs

Level: Semester II

Course Level: SEC-2

Name of the Subject: Electrical Circuit and Network Skills

Type of Course: SEC

Subject Code: PHY012S211 **Scheme of Evaluation: Practical**

L-T-P-C: 0-0-3-3 **Total credits: 3**

Course Objective:

To acquaint the student with different electrical elements/deviceand their working to apply in different electrical circuit

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**find** different electrical devices	**BT 1**
CO 2	**understand** the working of different electrical elements/devices	**BT 2**
CO 3	**apply** different electrical elements to design electrical circuits	**BT 3**
CO 4	**analyse** the output of different electrical circuits.	**BT 4**

List of experiments:

1. To draw the static characteristics curves of a PN junction diode in forward bias and hence determine its DC and AC resistances for a given current.
2. To determine thee.m.f. of a cell usinga cellof know e.m.f. with the help of potentiometer.
3. To study input and output characteristics of a npn Bipolar Junction Transistor (BJT) in Common- emitter configuration.
4. Assembling and testing of electrical switch boards
5. To study the RC characteristics using an Oscilloscope and Multimeter.
6. To study the response curve of a Series LCR circuit and determine its (a) Resonant Frequency, (b) Impedance at Resonance and (c) Quality Factor Q, and (d) Band Width.

Text

1. *B.Sc. Practical Physics* C.L. Arora S. Chand 20th edition (2010).

References:

1. Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition(2012).

Study material: https://nptel.ac.in/courses/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
0	60 hrs	30 hrs

Level: Semester III

Course Level: C-301

Name of the Subject: Ray and Wave Optics

Type of Course: Major

Subject Code: PHY012M301 **Scheme of Evaluation: Theory**

L-T-P-C: 3-1-0-4 **Total Credit: 4**

Course Objectives:
This course begins with the concepts of image formations, light propagation, corpuscular theory and wave theory of light to orient the students towards optics. Following that it will give the idea of lenses and other optical instruments and their uses. This course will also equip the students with knowledge of optical phenomena , such as, interference, diffraction, polarization etc.

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember Fermat's principle, the ray equation, and the thick lenses equation.	BT 1
CO 2	Understand the optical phenomena such as interference, diffraction, polarisation, and birefringence.	BT 2
CO 3	Apply knowledge of interference and diffractions in optical devices such as interferometers, slits and gratings. Solve problems related to optical aberrations, image formation and wavelength determination.	BT 3
CO 4	Analyze the use of normal and polarized light in thin film and birefringent materials in optical imaging systems, with emphasis on the human eye, the camera, the telescope and the microscope.	BT 4

Course Outline:

Modules	**Topics / Course content**	**Periods**
I	**Geometrical optics:**:Fermat's principles. Deduction of laws of reflection and refraction using Fermat's principle for plane and curved surfaces. Deduction of lens maker's formula. Thick lens: cardinal points (deduction not necessary), Construction of the image using Cardinal Points, Newton's Formula, Magnification for a Coaxial lens system.	**18**
II	**Defects of image:**Lens Aberration, Monochromatic aberration and chromatic aberration, Different types of monochromatic aberration (Spherical Aberration, COMA, Astigmatism, Curvature of the Field, Distortion). Chromatic aberration and its correction, Circle of Least Chromatic Aberration, Achromatic lenses and its condition.	**18**
III	**Wave Optics:**Newton's Corpuscular Theory, Reflection and refraction of light on Corpuscular Theory, Huygen's Principle, Reflection and refraction of a Plane Wave front at a Plane and Spherical Surface, Reflection and refraction of a Spherical Wave front at a Plane and Spherical Surface. Interference: coherent sources, principle of interference and Yong's double slits experiment, interference in Fresnel's mirrors and Biprism, Lloyd's single mirror, Newton rings, Michelson interferometer.	**18**
IV	**Diffraction and Polarization:**Diffraction: Principles of Fresnel and Fraunhofer Diffraction,Fraunhofer Diffraction at a single slit, double slit and at N slit, Plane Diffraction Grating, Dispersive power of a Grating. Polarization of light: Polarized light, Plane of Polarization, Brewster's Law, Malus Law, Double Refraction, Principal Plane, Nicol Prism, Elliptically and Circularly Polarized light, Quarter and Half wave plate.	**18**
	Total	**72**

Text:

1. *Fundamental of Optics; Jenkins F.A. and White H.E.: McGraw Hill, 4t edition, 2011.*

Reference Books:

1. Ghatak A.K, Optics, 2014. McGraw Hill Education; 5th edition2017.
2. Born and Wolf, Principles ofOptics,7thedition ,1999.

Additional Reading:

1. Arthur Schuster, *An Introduction to the Theory of Optics*, London: Edward Arnold, 1904.
2. Nader El-Bizri (2005), *A Philosophical Perspective on Alhazen's Optics*, Arabic Sciences and Philosophy. **15** (2): 189–218.
3. M. Born and E. Wolf (1999). *Principle of Optics*. Cambridge: Cambridge University Press.

NPTEL LINK: https://archive.nptel.ac.in/courses/115/107/115107131/

6

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
72 hrs	O	48 hrs

Level: Semester III

Course Level: C-302

Name of the Subject: Mathematical Physics I

Type of Course: Major

Subject Code: PHY012M302 **Scheme of Evaluation: Theory**

L-T-P-C: 3-1-0-4 **Total credits: 4**

Course objectives: This course will help the students to understand, apply, analyze, and evaluate different physical systems using mathematical concepts like vector algebra, matrices, special functions, etc.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remember** different topics like vectors, scalars, different types of matrices, gamma function, etc.	**BT 1**
CO 2	**understand** Gradient of a scalar field, Divergence and curl of a vector field, Rodrigues' Formulae, Legendre's polynomial etc.	**BT 2**
CO 3	**apply** the topics length, area and volume elements in different coordinate system, Legendre's Hermite differential equation, equally likely, independent events etc.	**BT 3**
CO 4	**analyze** and evaluate different problems of distinguished topics like gradient, divergence, curl, eigen value, eigen vector, Bessel's function, probability distributions etc.	**BT 4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I.	**Vector Calculus:** Understanding of Vectors, Scalars, Vector algebra, Product rules, Vector fields, scalar fields. Vector triple product, Gradient of a scalar field, Divergence and curl of a vector field, and their applications in different problems, Del and Laplacian operators. Evaluation of related problems. **Orthogonal Curvilinear Coordinates:** Concept of Orthogonal and non-orthogonal, Right handed and Left Handed Cartesian system, Analysis of Length, area and volume elements in cartesian, spherical and cylindrical coordinate systems. Vector identities, Gradient, divergence, curl and Laplacian in all these systems, Evaluation of related problems.	**18**
II	**Matrices:** Concept of Different types of matrices: Row, column, null, square, diagonal etc. Matrix addition, multiplication, and their properties, analysis of adjoint of matrix, determinant of matrix, inverse of matrices, Evaluation of Eigen value, Eigen vector. Solution of simultaneous linear equations. Diagonalisation of matrix.	**18**
III.	**Special functions (no rigorous derivations):** Understanding of Beta and Gamma functions and their properties, relation between them, analysis of Legendre's differential equations, Legendre's polynomial, Hermite's differential equations, Hermite's polynomial. Laguerre differential equation and laguerre Polynomials. Application of Rodrigues' Formulae for Lengendre, Hermite, Laguerre polynomials, Evaluation of Related problems. Bessel Functions: First and Second Kind, Recurrence Formulas, Zeros of Bessel Functions and Orthogonality.	**18**
IV	**Probability theory:** Analysis of Equally likely events, Independent events, Mutually exclusive events, Compound events, Favourable events, Expected value, Addition and Multiplication law of probability. Evaluation of related problems. Probability distributions - Gaussian distribution, mean and standard deviation, Poisson distribution. Theory of errors and related problems.	**18**
	Total	**72**

Text:

1. *Mathematical Physics* by: Das H.K. S. Chand publishing 8th edition (2018).
2. *Mathematical Physics* by: George B. Arfken, Elesvier Publisher 7th edition (2012).

NPTEL LINK https://nptel.ac.in/courses/111106148

Reference Books:

1. Rajput and Yogprakash *Mathematical Physics,* Pragati Prakashan, Meerut (2014).

Additional Readings:

3. Mathematics for Physicists (Dover Books on Physics), New edition, (1996)

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
72 hrs	O	48 hrs

Level: Semester III

Course Level: M-301

Type of Course: Minor

Course name: Modern Physics

Subject Code: PHY012N301 **Scheme of Evaluation: Theory**

L-T-P-C: 2-1-0-3 **Total Credit: 3**

Course Objectives: On completion of this course, students will be able to gain a basic understanding of modern physics such as Special Theory of relativity, basic quantum mechanics, nuclear structure, Radioactive decay and Elementary particles, Semiconductor and Superconductivity, laser and optical fibers etc.

Course Outcome:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the special theory of relativity, inadequacy of classical physics, quantum physics, nuclear physics, lasers etc.	**BT 1**
CO 2	Understand the concepts, principles and theory behind the fundamentals of relativity, quantum particles, nuclear emission, solid state materials, lasers	**BT 2**
CO 3	Apply the knowledge of inertial and non-inertial frames, nuclear reactions, particles physics, semiconductor devices, laser emission to quantify and solve problems related to those fields.	**BT 3**
CO 4	Analyze and discus the outcome and findings of solved problems and study of experimental verification of the underlying physical phenomena	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	Special theory of relativity: inertial frame of reference, Galilean transformations, velocity of light, Michelson-Morley experiment, Lorentz transformations, consequences of Lorentz transformations. Quantum theory: inadequacy of classical mechanics, the Frank-Hertz experiment, Spatial(space) quantization, the uncertainty principle, application of uncertainty principle.	**15**
II	Nuclear structure: Nuclear composition, nuclear properties, stable nuclei, binding energy; Nuclear transformation: Radioactive decay, half-life, alpha, beta and gamma decay, nuclear fission, and fusion; Elementary particles: interactions and particles, types, concept of quark.	**15**
III	Crystal structure and defects: space lattice and crystal structure, Bravis lattice, unit cell, atomic radius, density of crystal, coordinates number, Millar indices and crystal planes. Crystal bonding: ionic, covalent, metallic, molecular, or van-Waal's bonding, hydrogen bonding Semiconductor: Atomic structure and energy level, energy bands, conductor, semi-conductors and insulators, Fermi-Level, intrinsic and extrinsic semiconductor. Superconductivity: Experimental features of superconductivity, special features of superconductor, BCS theory of superconductivity, cooper Pairs	**15**
IV	Laser: Introduction, principle of Laser, working mechanism of three and four level laser, Important properties of Laser, applications of Lasers. Optical fibers: total internal reflection in optical fibers classification of optical fibers, advantages of optical fiber.	**15**
	Total	**60**

Text:

1. *Concept of Modern Physics*; Beiser A., McGraw Hill Education; 6th Ed., 2015, NewDelhi.
2. *Modern Physics*; Murugeshan R.and Sivaprasath K., S Chand, 18th Ed., 2016, NewDelhi.

Reference Books:

1. Krane K. S.; *Modern Physics*, John Wiley & Sons, 3rd Ed.,2012.
2. Kakani S.L. and Kakani S.*; Modern Physics*, Viva Books Pvt. 1st Ed. 2007, NewDelhi.

Additional Reading:

1. Gary N. Felder, *Discover Modern Physics*, 1st Edition, HB ISBN: 9781108842891
2. Mandal P., *Modern Physics*, Publisher Techno World (29 January 2021) B08N12HN53

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105104/

https://www.mooc-list.com/tags/modern-physics

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
60 hrs	O	30 hrs

Level: Semester IV

Course Level: S-401
Name of the Subject: Basic Instrumentation Skill
Subject Code: PHY012S411 **Scheme of Evaluation: Practical**
L-T-P-C: 0-0-2-2 **Total Credit: 3**

Course Objective:

To acquaint the student with the measurement of some selected electrical parameters and design of basic circuits.

Course Outcome:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember various terms associated with a few selected electrical devices.	BT 1
CO 2	Understand the measurement and design procedure of the selected electrical parameters and devices.	BT 2
CO 3	Apply the selected devices to measure voltage, current in a circuit.	BT 3
CO 4	Analyse the working characteristics of ammeter as a voltmeter, Wheatstone bridge.	BT 4

List of experiments:

1. To calculate the value of inductive reactance (X_L) of the coil at a particular frequency
2. To determine an unknown Low Resistance using Carey Foster's Bridge
3. To measure unknown voltage using DC potentiometer
4. To convert an ammeter into a voltmeter
5. To design a multi-range ammeter and voltmeter
6. To design a Wheatstone bridge

Text

3. *B.Sc. Practical Physics* C.L. Arora S. Chand 20th edition (2010).

References:

1. Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition(2012).

Additional Reading:

1. Jayanthi, Dr.A.N **.,** *Analog and digital circuit laboratory manual: ADC Lab manual.,* Notion press, (2021), ISBN: 9781639573677

NPTEL Link: https://nptel.ac.in/courses/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
60 hrs		30 hrs

Level: Semester IV

Course Level: M-401
Name of the Subject: Thermal & Statistical Physics
Type of Course: Major
Subject Code: PHY012M401 **Scheme of Evaluation: Theory**
L-T-P-C: 2-1-0-3 **Total credits: 3**

Course Objectives:
The objective of this course is to learn how to apply thermodynamic principles in order to interpret thermodynamic systems and to become familiar with the use of simple statistical mechanical models to predict thermodynamic properties.

Upon successful completion of the course, students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**Blooms Taxonomy Level**
CO1	Identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, free energies, and partition functions.	**BT1, BT2**
CO2	Apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.	**BT3**
CO3	Use the statistical Physics methods, such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems.	**BT4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Kinetic Theory of Matter:** Concept of Ideal or Perfect Gas, Degrees of Freedom, Maxwell's Law of Equipartition of Energy, Specific heat of Mono, Di, and Polyatomic gas, Change of State, Van der Walls' equation of State, Equation of State, Joule-Thomson Effect, Mean Free Path.	**15**
II	**Thermodynamics:** Laws of Thermodynamics, Zeroth law and concept of thermal equilibrium. First law and its consequences. Isothermal and adiabatic processes. Reversible, irreversible and quasi-static processes. Second law and entropy. Carnot cycle.	**15**
III	**Thermodynamical Relationship:** Maxwell's Thermodynamical Relations, Clausius-Clapeyron heat equation, Thermodynamic potentials and equilibrium of thermodynamical systems, Phase Transition (First Order and Second Order).	**15**

IV	**Statistical Physics:** Statistical Basics, Probability and Thermodynamic Probability, Degree of Freedom, Position and Momentum Space, Phase Space, Liouville's theorem, Statistical Ensemble (Microcanonical, Canonical and Grand-canonical), Entropy and Probability, Maxwell-Boltzmann, Fermi- Dirac and Bose-Einstein distributions	**15**
	Total	**60**

Textbook:

1. *Statistical mechanics*, R. K Patharia, Elsevier publications, 3rdedition, 2011.
2. *Fundamentals of Statistical and Thermal Physics*; F. Reif, Sarat Book House Pvt. Ltd, 1st Ed., 2009, Kolkata.
3. *Heat and thermodynamics*, Zemansky and Dittman, 7th edn.

Reference Books:

1. *Statistical and Thermal Physics- An introduction*, Lokanathan S. and Gambhi R.S.; P.H.I., 1st Ed., 2008, New Delhi.
2. *Statistical Mechanics*; Gupta and Kumar; Pragati Prakashan, 24th Ed., 2015, Meerut
3. Fundamentals of Statistical Mechanics1 January 2012 by B.B. Laud

Additional Books:

1. *Statistical Mechanics*; Kerson Huang; John Wiley & Sons, Inc., 1987.
2. *Statistical Mechanics*; Stayaprakash and J. P. Agarwal, Kedarnath Ramnath and Co, 1988-89.

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc19_ph10/preview

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs.	0	30 hrs.

Level: Semester IV

Course Level:C-402
Name of the Subject: Nuclear & Particle Physics
Type of Course: Major
Subject Code: PHY012M402 **Scheme of Evaluation: Theory**
L-T-P-C: 3-1-0-4 **Total credit: 4**

Course Objectives:
To impart the understanding of subatomic particles and their properties. Emphasis is on the fundamental forces and particles, as well as composites. To familiarize with different types of nuclear reactions, the concept of accelerators and detectors. To impart the understanding of classification of elementary particles.

Course Outcomes:

Upon completion of this course, students will be able to:		
Sl.No.	**Course Outcome**	**Blooms Taxonomy Level**
CO-1	**Remember** the basic properties of nuclei, the concept of binding energy, its various dependent parameters	**BT 1**
CO-2	**Understand** the nature and magnitude of different forces, particle interactions, families of sub- atomic particles with the different conservation laws, the formulations and contrasts between different nuclear models, energy losses due to ionizing radiations, gamma ray interactions through matter, comparative study of a range of detectors and accelerators, concept of quark model	**BT 2**
CO-3	**Apply** the concepts of binding energy, nuclear models, nuclear reactions, accelerators, with scientific reasonings and critical thinking skills to solve	**BT 3**

	problems	
CO-4	**Analyze** different types of nuclear reactions, Q- values, radioactivity and decay laws	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	General Properties of Nuclei and Mass spectroscopy: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density, matter density, binding energy, average binding energy and its variation with mass number, Parity, magnetic moment, electric moments, Mass spectroscopy.	**15**
II.	Nuclear reactions and Interaction of Nuclear Radiation with matter: Nuclear reactions, types of nuclear reactions, Q-value of a reaction, exothermic & endothermic reactions, reaction cross section, theory of nuclear fission, energy released in nuclear fission, nuclear fusion, source of stellar energy, nuclear reactors, Energy loss due to ionization (Bethe-Block formula), Gamma ray interaction through matter (photoelectric effect, Compton scattering, pair production).	**15**
III.	Nuclear forces, Nuclear models and Particle accelerators: Nuclear forces, Meson theory of nuclear forces, models of Nuclear structure – the liquid drop model, Semi empirical mass formula and significance of its various terms, Fermi gas model, nuclear shell model, introduction to particle accelerators, Cyclotron- its main components, construction and theory, Betatron- its construction and theory.	**15**
IV.	Radioactivity decay, Nuclear detectors and Particle physics: Discovery of Radioactivity, nature of nuclear radiations, properties of alpha, beta and gamma rays, theory of alpha decay, natural and artificial radioactivity, fundamental laws of radioactivity, concept of half-life and disintegration constant, Ionization chamber, Geiger-Muller counter, Scintillation counters and Solid state detectors, classification of elementary particles, particle interactions (concept of different types of forces), Conservation Laws (energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness) concept of quark model.	**15**
Total		**60**

Text Book:

1. *Introductory Nuclear Physics*, K S Krane, Wiley-India Publication, 3rd edition, 2008.
2. *Introduction to elementary particles*, D J Griffiths, Wiley, 2008.

Reference Books:

1. Ghoshal, S N, *Nuclear Physics*, First edition, S. Chand Publication, 2010.
2. Roy, R. R. & Nigam, B. P., *Nuclear Physics Theory and Experiments*, New Age International, 2014.

Additional Readings:

1. *Nuclear Physics*, D C Tayal, Himalaya Publishing House, 5th edition, 2011.

NPTEL LINK: https://nptel.ac.in/courses/115104043

Credit Distribution		
Lecture/Tutorial	Practicum	Experiential Learning
60 hrs.	0	60 hrs.

Level: Semester IV

Course Level: M-411

Name of the Subject: Physics Lab III

Type of Course: Minor

Subject Code: PHY012M411 **Scheme of Evaluation: Practical**

L-T-P-C: 0-0-3-3 **Total credits: 3**

Course objectives: This course will help the students to understand, apply, analyze, and evaluate different experiments in Physics

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Find** different physical device	**BT 1**
CO 2	**Demonstrate** different mechanisms like polarization of light, damping etc.	**BT 2**
CO 3	**Apply** different methods in physics experiments.	**BT 3**
CO 4	**Analyse** different experimental results and errors involved in the experiment	**BT 4**

List of experiments:

1. To determine the values of Cauchy's constants a and b
2. Analysis of elliptically polarized light using Babinet compensator
3. To verify the Law of Malus for Plane Polarized light
4. To determine the coefficient of damping, relaxation time and quality factor of a damped simple harmonic motion using a simple pendulum
5. To determine the Lande-g factor in a free radical using an electron spin resonance spectrometer
6. To study the RC characteristics using Oscilloscope and Multimeter
7. To study the thermocouple calibration and effect of junction temperature on voltage output
8. To convert the Weston galvanometer into an ammeter of 1 amp/3amp/100 micro-amp range
9. Determination of E.C.E. of copper by using an ammeter and a copper voltmeter
10. To determine the (a) charge sensitivity and (b) Current sensitivity of a B.G

Text

3. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
4. *B.Sc. Practical Physics* P. R. Sashi Kumar, Prentice Hall India learning (2011).

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition(2012)

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
o	60 hrs	30 hrs

Level: Semester IV

Course Level: N-411

Name of the Subject: General Physics Lab II

Type of Course: Minor

Subject Code: PHY012N411 **Scheme of Evaluation: Practical**

L-T-P-C: 0-0-3-3 **Total credits: 3**

Course objectives: This course will help the students to understand and apply different basic experiments in Physics to analyze, and evaluate different physical systems.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**find** different methodology for different elementary physics experiments.	**BT 1**
CO 2	**demonstrate** different mechanisms like statical method, using of potentiometer, travelling microscope, magnetometer etc.	**BT 2**
CO 3	**apply** different methods to execute power of given lens, I-V characteristics, refractive index of a liquid etc.	**BT 3**
CO 4	**analyse** different experimental results with error calculations.	**BT 4**

COURSE OUTLINE:

List of experiments:

1. Determination of Rigidity of Modulus of the material of the given rod by Statical method.
2. Determination of power of given lenses using an optical bench. (i) concave lens (ii) convex lens.
3. Determination of refractive index of a transparent liquid by using a travelling microscope.
4. To determine the e.m.f. of a cell using a cell of known e.m.f. with the help of potentiometer.
5. To draw the I-V characteristics curves of a PN junction in forward bias and hence determine its resistance in forward and reverse bias.
6. Determination of E.C.E. of copper by using an ammeter and a copper voltmeter.
7. Determination of the value of acceleration due to gravity by using the given bar pendulum.
8. To determine the mechanical equivalent of heat by Joules calorimeter.
9. Determination of horizontal components of earth's magnetic field using magnetometer.

Text

5. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
6. *B.Sc. Practical Physics* P. R. Sashi Kumar, Prentice Hall India learning (2011).

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition(2012)

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Credit Distribution		
Lecture/ Tutorial	Practicum	Experiential Learning
o	60 hrs	30 hrs

Level: Semester IV

Course Level:N-401
Name of the Subject: Atomic and Nuclear Physics
Type of Course: Minor
Subject Code: PHY012N401 **Scheme of Evaluation: Theory**
L-T-P-C: 2-1-0-3 **Total credit: 3**

Course Objectives: To make the students understand the basics of Atomic and Nuclear Physics.

Upon completion of this course, students will be able to:		
Sl.No.	**Course Outcome**	**Blooms Taxonomy Level**
CO-1	**Remember:**The structures of atom and nucleus, electrons motion in an atom and its energy, momentum and quantum numbers associated with them. The basic properties of nuclei, the concept of radioactive decay, half life, radioactive dating, radioisotope etc.	**BT 1**
CO-2	**Understand:** Atomic and molecular transitions and corresponding spectrums. The nuclear composition, mass, volume, density, binding energy, nuclear reactions and radioactive decays.	**BT 2**
CO-3	**Apply:** The concepts of couplings schemes and transitions rules to identify spectrums. Also, the concepts of binding energy, nuclear reactions, to solve problems.	**BT 3**
CO-4	**Analyze:**The coupling of angular momentum and the spectrum of different atoms and molecules. Also, different types of nuclear reactions, radioactivity and decay laws.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Hours**
I.	Atomic models: Thomson, Rutherford, Bohr. Vector atom model, Space quantization. Quantum number associated with the vector atom model. Spin – Orbit interaction, Spectral term, Hydrogen like atom spectra, Fine structure of hydrogen atom.	**15**
II.	Spectra of alkali elements: spectral series, spectra of sodium atoms, selection and intensity rules. LS-jj coupling, Transition rules. Splitting of spectra. Zeeman and Stark effect. Electrons spin resonance. Spectra of Alkali earth elements. X-ray spectra: continuous spectra, Duane-Hunt law, characteristics lines, Mosley law, Absorption spectra, fine structure.	**15**
III.	concept of a Nucleus – its composition, mass, volume, density and temperature, units and dimension.Mass defect and packing fraction, total binding energy, binding energy per nucleon, binding energy curve & its significance, nucleon separation energy, nuclear reactions, Q-value of a reaction, exothermic & endothermic reactions.	**15**
IV.	Type of radioactive decays, radioactive decay law, concept of half-life and disintegration constant, natural radioactivity, radioactive dating, Activity of Radioactive sources, its unit. Radioisotopes – their production & uses.	**15**
Total		**60**

Text:

1. *Fundamentals of molecular spectroscopy* – Colin N. Banwell and Elaine M. Mccash: McGraw-Hill College(2016).
2. *Introductory Nuclear Physics*, K S Krane, Wiley-India Publication, 3rd edition, 2008.

Reference Books:

1. Beiser.A :*Concept of Modern Physics*: Publisher: McGraw Hill Education(2009).
2. White :*Introduction to Atomic spectra* ; publisher Mc graw-hill book company(2016).

3. Ghoshal, S N, *Nuclear Physics*, First edition, S. Chand Publication, 2010.

Additional Readings:

2. *Elements of Spectroscopy*: Atomic, Molecular and Laser Physics"- Gupta, Kumar and Sharma, Pragati Prakashan, Meerut, 2016.
3. *Atomic and Moleculer Spectra* :Laser, KedarnathRamnath:publisher ,Raj Kumar,(2012).
4. *Nuclear Physics*, D C Tayal, Himalaya Publishing House, 5th edition, 2011.

NPTEL LINKS:

1. https://nptel.ac.in/courses/115101003
2. https://nptel.ac.in/courses/115104043

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs.	0	30 hrs.