THE ASSAM
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)

STRUCTURE OF THE SYLLABUS FOR 4 YEAR UG PROGRAMME

SCHOOL NAME – ROYAL SCHOOL OF APPLIED AND PURE SCIENCES
DEPARTMENT NAME - PHYSICS
PROGRAMME NAME - B.Sc. in PHYSICS

1st SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012 M101	Mechanics	100	3	3-0-0
	PHY012 M111	Physics Lab I	100	3	0-0-6
Minor	PHY012N101	Fundamentals of Physics	100	3	3-0-0
Interdisciplinary (IDC)	IKS-1	Introduction to Indian Knowledge System – I	100	3	3-0-0
Ability Enhancement course (AEC)	CEN982A101	Communicative English	100	1	1-0-0
	BHS982A102	Behavioral Science-I	100	1	1-0-0
Skill Enhancement Course (SEC)	PHY012S111	Physics Workshop Skills	100	3	0-0-6
Value Added Course (VAC)	VAC-1	From basket courses	100	3	0-0-6
Swayam 1	SWAYAM CODE 1	Swayam 1	100	3/4/5	
TOTAL CREDIT FOR 1st SEMESTER				**20 +** 3/4/5	
2nd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012 M201	Electricity and Magnetism	100	3	3-0-0
	PHY012 M211	Physics Lab II	100	3	0-0-6
Minor	PHY012N211	General Physics Lab I	100	3	0-0-6
IDC	IKS-2	Introduction to Indian Knowledge System – II	100	3	3-0-0
AEC	CEN982A201	Communicative English	100	1	1-0-0
	BHS982A 202	Behavioral Science-II	100	1	1-0-0
SEC	PHY012S211	Electrical Circuit and Network Skills	100	3	0-0-6
VAC	VAC-2	From basket courses	100	3	3-0-0
Swayam 2	SWAYAM CODE 2	Swayam 2	100	3/4/5	
TOTAL CREDIT FOR 2nd SEMESTER				**20 +** 3/4/5	

3rd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M301	Ray and wave optics	200	4	4-0-0
	PHY012M302	Mathematical Physics-I	200	4	4-0-0
Minor	PHY012N301	Modern Physics	200	4	4-0-0
IDC	PHY012I301	IKS related to the major field of Specialization (Introduction to Astrophysics)	200	3	3-0-0
AEC	CEN982A 301 & BHS982A 302	Communicative English and Behavioral Science-III	200	2	2-0-0
SEC	PHY012S311	Basic Instrumentation skills	200	3	0-0-6
Swayam 3	SWAYAM CODE 3	Swayam 3	200	3/4/5	
TOTAL CREDIT FOR 3rd SEMESTER				**20** + 3/4/5	
4th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M401	Thermal & Statistical Physics	200	4	4-0-0
	PHY012M402	Nuclear & Particle Physics	200	4	4-0-0
	PHY012 M411	Physics Lab III	200	4	0-0-8
Minor	PHY012N401	Atomic and Nuclear Physics	200	3	3-0-0
	PHY012N411	General Physics Lab II	200	3	0-0-6
AEC	CEN982A 401 & BHS982A 402	Communicative English and Behavioral Science-IV	200	2	2-0-0
Swayam 4	SWAYAM CODE 4	Swayam 4	200	3/4/5	
TOTAL CREDIT FOR 4th SEMESTER				**20** + 3/4/5	
5th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M501	Classical and Quantum Mechanics	300	4	4-0-0
	PHY012M502	Solid State and Mathematical Physics-II	300	4	4-0-0
	PHY012M503	Electrodynamics	300	4	4-0-0
Minor	PHY012N501	Fundamentals of Thermal Physics	300	4	4-0-0
Internship	PHY012M521	Internship	300	4	

TOTAL CREDIT FOR 5th SEMESTER				**20**	
6th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M601	Electronics	300	4	4-0-0
	PHY012M602	Advanced Classical and Quantum Mechanics	300	4	4-0-0
	PHY012M603	Atomic & Molecular Physics	300	4	4-0-0
	PHY012M611	Physics Lab IV	300	4	0-0-8
Minor	PHY012N601	Physical Optics	300	4	4-0-0
TOTAL CREDIT FOR 6th SEMESTER				**20**	
7th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M701	Theory of relativity	400	4	4-0-0
	PHY012M702	Astronomy	400	4	4-0-0
	PHY012M703	Mathematical Physics-III	400	4	4-0-0
	PHY012M704	Waves Oscillation & Sound	400	4	4-0-0
Minor	PHY012N701	Basics of electronics	400	4	4-0-0
TOTAL CREDIT FOR 7th SEMESTER				**20**	
8th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M801	Methods of selected instruments used Physical Sciences Research	400	4	4-0-0
Minor	PHY012N801	Research Methodology	400	4	4-0-0
Project / Dissertation	PHY012M821	Research Project	400	12	
For the students who are not eligible for the Research Project*					
Or 400 level advanced course Core (in lieu of Project / Dissertation)	PHY012M803	Fiber Optics and Basic of Laser	400	4	4-0-0
	PHY012M804	Plasma and space physics	400	4	4-0-0
	PHY012M805	Nanophysics	400	4	4-0-0
TOTAL CREDIT FOR 8th SEMESTER				**20**	

Detailed Syllabus

Level: Semester I

Course Level: 100

Name of the Subject: Mechanics

Type of Course: Major

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

L-T-P: 3-0-0 **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:		
CO	**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	Practical	Experiential Learning
60 hrs	0	30 hrs

Level: Semester I

Course Level: 100

Name of the Subject: Physics Lab I

Type of Course: Major

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

L-T-P: 0-0-6 **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:		
CO	**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	Practical	Experiential Learning
0	60 hrs	30 hrs

Level: Semester I

Course Level: 100

Name of the Subject: Fundamentals of Physics

Type of Course: Minor

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

L-T-P: 3-0-0 **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:		
CO	**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	Practical	Experiential Learning
60 hrs		30 hrs

Level: Semester I

Course Level: 100

Name of the Subject: Physics Workshop Skills

Type of Course: SEC

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

L-T-P: 0-0-6 **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:		
CO	**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	Practical	Experiential Learning
0	60 hrs	30 hrs

Level: Semester II

Course Level: 100

Name of the Subject: Electricity and Magnetism

Type of Course: Major

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

L-T-P: 3-0-0 **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:		
CO	**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	Practical	Experiential Learning
60 hrs	0	30 hrs

Level: Semester II

Course Level: 100

Name of the Subject: Physics Lab II

Type of Course: Major

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

L-T-P: 0-0-6 **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:		
CO	**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	Practical	Experiential Learning
0	60 hrs	30 hrs

Level: Semester II

Course Level: 100

Name of the Subject: General Physics Lab I

Type of Course: Minor

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

L-T-P-C: 0-0-6 **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:		
CO	**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	Practical	Experiential Learning
0	60 hrs	30 hrs

Level: Semester II

Course Level: 100

Name of the Subject: Electrical Circuit and Network Skills

Type of Course: SEC

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

L-T-P: 0-0-6 **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:		
CO	**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 the e.m.f. of a cell using a cell of known 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	Practical	Experiential Learning
0	60 hrs	30 hrs

Level: Semester III

Course Level: 200

Name of the Subject: Ray and Wave Optics

Type of Course: Major

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

L-T-P: 4-0-0 **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:		
CO	**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	Practical	Experiential Learning
72 hrs	0	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: 4-0-0 **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:		
CO	**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	Practical	Experiential Learning
72 hrs	O	48 hrs

Level: Semester III

Course Level: 200

Type of Course: Minor

Course name: Modern Physics

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

L-T-P: 4-0-0 **Total Credit: 4**

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:		
CO	**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	Practical	Experiential Learning
60 hrs	0	30 hrs

Level: Semester III

Course Level: 200

Name of the Subject: Introduction to Astrophysics

Type of Course: IDC

Subject Code: PHY012I301 **Scheme of Evaluation: Theory**

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

Course Objectives: Astrophysics is the physics of the stars. Therefore, this course is intended to introduce the theoretical concept for a clear understanding of astronomical phenomena.

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 theoretical and practical aspects of modern observational astronomy, photometry, spectroscopy, stellar classification, detectors, and basic information of telescopes.	**BT1**
CO 2	**Understand** the fundamentals in the Astrophysics like the classification of stars, stellar evolution, interstellar matter, galaxies etc.	**BT 2**
CO 3	**Apply** knowledge of astrophysics to practical application of observational techniques.	**BT 3**
CO 4	**Analyze** and evaluate astrophysical calculations of fundamental character.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Basics of Astronomy**: Evolution of Astronomy, The celestial sphere, Altitude and Azimuth, Declination and hour-angle, coordinate systems and transformation equations. The concept of time — solar time and sidereal time. Magnitude scales, apparent, absolute, and instrumental magnitudes. Measuring stellar distance method parallax and other methods to determine stellar distances, HR Diagram.	**9**
II	**Telescopes and Detectors**: Different types of astronomical telescopes, mounting of telescopes, Radio Telescope, space based telescopes, Astronomical Spectrograph, Photographic Photometry, Detectors.	**9**
III	**Stars**: Formation of stars, evolution of stars, Compact stars (White dwarf, Neutron star, Black Hole), Chandrasekhar Mass Limit, Jeans criterion, Transport of energy inside a star, Binary stars, . Nucleosynthesis – hydrogen burning (pp chain and CNO cycle), triple alpha reaction.	**9**
IV	**Galaxies and Universe:** : The Milky way Galaxy, Dark Matter, Kinematics, Hubble classification scheme for external galaxies, Normal galaxies and AGNs, Unified model, Hubble's law, Cosmic Microwave Background radiation, Elementary ideas on structure formations	**9**
	Total	**36**

Text:

1. An Introduction to Astrophysics; Baidya Nath Basu, Prentice Hall Publication, 2nd Ed.,2013, New Delhi

2. An Introduction to Astronomy and Astrophysics, Pankaj Jain, CRC Press; 1st edition (8 April 2015)

References:

1. 1.V.B. Bhatia; Text Book on Astronomy and Astrophysics with elements of cosmology, Narosa Publishing House, 2nd Ed.,2001, New Delhi
2. 2.K. D. Abhayankar; Astrophysics: Stars and Galaxies, Abe Books,1st Ed., 2002, Hyderabad

Level: Semester III

Course Level: 200
Name of the Subject: Basic Instrumentation Skill
Subject Code: PHY012S311 **Scheme of Evaluation: Practical**
L-T-P: 0-0-6 **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:		
CO	**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	Practical	Experiential Learning
60 hrs	0	30 hrs

Level: Semester IV

Course Level: 200
Name of the Subject: Thermal & Statistical Physics
Type of Course: Major
Subject Code: PHY012M401 **Scheme of Evaluation: Theory**
L-T-P: 4-0-0 **Total credits: 4**

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:		
CO	**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**
CO2	Apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.	**BT2**
CO3	Use the statistical Physics methods, such as Boltzmann distribution, Gibbs distribution in physical system.	**BT3**
CO4	Analyze 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: 200
Name of the Subject: Nuclear & Particle Physics
Type of Course: Major
Subject Code: PHY012M402 **Scheme of Evaluation: Theory**
L-T-P: 4-0-0 **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:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO1	**Remember** the basic properties of nuclei, the concept of binding energy, its various dependent parameters	**BT 1**
CO2	**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**
CO3	**Apply** the concepts of binding energy, nuclear models, nuclear reactions, accelerators, with scientific reasonings and critical thinking skills to solve problems	**BT 3**
CO4	**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	**15**

	number, Lepton number, Isospin, Strangeness) concept of quark model.	
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	Practical	Experiential Learning
60 hrs.	0	60 hrs.

Level: Semester IV

Course Level: 200

Name of the Subject: Physics Lab III

Type of Course: Major

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

L-T-P: 0-0-8 **Total credits: 4**

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:		
CO	**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	Practical	Experiential Learning
o	60 hrs	30 hrs

Level: Semester IV

Course Level: 200

Name of the Subject: General Physics Lab II

Type of Course: Minor

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

L-T-P: 0-0-6 **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:		
CO	**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
0	60 hrs	30 hrs

Level: Semester IV

Course Level: 200
Name of the Subject: Atomic and Nuclear Physics
Type of Course: Minor
Subject Code: PHY012N401 **Scheme of Evaluation: Theory**
L-T-P: 3-0-0 **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:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO1	**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**
CO2	**Understand:** Atomic and molecular transitions and corresponding spectrums. The nuclear composition, mass, volume, density, binding energy, nuclear reactions and radioactive decays.	**BT 2**
CO3	**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**
CO4	**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.

Level: Semester V

Course Level: 300

Name of the Subject: Classical and Quantum Mechanics

Type of Course: Major

Subject Code: PHY012M501 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r different constraints involved in the motion of a physical system, photoelectric effect, operators etc.	**BT 1**
CO 2	**Understand** the basic concepts of central forces, Lagrangian and Hamlitonian dynamics, Compton effect, de-Broglie hypothesis, Schrödinger equation etc.	**BT 2**
CO 3	**Apply** Lagrangian and Hamlitonian dynamics to a few physical systems, Schrödinger equation in closed systems like particle in box, quantum harmonic oscillator etc.	**BT 3**
CO 4	**Analyze** commutation relation among position and momentum operators, different components of angular momentum operator, constructive and destructive operators of quantum harmonic oscillator etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Constraints, generalized co-ordinates; principle of virtual work, D' Alembert's principle and Lagrange's equations of motion; applications of Lagrangian formulations to atwood machine, simple pendulum, bead sliding on rotating wire, compound pendulum, linear harmonic oscillator	**15**
II.	Hamilton's principle; Lagrange's equations from Hamilton's principle; Hamilton's canonical equations of motion; applications of Hamilton's equations to simple problems; Poisson brackets. Concept of Central Force and Kepler's laws of planetary motion.	**15**
III.	Inadequacies of Classical Physics, Black-body radiation, Plank's Law, Photoelectric effect, Compton effect, de Broglie hypothesis, Wave-particle duality of radiation and matter, Schrödinger equation (time-dependent and time- independent); Physical interpretation of wave function; Born interpretation; Equation of continuity; Probability density and Probability current density. Heisenberg's Uncertainty Principle; Operator, Expectation value of a physical variable or operator, Application of Schrodinger equation to one-dimensional problems; Particle in a box; linear harmonic oscillator; square well potentials; potential step; barrier potential; tunneling effect.	**15**

IV.	Different types of operators: linear, Hermitian, unitary etc. Commutator of two operators; Commutator algebra; Eigen values and Eigen functions of an operator; Commutator or position and momentum operators' Angular momentum operator in quantum mechanics; commutation relations of the three components; Commutation relation between position and angular momentum, between linear momentum and angular momentum	**15**
Total		**60**

Textbooks:

1. *Classical Mechanics*; Goldstein H., Narosa Publishing House, 3rdEd., New Delhi,2011.
2. *Introductory Quantum Mechanics; Liboff R.L., Pearson Education, 4th Ed., 2007, New Delhi.*
3. *Basics of Quantum Mechanics, Ajoy Ghatak, Mc. Millan Publishing, 2009*

Reference Books:

1. Rana &Yoag, *Classical Mechanics,* Tata McGraw-Hill Publishing Company Limited, 1st Ed., New Delhi,2017.
2. Upadhaya J. C, *Classical Mechanics,* Himalaya Publishing House, 3rd Ed., Mumbai,2017
3. L.I. Schiff, Bandhyopadhay J.; Quantum Mechanics, McGraw Hill Education; 4th Ed., 2017, New Delhi

NPTEL LINK: https://archive.nptel.ac.in/courses/122/106/122106027/
NPTEL LINK: https://archive.nptel.ac.in/courses/115/101/115101107

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

Level: Semester V

Course Level: 300

Name of the Subject: Solid state and Mathematical Physics

Type of Course: Major

Subject Code: PHY012M502 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** lattice, X-ray diffraction, line integral, Gauss divergence theorem, Stokes' theorem etc.	**BT 1**
CO 2	**Understand** unit cell, Miller indices, band theory of solid, the complex variables, analytic function etc.	**BT 2**
CO 3	**Apply** K-P model, Hall Effect, residue theorem to solve complex integrals.	**BT 3**
CO 4	**Analyze** Superconductivity, Meissner effect, Taylor's series method, method of separation of variables, etc to solve problems.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Crystal Lattices and Unit Cells:** Bravais lattices, primitive and conventional unit cells, crystal systems. Miller Indices and X-ray Diffraction: Bragg's Law, Lattice Vibrations and Phonons, dispersion relations for mono atomic and diatomic chains. Heat Capacity of Solids: Classical theory (Dulong-Petit law), Einstein and Debye models	**15**
II.	**Electronic Properties of Solids:** Free Electron Theory: Drude model, electrical and thermal conductivity in metals. Fermi energy, density of states. Band Theory of Solids: Bloch's theorem, Kronig-Penney model (Discussion only), energy bands in metals, semiconductors, and insulators. Hall Effect: Hall coefficient, applications. Fundamentals of Superconductivity: Meissner effect, critical temperature, type-I and type-II superconductors. BCS Theory: Cooper pairs, Josephson effect	**15**
III.	**Integration of vectors:** Understanding of line integral, surface integral and volume integrals of vectors and their applications to simple physical problems. Analysis of Gauss' divergence theorem, Green's theorem, Stokes' theorem and problems. **Differential equations:** Concept of order and degree of differential equation, Second order linear differential equation and its solution as sum of complementary function (C.F.) and particular integral (P.I.). Homogeneous and Non-homogeneous differential equation, series solution of differential equation: Frobenius method. Partial differential equation. Method of separation of variables. Laplace equation, wave equation and their solutions. Taylor series method, Euler method, Runge- kutta methods to obtain the numeric values from ordinary differential equation.	**15**

IV.	**Complex variables:** Understanding of Algebraic notation (z), Argand diagram, modulus and argument, powers of iota (1), complex conjugate, complex numbers in cartesian, polar, and exponential forms, Euler's formula, De-Moiver's theorem. Functions of complex variable, concept of neighbourhood, continuity and differentiability of complex function. Analysis of analytic function, Cauchy Reimann conditions in cartesian and polar form and its application to analyze analyticity of different complex functions, Evaluation of related problems, concept of singular point, poles of order 'n'. Cauchy integral theorem. Cauchy integral formula and related problems. Methods to find residue, Cauchy's residue theorem. Complex integrals: Simple contour integrals, integration round unit circle, and complex function in the -ve infinte to +ve infinte limits.	**15**
Total		**60**

Text:

1. Mathematical Physics by Das H.K. S. Chand publishing 8th edition(2018).
2. Mathematical Physics by George B. Arfken,Elesvier Publisher7th edition(2012).

Reference Books:

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

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc21_ma27/preview

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

Level: Semester V

Course Level: 300

Name of the Subject: Electrodynamics

Type of Course: Major

Subject Code: PHY012M503 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course will help the student in understanding the relation between charge and its field, characteristics of magnetic force and time varying e.m.f. It will also help in analysing the interaction between e.m. wave and matter.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Remember** determining factors of electromagnetic forces and fields.	**BT 1**
CO 2	**Understand** the relationship between electric and magnetic fields.	**BT 2**
CO 3	**Apply** the concepts of space and time varying electromagnetic fields.	**BT 3**
CO 4	**Analyze** the behavior of electromagnetic wave in a matter.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Concept of electric potential, electric potential energy of single charge and a charge distribution; surface charge and the force on the surface of a conductor, Laplace's equation.	**15**
II.	Force on a moving charge and current carrying conductor in a magnetic field; force between two current-carrying wires, general expressions for fields due to current densities, curl and divergence of the magnetic field, Ampere's law. Motional electromotive force; Faraday's law, electromagnetic field equation in integral and differential form, displacement current, Maxwell's equations, energy conservation law, Poynting theorem.	**15**
III.	Origin and characteristics of electromagnetic wave; monochromatic plane wave equation in free space and conducting medium; reflection and refraction of plane electromagnetic wave for normal and oblique incidence, Snell's law.	**15**
IV.	Macroscopic electrodynamics: macroscopic Maxwell equation, averaged sources applications of macroscopic electrodynamics, Electrostatics in the presence of matter, Magnetostatics in the presence of matter Relativistic electrodynamics: magnetism as a relativistic phenomenon, transformation of fields, field tensor, electrodynamics in tensor notation, relativistic potential.	**15**
Total		**60**

Text:

1. Introduction to Electrodynamics, Griffiths D.J., PHI, 4th Ed., 2016, New Delhi
2. Electricity and Management, Tayal D. C., Himalaya Publishing House, 4th ED., (Revised), 2014, Mumbai

Reference Books:

1. Chakraborty B., Principles of Electrodynamics, Books & Allied Ltd., 1st Ed., 2010, Kolkata

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc22_ph46/preview

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

Level: Semester V

Course Level: N 501
Name of the Subject: Fundamentals of Thermal Physics
Type of Course: Minor
Subject Code: PHY012N501 **Scheme of Evaluation: Theory**
L-T-P:4-0-0 **Total credit: 4**

Course Objectives: To make the students understand the basics of Thermal Physics and it's applications

Upon completion of this course, students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO1	**Remember:** Fundamental concepts of Thermodynamics, laws of thermodynamics, Kinetic theory of gases and Entropy. The ideas of Heat engine.	**BT 1**
CO2	**Understand:** Temperature and Free energies etc.The ideas of specific heat of gas, change of states, Black body radiation.	**BT 2**
CO3	**Apply:** the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.	**BT 3**
CO4	**Analyze:** Theory of radiation and its applications. Solve problems in some physical systems.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Hours**
I.	**Thermodynamic Description of system**: Zeroth Law of thermodynamics and temperature. Laws of Thermodynamics, First law and its consequences. Isothermal and adiabatic processes. Reversible, irreversible processes. Second law and entropy. Carnot's cycle and theorem. Entropy changes in reversible and irreversible processes. Third law of thermodynamics, Unattainability of absolute zero.	**15**
II.	**Thermodynamic Potentials:** Concept of Ideal or Perfect Gas. Degrees of Freedom. Enthalpy, Gibbs, Helmholtz and Internal Energy functions. Specific heat of Mono, Di, and Polyatomic gas, Change of State. Van der Walls' equation of State. Maxwell's relations and applications. Joule-Thompson Effect. Clausius-Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V.	**15**
III.	**Kinetic Theory of Gases:** Derivation of Maxwell's law of distribution of velocities and its experimental verification. Mean free path. Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.	**15**
IV.	**Theory of Radiation:** Blackbody radiation. Spectral distribution. Concept of Energy Density. Derivation of Planck's law. Deduction of Wien's distribution law. Rayleigh- Jeans Law. Stefan Boltzmann Law and Wien's displacement law from Planck's law.	**15**
Total		**60**

Text:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
3. Heat and Thermodynamics, M.W. Zemasky and R. Dittman, 1981, McGraw Hill

Reference Books:

1. *Lokanathan S. and Gambhi R.S.; Statistical and Thermal Physics- An introduction, P.H.I., 1st Ed., 2008, New Delhi*
2. *Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears and*
3. *G.L.Salinger. 1988, Narosa*

Additional Readings:

1. *University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.*
2. *Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.*

NPTEL LINK: *https://onlinecourses.nptel.ac.in/noc23_ph11/preview*

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

Level: Semester VI

Course Level: 300

Name of the Subject: Electronics

Type of Course: Major

Subject Code: PHY012M601 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course will provide the students with the fundamental skills to understand the basics of semiconductors and components, apply, analyze and evaluate different biasing techniques to operate transistors, FET, MOSFET and operational amplifier in different modes.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r basics of semiconductors & devices and their applications in different areas.	**BT 1**
CO 2	**Understand** the principles of semiconductor devices and their applications.	**BT 2**
CO 3	**Apply** logic gates, flip flops in building block of digital systems.	**BT 3**
CO 4	**Analyze** output in different operational modes of different semiconductor devices.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Semiconductor and Transistors**: Concept of Bandgap in semiconductor, Types of Semiconductors, Introduction to P-N junction Diode and V-I characteristics, Biasing of PN junction, Load line analysis, Types of diode (Zener, LED, Tunnel etc),Transistor and its characteristics (Introduction to BJT), Transistor as an amplifier and switch, Half wave and Full-wave rectifiers, filters.	**15**
II.	**Operational amplifier and its applications:** Introduction to operational amplifiers, Ideal operational amplifier, Characteristics of OP-AMP, OP-AMP in open loop and closed loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier, OP-AMP as adder, subtractor, differentiators, integrators, logarithmic amplifier, Applications of OM-AMP, Solution of differential equations, Filters and noise reduction, Differential amplifier, Concept of Feedback amplifier.	**15**
III.	**Digital Electronics**: Difference between analog and digital signals, Number systems, Boolean algebra and Logic gates, Laws of Boolean algebra, De Morgan's theorem, Reduction Boolean expression, Karnaugh map, Simplification using K-map, Flip-Flops, Registers, Counters, comparators, A/D and D/A converters, Multiplexer, Demultiplexer.	**15**
IV.	**Transistor Oscillators and multivibrators:** Introduction to Feedback oscillators, Hartley oscillator, Colpitt oscillator, Phase shift oscillator, Barkhausen's criteria for oscillation, R-C oscillator and Wein bridge oscillator, Multivibrators, astable, mono-stable, bistable and multi-vibrators RC-timing circuits.	**15**
Total		**60**

Text Book:

1. Handbook of Electronics; Gupta & Kumar, Pragati Prakashan, 38th Edition 2012.
2. R.P. Jain , "Modern Digital Electronics" , Tata Mc Graw Hill, 3rd Edition, 2007.

Reference Book:

1.Talukdar P. H.; Digital Logic and System Design, Mani Manik Prakash, 1st Ed., 2016, Guwahati.
2.Chattopadhyay D.; Electronics: Fundamentals & Applications; New Age International, 1st Ed., 2010, New Delhi.

NPTEL LINK: https://nptel.ac.in/courses/122106025

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

Level: Semester VI

Course Level: 300

Name of the Subject: Advanced Classical and Quantum Mechanics

Type of Course: Major

Subject Code: PHY012M602 **Scheme of Evaluation: Theory**

L-T-: 4-0-0 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r different Canonical Invariants of a physical system, different operators and commutation relations etc.	**BT 1**
CO 2	**Understand** the concepts of Hamilton-Jacobi Method, hydrogen atom problem, approximation methods	**BT 2**
CO 3	**Apply** Canonical Transformations to a few physical systems, spherical harmonics, eigen value and eigen function in case of hydrogen atom problem.	**BT 3**
CO 4	**Analyze** different approximation methods in ideal quantum mechanical systems, etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Equations of Canonical Transformations; Examples of Canonical Transformations; Poisson Brackets and Other Canonical Invariants, Conservation Theorems in Poisson Bracket Formulation, Infinitesimal Canonical Transformations; Angular Momentum Poisson Bracket Relations; Liouville's Theorem	**15**
II.	Hamilton-Jacobi Equation; Solution of Harmonic Oscillator Problem using Hamilton-Jacobi Method; Separation of Variables in the Hamilton-Jacobi Equation; Action-Angle Variables in 1-D Systems; Kepler Problem in Action-Angle Variables	**15**
III.	Eigen values and Eigen functions of angular momentum operator; Ladder operator and their applications, Angular momentum operator in spherical polar coordinates; particle in a central field, application of Schrodinger equation to hydrogen atom.	**15**
IV.	approximation methods in quantum mechanics; Time dependent perturbation theory for a non-degenerate case and for a degenerate case, Stark effect, Zeeman effect, Variational method, application to the helium atom, the WKB approximation.	**15**
Total		**60**

Textbooks:

4. *Classical Mechanics*; Goldstein H., Narosa Publishing House, 3rdEd., New Delhi,2011.
5. *Introductory Quantum Mechanics; Liboff R.L., Pearson Education, 4th Ed., 2007, New Delhi.*

Reference Books:

4. Rana &Yoag, *Classical Mechanics,* Tata McGraw-Hill Publishing Company Limited, 1st Ed., New Delhi,2017.
5. Upadhaya J. C, *Classical Mechanics,* Himalaya Publishing House, 3rd Ed., Mumbai,2017
6. L.I. Schiff, Bandhyopadhay J.; Quantum Mechanics, McGraw Hill Education; 4th Ed., 2017, New Delhi

NPTEL LINK: https://archive.nptel.ac.in/courses/122/106/122106027/
NPTEL LINK: https://archive.nptel.ac.in/courses/115/101/115101107

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

Level: Semester VI

Course Level: 300

Name of the Subject: Atomic and Molecular Physics

Type of Course: Major

Subject Code: PHY012M603 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

To develop basic foundations in atomic models and grasp the concept of energy configuration of electrons in atoms and molecules. And to understand the transition spectrums of electronic, vibrational and rotational energy levels.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Remember** the atomic structures, electrons motion in an atom and energy, momentum and quantum numbers associated with them.	**BT 1**
CO 2	**Understand** problems related to atomic and molecular transitions and corresponding spectrums.	**BT 2**
CO 3	**Apply** the knowledge to identify allowed transitions and measure the wavelength of corresponding emitted spectrum.	**BT 3**
CO 4	**Analyse** the couplings of angular momentum vectors and transition rules in atoms and molecules.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Thomson Model, Rutherford alpha particle finding experiment and nuclear atom model. Limitation of the model. Bohr atom model. Hydrogen like atom spectra. Correspondence principle.	**15**
II.	Sommerfeld model (elliptical orbit and relativistic correction), Vector atom model (Space quantization and spinning electron). Quantum number associated with vector atom model. Basics of Spin – Orbit interaction, Spectral term, Fine structure of hydrogen atom, Stern- Gerlach experiment.	**15**
III.	Spectra of alkali elements: general features, spectral series, spectra of sodium atom. Basics of electronic transitions. X-ray spectra: continuous spectra, Duane-Hunt law, characteristics lines, Mosley law, Absorption spectra, fine structure.	**15**
IV.	Molecular Spectra: The Born-Oppenheimer approximation, rotational spectra, rigid diatomic molecule, rotational energy of the diatomic molecule, simple harmonic oscillator, and Anharmonic oscillator.	**15**
Total		**60**

Text:

1. Fundamentals of molecular spectroscopy – Colin N. Banwell and Elaine M. Mccash: McGraw-Hill College (2016).
2. Elements of Spectroscopy: Atomic, Molecular and Laser Physics - Gupta, Kumar and Sharma, Pragati Prakashan, Meerut, (2016).

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. Raj Kumar: Atomic and Molecular Spectra: Laser; Publisher: Kedarnath Ramnath (2012).
4. Gupta. S.L., V. Kumar, R.C. Sharma: Elements of Spectroscopy; Pragati Prakashan. (2016).
5. Rajam J.B: Atomic physics; Publisher: S. Chand (2010)

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc25_ph04/preview

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

Level: Semester VI

Course Level: M-611

Name of the Subject: Physics Lab IV

Type of Course: Major

Subject Code: PHY012M611 **Scheme of Evaluation: Practical**

L-T-P: 0-0-8 **Total credits: 4**

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:		
CO	**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. Measurement of Planck's constant.
2. To verify the Law of Malus for Plane Polarized light
3. Determination of the wavelength of a diode laser using Michelson interferometer.
4. Forbidden Energy Gap from P-N junction
5. Study of the characteristics of a GM tube
6. Photo-diode Characteristics
7. Solar-Cell Characteristics.
8. To study the RC characteristics using an Oscilloscope and Multimeter.

Text

7. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
8. *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	Practical	Experiential Learning
o	60 hrs	30 hrs

Level: Semester VI

Course Level: 300

Name of the Subject: Physical Optics
Type of Course: Minor
Subject Code: PHY012N601 **Scheme of Evaluation: Theory**
L-T-P: 4-0-0 **Total credit: 4**

Course Objectives: To make the students understand the basics of Physical Optics and its applications

Upon completion of this course, students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO1	**Remember:** Fundamental wave properties and superposition of waves, interference, diffraction, polarization and its significance.	**BT 1**
CO2	**Understand:** Understand and apply wave theory. Use Huygens' principle to describe reflection and refraction.	**BT 2**
CO3	**Apply:** Apply the principle of superposition to interference effects. Demonstrate Young's Double-slit experiment and thin-film interference. Use Malus's law and Brewster's law to solve polarization-related problems	**BT 3**
CO4	**Analyze:** Analyse the energy and momentum properties of light waves; Calculate the diffraction patterns from single, double-slits and a diffraction grating with applications.	**BT 4**

COURSE OUTLINE:

Modules	Topics / Course content	Hours
I.	**Wave Nature of Light:** Basic wave properties; Huygens' Principle; Reflection and Refraction using Huygens' principle; Superposition of Waves; Phase and Group Velocity; Coherence (Temporal and Spatial) and path difference; Energy and momentum of light waves; Light as an electromagnetic wave; Maxwell's equations.	**15**
II.	**Interference:** Principle of superposition; Constructive and destructive interference; Interference by Division of Wavefront, Young's Double-Slit Experiment, Fresnel's Biprism; Interference by Division of Amplitude, Thin Films, Newton's Rings, Michelson Interferometer; Interference in Wedge-Shaped Films; Optical Path Difference and Fringe Width.	**15**
III.	**Diffraction:** Fresnel and Fraunhofer Diffraction; Single-Slit and Double-Slit Diffraction; Diffraction Grating and Resolving Power; Circular Apertures and Airy Disk; Zone Plates.	**15**
IV.	**Polarization:** Plane, Circular, and Elliptical Polarization; Malus's Law and Brewster's Angle; Double Refraction (Birefringence); Nicol Prism; Wave Plates (Quarter and Half-Wave Plates); Optical Activity and Fresnel's Laws; applications of polarization.	**15**
Total		**60**

Text:

1. Fundamental of Optics; Jenkins F.A. and White H.E.: McGraw Hill, 4t edition, 2011.
2. M. Born and E. Wolf (1999). Principle of Optics. Cambridge: Cambridge University Press.

Reference Books:

4. Ghatak A.K, Optics, 2014. McGraw Hill Education; 5th edition2017.

Additional Readings:

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.

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

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

Level: Semester VII

Course Level: 400

Name of the Subject: Theory of relativity

Type of Course: Major

Subject Code: PHY012M701 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits : 4**

This course emphasis to enhance the understanding of the basics of Relativity with respect to space and time, to impart the concept of different frame of references, to familiarize the understanding of Newtonian relativity, Galilean Transformation equations and special theory of Relativity and to impart the elementary concept of General Theory of Relativity.

Course Outcomes:

Upon successful completion of the course students will be able to:		
CO	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the concept of space, time and mass, frame of reference, Newtonian relativity, Michelson-Morley experiment, the elementary concept of General Theory of Relativity.	**BT1**
CO2	Understand the Postulates of special theory of Relativity, Lorentz transformation, Doppler Effect, Space-time diagram, General Theory of Relativity (Elementary).	**BT2**
CO3	Apply the concepts of length contraction and time dilation to solve problems.	**BT3**
CO4	Analyze the special and general theory of relativity.	**BT4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I.	Concept of space, time and mass in Newtonian mechanics, frame of reference, inertial frame and non-inertial frame, Newtonian relativity, Galilean Transformation equations, the ether hypothesis, the Michelson-Morley experiment, explanation of the negative result.	**15**
II.	Constancy of speed of light, Postulates of special theory of Relativity, Lorentz transformation equations-its derivation, Inverse Lorentz transformation, Length contraction and Time dilation with illustrations, the Twin Paradox, Relativity of Simultaneity.	**15**
III.	Relativistic addition of velocities, variation of mass with velocity, mass-energy equivalence, relativistic formula for kinetic energy, unified mass unit, relationship between the total energy, the rest energy and the momentum, Relativistic Doppler Effect.	**15**
IV.	Space-time diagram, Minkowski's four-dimensional space-time continuum, world- line, world-point, geodesic, four vectors, four velocity, four momentum, four force, General Theory of Relativity (Elementary), effect of gravitational field on a ray light, gravitational red shift.	**15**
Total		**60**

Text Book:

1. *Introduction to special relativity*, Robert Resnick, John Wiley & Sons, Canada, Limited, 2007.
2. *Fundamentals of special and general relativity*, K.D. Krori, Publisher, PHI Learning Pvt. Ltd., 2010.

Reference Books:

1. Edwin F. Taylor and John Archibald Wheeler, *Spacetime Physics: Introduction to Special Relativity, 2nd ed.*, W. H. Freeman & Company, 1992.
2. Bernard F. Schutz, *A First Course in General Relativity* Cambridge University Press, 1985.

NPTEL LINK: https://nptel.ac.in/courses/115/101/115101011

Level: Semester VII

Course Level: 400

Name of the Subject: Astronomy

Type of Course: Major

Subject Code: PHY012M702 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:
Astrophysics is the physics of the stars. Therefore this course is intended to introduce the theoretical concept for a clear understanding of the astronomical phenomena.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r theoretical and practical aspects of modern observational astronomy, Photometry, spectroscopy, stellar classification, detectors, and basic information of telescopes.	**BT 1**
CO 2	**Understand** the fundamentals in the Astrophysics like the classification of stars, stellar evolution, interstellar matter, galaxies etc.	**BT 2**
CO 3	**Apply** knowledge of astrophysics to practical application of observational techniques.	**BT 3**
CO 4	**Analyze** and evaluate astrophysical calculations of fundamental character.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Basics of Astronomy**: Evolution of Astronomy, The celestial sphere, Altitude and Azimuth, Declination and hour-angle, coordinate systems and transformation equations. Concept of time — solar time and sidereal time. Magnitude scales, apparent, absolute, and instrumental magnitudes. Measuring stellar distance method parallax and other methods to determine stellar distances, HR Diagram, Color Index, Spectral Class.	**15**
II	**Telescopes and Detectors**: Different types of astronomical telescopes, Mounting of telescope, Radio Telescope, Space based telescope, Astronomical Spectrograph, Photographic Photometry, Detectors, Radiation theory: Equation of radiative transfer — concepts of flux, intensity, and temperature. Formation of emission and absorption lines, limb darkening.	**15**
III	**Stars**: Formation of stars, Evolution of stars, Compact stars (White dwarf, Neutron star, Black Hole), Degenerate stars, mass–radius relation and Chandrasekhar mass limit, Jeans criterion, Integral theorems of hydrostatic equilibrium of stars, Transport of energy inside a star, Binary stars, . Nucleosynthesis – hydrogen burning (pp chain and CNO cycle), triple alpha reaction.	**15**
IV	**Galaxies and Universe:** : The Milky way Galaxy, Dark Matter, Kinematics, Hubble classification scheme for external galaxies, Normal galaxies and AGNs, Unified model, Basics of X-ray astronomy, black holes, and gamma ray bursts, Hubble's law, nucleo-synthesis, Cosmic Microwave Background radiation, Elementary ideas on structure formations	**15**
	Total	**60**

Text:

3. An Introduction to Astrophysics; Baidyanath Basu, Prentice Hall Publication, 2nd Ed.,2013, New Delhi
4. An Introduction to Astronomy and Astrophysics, Pankaj Jain, CRC Press; 1st edition (8 April 2015)

References:

3. 1.V.B.Bhatia; Text Book on Astronomy and Astrophysics with elements of cosmology, Narosa Publishing House, 2nd Ed.,2001, New Delhi
4. 2.K. D. Abhayankar; Astrophysics: Stars and Galaxies, Abe Books,1st Ed., 2002, Hyderabad

NPTEL LINK:https://onlinecourses.nptel.ac.in/noc23_ph21/preview

Level: Semester VII

Course Level: 400

Name of the Subject: Mathematical Physics III

Type of Course: Major

Subject Code: PHY012M703 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few 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	**Remember** vector algebra, complex variable, analytic function, Legendre polynomial etc.	**BT 1**
CO 2	**Understand** the concept of homogeneous and non-homogeneous differential equation, Green's function etc.	**BT 2**
CO 3	**Apply** different mathematical technique to solve physical problems.	**BT 3**
CO 4	**Analyze** tensors, Caley-Hamilton theorem etc Bessel's function, Laplace transform, Wronskian etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Vector algebra and vector calculus, linear independence, basis expansion, Schmidt orthogonalisation. Matrices: Representation of linear transformations and change of base; Eigenvalues and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors, Concepts of tensors, covariant and contravariant tensor, mixed tensor of different rank, algebra in tensor analysis: addition, subtraction, outer multiplication, contraction, inner multiplication, quotient law.	**15**
II.	Complex numbers, triangular inequalities, Schwarz inequality. Function of a complex variable: single and multiple-valued function, limit and continuity; Differentiation; Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals, Cauchy's theorem (elementary proof only), converse of Cauchy's theorem, Cauchy's Integral Formula and its corollaries; Classification of singularities; Residue theorem and evaluation of some typical real integrals using this theorem.	**15**
III.	Theory of second order linear homogeneous differential equations Singular points: regular and irregular singular points; Frobenius method. Linear independence of solutions: Wronskian, second solution. Sturm-Liouville's theory; Hermitian operators; Completeness. Inhomogeneous differential equations: Green's functions	**15**
IV.	Special functions Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions., generating function Integral transforms Fourier and Laplace transforms and their inverse transforms, Bromwich integral [use of partial fractions in calculating inverse Laplace transforms]; Transform of Derivative and integral of a function; Solution of differential equations using integral transforms, Delta function.	**15**
Total		**60**

Text:

1. Mathematical Physics by Das H.K. S. Chand publishing 8th edition(2018).
2. Mathematical Physics by George B. Arfken,Elesvier Publisher7th edition(2012).

Reference Books:

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

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc21_ma27/preview

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

Level: Semester VII

Course Level: 400

Name of the Subject: Wave, Oscillation and sound

Type of Course: Major

Subject Code: PHY012M704 **Scheme of Evaluation: Theory**

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

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r periodic motion, simple harmonic motion, vibration of string, ultrasonic waves etc	**BT 1**
CO 2	**Understand** the basic concepts of phase and group velocity, differential equation of wave motion, Doppler's effect etc.	**BT 2**
CO 3	**Apply** different types of vibration in different physical system like mass-spring system, strings. Apply concept of sound to calculate velocity of sound in air, intensity of sound etc.	**BT 3**
CO 4	**Analyze** Lissajous' figures, differential equation of wave motion, Sabine's formula, Kundt's tube etc., Reverberation effect, etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Simple harmonic motion:** Periodic motion, Simple harmonic motion, Characteristics S.H.M., Vibration of simple spring's mass system, Free Vibrations, Damped and forced vibrations, Resonance. **Superposition of waves:** Principle of superposition of waves, Superposition of two waves, Interference of waves, Beats, Stationary waves, Lissajous' figures, Group and phase velocity.	**15**
II.	**Wave Motion:** Types of wave motion, Sound as wave, Phase velocity (wave velocity) and particle velocity, Linear equation of plane progressive wave motion in one and three dimensions, Instantaneous and average energy of one dimensional wave, Differential equation of wave motion. **Vibration of strings:** Transverse vibration of string, Wave equation in linear approximation, Eigen values and eigen functions of pluck and stuck string	**15**
III.	Velocity of Sound: Velocity of longitudinal waves in a gaseous medium, Calculation of velocity of sound in air, Effect of pressure, temperature and humidity on the speed of sound, Kundt's tube, Application of Kundt's tube. Doppler's effect, Application of Doppler's principle.	**15**
IV.	**Sound:** Musical sounds and noise, characteristics of musical sounds, Intensity of sound, IV Acoustics of buildings, Reverberation and time of reverberation, Sabine's formula for 12 reverberation time, Absorption coefficient and its measurement, Transmission of sound and transmission loss. **Ultrasound:** Ultrasonic waves, Production of ultrasonic waves, Detection of ultrasonics,	**15**

	Properties and application of ultrasonic waves.	
Total		**60**

Text Book:

1. Oscillations, Waves and Acoustics; P.K. Mittal, Dreamtech Press (1 September 2019)

Reference Book:

1. N Bajaj; The Physics of Waves and Oscillations, McGraw Hill Education (1 July 2017)
2. KAKANI S.L.; WAVES OSCILLATIONS AND ACOUSTICS, CBS; 2nd edition (1 January 2018)

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc19_ph18/preview

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

Level: Semester VII

Course Level: 400

Name of the Subject: Basics of Electronics

Type of Course: Minor

Subject Code: PHY012N701 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course will provide the students with the fundamental skills to understand the basics of semiconductors and components, apply, analyze and evaluate different biasing techniques to operate transistors, FET, MOSFET and operational amplifier in different modes.

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 basics of semiconductors & devices and their applications in different areas.	**BT 1**
CO 2	**Understand** the principles of semiconductor devices and their applications.	**BT 2**
CO 3	**Apply** logic gates, flip flops in building block of digital systems.	**BT 3**
CO 4	**Analyze** output in different operational modes of different semiconductor devices.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Semiconductor and Transistors**: Concept of Bandgap in semiconductor, Types of Semiconductors, Introduction to P-N junction Diode and V-I characteristics, Biasing of PN junction, Types of diode (Zener, LED, photodiode, etc),Transistor and its characteristics, Transistor as an amplifier and switch, rectifiers.	**15**
II.	**Operational amplifier and its applications:** Introduction to operational amplifiers, Ideal operational amplifier, Characteristics of OM-AMP, op-amp with negative feedback, inverting and non-inverting amplifier, OM-AMP as adder, subtractor, differentiators, integrators, Filters and noise reduction, Differential amplifier.	**15**
III.	**Digital Electronics**: Difference between analog and digital signals, Number systems, Boolean algebra and Logic gates, Laws of Boolean algebra, De Morgan's theorem, Reduction Boolean expression, Karnaugh map, Flip-Flops, Registers, Counters, comparators, A/D and D/A converters.	**15**
IV.	**Transistor Oscillators and multivibrators:** Introduction to Feedback oscillators, Hartley oscillator, Phase shift oscillator, R-C oscillator and Wein bridge oscillator, Concept of Multivibrators, RC-timing circuits.	**15**
Total		**60**

Text Book:

1. Integrated Electronics; Jacob Millman, Christos Halkias and Chetan D. Parikh, McGraw Hill Education; 2nd edition (1 July 2017).
2. Handbook of Electronics; Gupta & Kumar, Pragati Prakashan, 38th Edition 2012.
3. R.P. Jain , "Modern Digital Electronics", Tata Mc Graw Hill, 3rd Edition, 2007.

Reference Book:

1.Talukdar P. H.; Digital Logic and System Design, Mani Manik Prakash, 1st Ed., 2016, Guwahati.
2.Chattopadhyay D.; Electronics: Fundamentals & Applications; New Age International, 1st Ed., 2010, New Delhi.

NPTEL LINK: https://nptel.ac.in/courses/122106025

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

Level: Semester VIII

Course Level: 400

Name of the Subject: Methods of selected instruments used in physical science

Type of Course: Major
Subject Code: PHY012M801 **Scheme of Evaluation: Theory**
L-T-P: 4-0-0 **Total credits: 4**
Course Objectives:
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Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Understand** the **principles** and **working mechanisms** of various instruments used in physics research and material characterization.	**BT 2**
CO 2	**Apply** and **calibration the** spectroscopic, microscopic, and thermal analysis instruments.	**BT 3**
CO 3	**Analyze**the and interpret **experimental data** from various characterization techniques.	**BT 4**
CO 4	**Develop** a strong foundation for **advanced research** in various field of experimental physics.	**BT 5**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Role of Instruments in Physics Research**:** Importance of material characterization, Basic concepts of accuracy, precision, and sensitivity. Calibration and Data Acquisition**:** Basics of calibration and measurement: Noise reduction. Error calculations and statistical analysis (Technical aspects). Computer simulation techniques and their uses in theoretical research.	**10**
II.	X-ray Spectroscopy (XPS & XRF) Principles and applications in determining the composition and oxidation state of materials. UV-Visible and FTIR Spectroscopy**:** Principles and applications. Raman Spectroscopy: Scattering phenomenon and application molecular vibrations. Introductory idea of Mass spectroscopy: Ionization, mass-to-charge ratio. Types of mass spectrometers and Applications in isotop analysis. GM counter: the principle, threshold voltage and application in nuclear physics.	**10**
III.	Optical Microscopy & Fluorescence Microscopy**:** Imaging principles and magnification techniques, Resolution, Rayleigh criterion. Techniques to enhance resolution (confocal microscopy). Electron Microscopy: SEM & TEM, Principles of electron-matter interaction, application in High-resolution imaging of nanostructures, thin films, and microstructures. Atomic Force Microscopy (AFM) & Scanning Tunneling Microscopy (STM).	**15**
IV.	Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC)**:** Measuring thermal stability and phase transitions**.** X-ray Diffraction (XRD) for Structural Analysis**.** Bragg's Law**,** crystallinity analysis, and size detection of nanoparticles. Magnetic property measurement trough VSM and SQID. Four-Point Probe Method & Hall Effect Measurements**.** I-V Characteristics Used to analyze diodes, transistors, and resistors. **C**-V Profiling (Capacitance-Voltage Measurement) – Determines doping profiles in semiconductors.	**15**
Total		**60**

Text:

1. **R.S. Khandpur** – *Handbook of Analytical Instruments* (McGraw Hill)
2. **Skoog, Holler & Crouch** – *Principles of Instrumental Analysis* (Cengage Learning)

3. **William F. Smith & J. Hashemi** – *Foundations of Materials Science and Engineering*

Reference Books:

4. **H.P. Klug & L.E. Alexander** – *X-ray Diffraction Procedures*
5. **C. Kittel** – *Introduction to Solid State Physics*
6. **J. Goldstein et al.** – *Scanning Electron Microscopy and X-ray Microanalysis*

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

Level: Semester VIII

Course Level: 400

Name of the Subject: Research Methodology

Type of Course: Minor

Subject Code: PHY012N801 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course provides a structured approach to research methodology**,** ensuring students develop skills in scientific investigation, data analysis, and academic writing.

. **Course Outcomes:**

On successful completion of the course, the students will be able to:		
CO	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Understand** the basic principles of scientific research and its importance.	**BT 1**
CO 2	**Apply** various research techniques, including literature review data collection and analysis.	**BT 2**
CO 3	**Evaluate** different methodologies and select appropriate methods for different research projects.	**BT 3**
CO 4	**Analyze** and interpret research data for presentation, **Develop** scientific writing skills and understand the publication process.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Basic concepts of research and its role in scientific advancements. Definition and Characteristics of Research, Types of Research – Fundamental, Applied, Experimental, and Descriptive Research, Scientific Approach and Methodology – Steps in Research, Selecting the appropriate research methodology and experimental design: Qualitative vs Quantitative Research Methods, Theoretical and Experimental Research Design,Variables, Sampling Methods. Ethics in Research and Plagiarism.	**15**
II.	Literature Review & Research Problem Formulation: Finding, analyzing, and structuring information from previous research: Importance of Literature Review, Sources of Literature – Journals, Books, Theses, Patents, and Online Databases, Identifying Research Gaps and Formulating a Problem Statement, Citation & Referencing Styles (APA, IEEE, Chicago, etc.) and Bibliography.	**15**
III.	Data Collection, Analysis & Presentation: Collecting and analyzing data with appropriate statistical tools (Mean, Standard Deviation, Regression, Correlation), Primary & Secondary Data Collection, Error Analysis & Uncertainty in Measurements, Graphical Representation of Data – Histograms, Scatter Plots, Pie Charts, Introduction to Research Tools – MATLAB, SPSS, Origin, LaTeX.	**15**

IV.	Scientific Writing & Research Communication: Research Report Writing & Presentation Techniques, Scientific Paper Writing (Abstract, Introduction, Methodology, Results, Discussion, Conclusion), Publication Process – Journals, Peer Review, Impact Factor, Oral and Poster Presentations, Patents & Intellectual Property Rights (IPR).Indexing of paper and journal.	**15**
Total		**60**

Textbooks:

1. **C.R. Kothari & Gaurav Garg** – *Research Methodology: Methods & Techniques* (New Age)
2. **Wayne C. Booth et al.** – *The Craft of Research* (University of Chicago Press)
3. **Norman Blaikie** – *Designing Social Research*

Reference Books:

4. **J.W. Creswell** – *Research Design: Qualitative, Quantitative & Mixed Methods*
5. **Day & Gastel** – *How to Write & Publish a Scientific Paper*

Online Resources:

- **Google Scholar, IEEE Xplore, ScienceDirect** (For literature search)
- **LaTeX, Overleaf** (For report formatting)
- **SPSS, MATLAB, Python (Pandas, NumPy)** (For data analysis)

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

Level: Semester VIII

Course Level: 400

Name of the Subject: Fiber Optics and Basics of Laser

Type of Course: Major

Subject Code: PHY012M803 **Scheme of Evaluation: Theory**

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

Course Objective:

To develop a strong foundation for fiber optics and laser technology. To develop analytical concepts of fiber cable and laser properties and applications. To understand the relations and application and advantages. To apply knowledge of cables and lasers for communications.

Upon successful completion of the course students will be able to:		
CO	**COURSE OUTCOME (CO)**	**BLOOM'S TAXONOMY LEVEL**
CO1	Remember the basic principle of optical fiber and its application in communication.	**BT1**
CO2	Understand the different types of fiber and evaluate the properties and calculate the advantages of different fibers	**BT2**
CO3	Apply laser technology to increase the quality factor of lasers in communications conclude for maximum transmission in optical fiber cable using laser technology	**BT3**
CO4	Analyze the different fibers and calculate how the fibers work in optical communications	**BT4**

COURSE OUTLINE:

Modules	**Topics & Course Contents**	**Periods**
I.	Optical fibers and their properties: Construction of optical fiber cable: Guiding mechanism in optical fiber and the Basic component of optical fiber communication, Principles of light propagation through a fiber: Total internal reflection, Acceptance angle (θ_a), Numerical aperture and Signal attenuation, Different types of fibres and their properties: Single and multimode fibers and Step index and graded index fibers	**15**
II	Fiber characteristics: Mechanical characteristics and Transmission characteristics, Absorption losses, scattering losses, Dispersion, Connectors and splicers, Fibre optic sensors, Optical communications; Point to point optical communication.	**15**
III	Properties of laser: Monochromaticity, Coherence, Divergence and Directionality and Brightness, Spontaneous and stimulated emission; Condition for lasing action, population inversion, Fundamental characteristics of lasers: Two-Level Laser, Three Level Laser, and four level lasers, Einstein's A and B co-efficient and their relation.	**15**
IV	Basic components of lasers: pumping sources, gain medium, laser resonator cavities: different types of laser cavity and their working principles, cavity stability and cavity modes, Q-factor, losses in the cavity; Types of lasers: solid state lasers (Ruby lasers) and Semiconductor diode lasers. Working principles and applications of lasers (Holography, pollution measurement)	**15**
	TOTAL	**60**

Textbook:

1. *An Introduction to Fiber Optics,* Ajoy Ghatak, K. Thyagarajan, Cambridge University Press,Online publication date: June 2012, Print publication year:1998, Online ISBN:9781139174770
2. *Laser and nonlinear optics*, B.B. Laud, New age international (P)limited, 3rd edition, 2011.

Reference Books:

1. R. P. Khare, *Fiber optics and optoelectronics*.Oxford University Press, 2004
2. Thyagarajan K, and Ghatak A., *Laser's fundamentals and applications*, Spinger, New York,ISSN-1868-4513, 2010.
3. Karl F. Renk, *Basics of Laser Physics* , Springer; 2nd ed. 2017 edition (April 7, 2017)

Level: Semester VIII

Course Level: 400

Name of the Subject: Plasma and Space Physics

Type of Course: Major

Subject Code: PHY012M804 **Scheme of Evaluation: Theory**

L-T-P: 4-0-0 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
CO	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r fourth state of matter, plasma, ionosphere etc.	**BT 1**
CO 2	**Understand** the Debye shielding, fluid equation of motion, Solar flares, Sunspots	**BT 2**
CO 3	**Apply** equation of continuity, equation of state to understand plasma, ionospheric density.	**BT 3**
CO 4	**Analyze** MHD waves: magneto-sonic and Alfven waves, Solar flares, Sunspots, plasma in the Earth's middle and inner magnetosphere	**BT 4**

COURSE OUTLINE:

Modules	**Course Contents**	**Periods**
I.	**Plasma Physics:** Understanding of elementary concepts: plasma oscillations, Debye shielding, plasma parameters, criteria for plasmas, analysis of Plasma confinement: single particle motion, ∇B⊥B: Grad- B drift, curvature drift, their applications and analysis. ∇B ll B: magnetic mirrors, non-uniform E Field, time-varying E Field, time-varying B Field, adiabatic invariants: first, second and third adiabatic invariant (Pinch effect, magnetic mirrors); Evaluation of related problems.	**15**
II	**Plasma as fluids:** Analysis of relation of plasma physics to ordinary electromagnetics: Maxwell's equations, dielectric constant of a plasma; fluid equation of motion, convective derivative, stress tensor, collisions, comparison with ordinary hydrodynamics, analysis of equation of continuity, equation of state; plasma approximation. Evaluation of related problems. MHD waves: magneto-sonic and Alfven waves, propagation at arbitrary directions: pure Alfven wave, fast and slow MHD waves, phase velocities, wave normal surfaces.	**15**
III.	**Space Physics:** Introduction: Understanding of early studies on geomagnetic field, ionosphere and magnetosphere, magnetospheric exploration, planetary and interplanetary exploration. Analysis of Solar phenomena: structure of the Sun, Solar activity, prominences, coronal heating, Solar flares, Sunspots. Analysis of solar wind properties, solar wind formations, interaction of Solar wind with magnetized and unmagnetized planets. Evaluation of related problems.	**15**
IV	Ionosphere: Concept of Ion production and loss, determination of ionospheric density. Magnetosphere: Analysis of magnetopause, magnetotail, magnetic reconnection, plasma flow in the magnetosphere, magnetic field configuration of the Earth's magnetosphere, plasma in the Earth's middle and inner magnetosphere, Ionosphere-Magnetosphere coupling, Evaluation of related problems.	**15**
	Total	**60**

Texts:

1. *Plasma Physics and Controlled Fusion*; Chen F.F., Springer International, 3rd Ed., 2016, Switzerland
2. *Fundamentals of Plasma Physics;* Bittencourt J.A. 3rd Ed., 2004, *Springer* (India)
3. *Introduction to Space Physics*; Russell C. T., Cambridge University Press ; 1st Ed., 1995, Cambridge

References:

1. Gurnett D. A. and Bhattacharjee A.; *Introduction to Plasma Physics with space and laboratory applications*, Cambridge University Press, 1st Ed., 2005, Cambridge.
2. Robert J. G. and Rutherford P. H.; *Introduction to Plasma Physics*, IOP Publishing Ltd, 1st Ed. (Reprint) 1995, Philadelphia

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

Level: Semester VIII

Course Level: 400

Name of the Subject: Nanophysics

Type of Course: Major

Subject Code: PHY012M805 **Scheme of Evaluation: Theory**

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

This course introduces the basic concepts and principles to understand the physics of nanomaterials. The emphasis of this course is to impart the understanding of the effect of dimensional confinement of charge carries on the electrical, optical and structural properties.

Course Outcomes:

Upon successful completion of the course students will be able to:		
CO	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the difference between nanomaterials and bulk materials and their properties.	**BT1**
CO2	Understand the concept of various characterization tools required to study the structural, optical and electrical properties of nanomaterials and learn the applications areas of nanomaterials.	**BT2**
CO3	Apply the knowledge to resolve the related problems.	**BT3**
CO4	Analyze the concepts of the physics of nanomaterials, to solve problems, with logical interpretations and critical thinking.	**BT4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I.	Introduction to nanoscale physics: Definition, Difference between bulk and nanoscale materials and their significance, Importance of Nanoscale and Technology, History of Nanotechnology, 0D, 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), density of states of materials at nanoscale.	**15**
II.	Synthesis of nanomaterials: Different approaches: Top-down approach and bottom-up approach. Top-down approach: photolithography, electron-beam lithography. bottom-up approach: chemical methods, sol-gel processing, hydrothermal process.	**15**
III.	Characterization of materials: Structure and Surface morphology: Phenomena of diffraction radiation, X-ray diffraction, phase identification, Scherrer formula, scanning electron microscopy (SEM), transmission electron microscopy (TEM), Spectroscopy: Working principle of UV-Vis spectroscopy, IR Spectroscopy, Raman and Photoluminescence Spectroscopy.	**15**
IV.	Properties of nanomaterials: Properties at the nanoscale, effect of confinement, quantum confinement, size quantization effect on electronic state, surface-to-volume ratio, chemical properties of nanomaterials. Nanotechnology in different fields.	**15**
Total		**60**

Texts:

1. *Nanostructures and Nanomaterials: Synthesis, Properties, and Applications*; G. Cao, Y. Wang, World Scientific, 2nd Ed.,2011, Singapore
2. *Introduction to Nanotechnology;* C. P. Poole, J. F. J. Owens, Wiley India ,1st Ed.,2003, New Delhi

Reference:

1. T. Pradeep; *A Textbook of Nanoscience and Nanotechnology*, Tata McGraw Hill, 1st Ed., 2012, New Delhi

NPTEL link: https://nptel.ac.in/courses/118102003