ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF APPLIED AND PURE SCIENCES

DEPARTMENT OF PHYSICS

Learning Outcomes-based Curriculum Framework (LOCF) for Undergraduate Programme in B.Sc Physics

W.E.F 2022 - 23

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1. Preamble

Education is the backbone of a nation. It is the most powerful sector and acts as the key for the success of the nation. On the other hand, students are the pillar of a nation who will lead the nation in the times to come. So, the synergy between the education system of a country and its student community is vital for the sustainable development of the nation. This interdependence necessitates the dynamic nature of the education system and demands the change with time. To inhabit this dynamics requirement, The Assam Royal Global University is upgrading its undergraduate programme. Higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution – ademocratic, just, socially conscious, cultured, and humane nation upholding liberty, equality,fraternity, and justice for all. Higher education significantly contributes towards sustainable livelihoods and economic development of the nation.A holistic and multidisciplinary education would aim to develop all capacities of human beings -intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner.Such an education will help develop well-rounded individuals that possess.As India moves towards becoming a knowledge economy and society, more and more young Indians are likely to aspire for higher education. The syllabuses aim at making higher education multidisciplinary learning process. In other words, the curriculum will be flexible, it will allow students to take up creative subject-combinations.

The new curriculum of B. Sc. Honors in Physics under The Assam Royal Global University will be more flexible, multi-disciplinary and holistic.

1.1. Introduction

The syllabus aims at a new and forward-looking Vision for India's Higher Education System. At the societal level, higher education must enable the development of an enlightened,socially conscious, knowledgeable, and skilled nation that can find and implement robust solutions to its own problems.

The B.Sc. Physics curriculum has been developed to train the student with theoretical and practical knowledge of the subject matter using CBCS methodology. The curriculum also aims to provide sound training to pursue research in the field of Physics or any other interdisciplinary areas.

The learning outcomes of the course are designed in such a way that the students understand

the objectives of the course which enable them to realize the usefulness of the applied sciences for the well being of the humankind and the natural environment. The course contents include both fundamentals as well as upcoming developments in the field of Physics and interdisciplinary branches of sciences.

1.2. 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. Physics course curriculum and syllabus are framed on the outcome-based teaching-learning process. The Learning Outcomes-based Curriculum Framework (LOCF) 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 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 in making the right choice in their future endeavors.

1.2.1. Nature of bachelor's degree programme in Physics (Honours)

Physics is the study of natural science. It has a wide range of applications in natural sciences, engineering, medical sciences etc. The key areas of study in Physics are:

Mechanics; Optics and laser; Waves and oscillation; Electricity and magnetism ; Electrodynamics; Thermodynamics; Concept of nucleus; Electronics; Atom and molecules; Matter and its constituent; Concept of crystal; Mathematical physics; Relativity; Quantum mechanics; Statistical mechanics; Digital system and applications; Astrophysics; Atoms and Molecular Physics; Laser Physics; Solid State Physics

The B.Sc. Physics course curriculum has been designed by considering the above branches

of physics along with a few papers for skills, and values that a student intends to acquire to look for professional avenues or move to higher education at the postgraduate level. The bachelor's degree in Physics is a 3 year degree course which is divided into 6 semesters as .

Sl.No	Year	Semester	Credits
1	1	I	24
2		II	24
3	2	III	24
4		IV	24
5	3	V	26
6		VI	26
Grand Total Credits			**148**

Bachelor's Degree (H) program attract entrants from the secondary level or equivalent, often with subject knowledge that may or may not be directly relevant to the field of study/profession. Thus, B.Sc. (H) Course in Physics aims to equip students to qualify for joining a profession or to provide development opportunities in particular employment settings. Graduates are enabled to enter a variety of jobs or to continue academic study at a higher level.

1.2.2. Aims of bachelor's degree (H) Programme in Physics:

The overall aims of the B.Sc. Physics Program are to:

- Create a strong interest in learning Physics.
- Provide an in-depth understanding of the basic concepts of physical sciences
- Enable the students to acquaint with suitable tools and skills of Physics
- Solid understanding of the fundamental areas of modern Physics
- The students will understand the principles and application of physical science to address problems in a variety of disciplines

- Assist the students to become more capable, competent as well as confident in their performances which will eventually make them employable or risk-taker in their future endeavors

1.3. 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.

GA-1: 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:Communication skills: Communication is important in any discipline. The physics discipline is not an exception. The student is expected to have the required this 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 document.

GA-3: Critical thinking: It enables the student to think about a problem in an analytical way to produce a logical solution.

GA-4: Problem-solving: Problem-solving is an integral part of the physics syllabus. The student is expected to be equipped with the necessary analytical and critical thinking abilities.

GA-5: Analytical reasoning: The student should develop the skill of logical conclusions based on knowledge, facts, and observations. Potentiality 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-6: Cooperation/Team works: In general, a class is consisting of students from diverse fields. The student should behave with classmates in an accommodating as well as meaningful way.

GA-7: Scientific reasoning: A student should inculcate the expertise of investigating a phenomenon in terms of scientific reasoning.

GA-8: Reflective thinking: It helps the student to make a judgement about some happenings based on their experiences.

1.4. Qualification Descriptors for a bachelor's degree programme in Physics

The B.Sc. Physics course includes a wide range of topic from different branches of physics. In the qualification descriptors category of this course, the following points may be included.

1. Understanding of in-depth concepts of different domains in physical science through theory and experiment.

2. Development of theoretical and practical knowledge to become specialized in the subject matter.

3. Dissemination of acquired results in a scientific manner in the range of different context

4. Exhibit inclusive knowledge about physics in context to current research

5. Development of knowledge and capability to participate fruitfully in a physics-related discussion and contribute to solving the problem of the discussion.

6. Make capable to explore opportunities in the field of physics and related branches for jobs, research, or businesses.

7. Application of the physical concepts for the sustainable development of the county

8. Exploring advanced and new topics in physical science through the application of existing knowledge and understanding.

1.5. Programme Learning Outcomes relating to BSc Honours degree programme in Physics

Students graduating with the degree BSc (Physics) will be able to achieve the following:

PO 1: Physics Knowledge: Apply the basic knowledge of physics to the solutionofadvancephysicsproblems.

PO2:ConductInvestigationsofComplexProblems: Useresearch-basedknowledgeandresearchmethodsincludingdesign of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.

PO3:ProblemAnalysis: Identify,formulate,researchliterature,andanalyzecomplexphysicsproblemsreaching substantiatedconclusionsusingprinciple of physics.

PO 4: Communication: Communicateeffectivelyon physic related activitieswiththecommunityandwithsocietyatlarge,suchas,beingabletocomprehendandwriteeffectivereportsanddesigndocumentation,makeeffectivepresentations,alsogiveandreceiveclearin

structions.

PO5:Ethics, IndividualandTeamWork: Apply ethical principles and commit to professional ethics and responsibilities and norms of thephysicspractice. Functioneffectivelyasanindividual,andasamemberorleaderindiverseteams,andinmultidisciplinarysettings.

PO 6: Design/Development of Solutions: Design solutions for advanced physics problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO 7: The physics and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional physics application.

PO8: Environment and Sustainability: Understand the impact of the applied physics solutionsinsocietalandenvironmentalcontexts,anddemonstratetheknowledgeforsustainabledevelopment.

1.6. B.Sc Physics Programme Specific Outcomes

PSO1: Building a critical understanding of the subject matters to conduct research and analyse 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 developnew and innovative ideas/solutions in physics and allied fields for the society and the environment at large.

1.7. Teaching Learning Process

Teaching and learning in this programme involves classroom lectures as well as tutorial and remedial classes.

Tutorial classes: Tutorials allow closer interaction between students and teacher as each student gets individual attention. The tutorials are conducted for students who are unable to achieve average grades in their weekly assessments. Tutorials are divided into three categories, viz. discussion-based tutorials (focusing on deeper exploration of course content through discussions and debates), problem-solving tutorials (focusing on problem solving processes and quantitative reasoning), and Q&A tutorials (students ask questions about course content and assignments and consolidate their

learning in the guiding presence of the tutor).

Remedial classes: The remedial classes are conducted for students who achieve average and above average grades in their weekly assessments. The focus is laid to equip the students to perform better in the exams/assessments. The students are divided into small groups to provide dedicated learning support. Tutors are assigned to provide extra time and resources to help them understand concepts with advanced nuances. Small groups allow tutors to address their specific needs and monitor them. Following methods are adopted for tutorial and remedial classes:

- Written assignments and projects submitted by students
- Project-based learning
- Group discussions
- Home assignments
- Class tests, quizzesorganised in the department
- Seminars and conferences
- Extra-curricular activities like cultural activities, community outreach programmes etc.
- Field trip, excursions, study tour, interacting with eminent authors, etc.

1.8. Assessment Methods

<table>
<tr><th></th><th>Component of Evaluation</th><th>Marks</th><th>Frequency</th><th>Code</th><th>Weightage (%)</th></tr>
<tr><td>A</td><td>Continuous Evaluation</td><td></td><td></td><td></td><td></td></tr>
<tr><td>i</td><td>Analysis/Class test</td><td rowspan="5">Combination of any three from (i) to (v) with 5 marks each</td><td>1-3</td><td>C</td><td rowspan="6">25%</td></tr>
<tr><td>ii</td><td>Home Assignment</td><td>1-3</td><td>H</td></tr>
<tr><td>iii</td><td>Project</td><td>1</td><td>P</td></tr>
<tr><td>iv</td><td>Seminar</td><td>1-2</td><td>S</td></tr>
<tr><td>v</td><td>Viva-Voce/Presentation</td><td>1-2</td><td>V</td></tr>
<tr><td>vi</td><td>MSE</td><td>MSE shall be of 10 marks</td><td>1-3</td><td>Q/CT</td></tr>
<tr><td>vii</td><td>Attendance</td><td>Attendance shall be of 5 marks</td><td>100%</td><td>A</td><td>5%</td></tr>
<tr><td>B</td><td>Semester End Examination</td><td></td><td>1</td><td>SEE</td><td>70%</td></tr>
<tr><td colspan="5">Total</td><td>100%</td></tr>
</table>

2. Course Structure

B.Sc. (H) Physics							
Programme Structure							
1st Semester							
Sl. N.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	PHY012C101	Mechanics	3	2	0	4	5
2	PHY012C102	Mathematical Physics-I	3	2	0	4	5
3	PHY012C113	Physics Lab I	0	0	4	4	8
SEC							
4	PHY012S101	Physics Workshop Skills	0	0	2	2	4
Value Added Courses (VAC)							
5	XXXXXXXX	Will select one course from a basket ofcourses	-	-	-	2	4
Generic Elective							
6	PHY012G101	Fundamentals of Physics	3	0	0	3	3
7	PHY012G102	Physics of earth	3	0	0	3	3
Ability Enhancement Compulsory Courses (AECC)							
8	CEN982A101	Communicative English- I:	1	0	0	1	1
9	BHS982A102	Behavioral Science-I	1	0	0	1	1
			Total Credit = 24				
2nd Semester							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	PHY012C201	Electricity and Magnetism	3	2	0	4	5
2	PHY012C202	Thermal & StatisticalPhysics	3	2	0	4	5
3	PHY012C213	Physics Lab II	0	0	4	4	8

SEC							
4	PHY012S201	Electrical Circuit and Network Skills	0	0	2	2	2
VAC							
5	XXXXXXXX	VA2: Will select one course from a basket of courses	-	-	-	2	4
Generic Elective							
6	PHY012G201	Basics of Practical Physics	3	0	0	3	3
7	PHY012G202	Optics and Atomic Physics	3	0	0	3	3
Ability Enhancement Compulsory Courses(AECC)							
8	CEN982A201	Communicative English – II: Conversation and Public Speaking	1	0	0	1	1
9	BHS982A202	Behavioral Science-II	1	0	0	1	1
			Total Credit = 24				
3rd Semester							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	PHY012C301	Ray and wave optics	3	2	0	4	5
2	PHY012C302	Mathematical Physics-II	3	2	0	4	5
DSE (Any one)							
3	PHY012D301	Atmospheric Physics	3	2	0	4	5
4	PHY012D302	Geophysics	3	2	0	4	5
5	PHY012D303	Theory of relativity	3	2	0	4	5
Generic Elective							
6	PHY012G301	Electricity and Magnetism	3	0	0	3	3
7	PHY012G302	Introduction to Astrophysics	3	0	0	3	3
Ability Enhancement Compulsory Courses(AECC)							
8	CEN982A301	CEN-3	1	0	0	1	1

9	XXXXXXXX	ILD	1	0	0	1	1
10	XXXXXXXX	4 week internship after 2nd sem. exam	0	0	0	4	
			Total Credit = 24				
4th Semester							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	PHY012C401	Quantum Mechanics	3	2	0	4	5
2	PHY012C402	Nuclear & Particle Physics	3	2	0	4	5
DSE (Any one)							
3	PHY012D401	Physics of non-conventional sources of energy	3	2	0	4	5
4	PHY012D402	Plasma and space physics	3	2	0	4	5
SEC& VAC							
5	PHY012S401	Basic Instrumentation skills	0	0	2	2	2
6	XXXXXXX	VAC3: Will select one course from a basket of courses	-	-	-	2	4
Generic Elective							
7	PHY012G411	General Physics Lab	0	0	3	3	3
8	PHY012G401	Thermal Physics	3	0	0	3	3
Ability Enhancement Compulsory Courses(AECC)							
9	CEN982A401	AECC7 (CEN-4)	1	0	0	1	1
10	XXXXXXX	AECC8 (Functional Language)	1	0	0	1	1
			Total Credit = 24				
5th Semester							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							

1	PHY012C501	Solid State Physics	3	2	0	4	5
2	PHY012C502	Mathematical Physics-III	3	2	0	4	5
DSE (Paper PHY012D503 & any one from the remaining)							
3	PHY012D501	Nano-Physics	3	2	0	4	5
4	PHY012D502	Fiber Optics and Laser technology.	3	2	0	4	5
5	PHY012D503	Classical Mechanics	3	2	0	4	5
6	PHY012D504	Biophysics	3	2	0	4	5
VAC							
	XXXXX	VAC3: Will select one course from a basket of courses	-	-	-	2	4
Ability Enhancement Compulsory Courses(AECC)							
8	CEN982A501	AECC9 (CEN 5)	1	0	0	1	1
9	XXXXX	AECC 10 (Environmental studies and sustainable development)	1	0	0	1	1
10	XXXXXXXX	6 weeks internship after the 4th semester	0	0	0	6	……
			Total Credit = 26				

6th Semester							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	PHY012C601	Atomic & Molecular Physics	3	2	0	4	5
2	PHY012C602	Electrodynamics	3	2	0	4	5
DSE (DSE (Paper PHY012D604 & any two from the remaining)							
3	PHY012D601	Basic Electronics	3	2	0	4	5
4	PHY012D602	Astronomy	3	2	0	4	5
5	PHY012D603	Waves Oscillation &	3	2	0	4	5

		Sound					
6	PHY012D604	Research Methodology&Minor Project	0	0	4	4	8
SEC							
7	PHY012S601	Computational Physics Skill	0	0	2	2	2
8	XXXXXXX	VAC4: Will select onecourse from a basket of courses	-	-	-	2	4
Ability Enhancement Compulsory Courses(AECC)							
9	CEN982A401	AECC 11 (CEN-6)	1	0	0	1	1
10	XXXXXXX	AECC 12 Human value and gender sensitization	1	0	0	1	1
			Total Credit = 26				

SYLLABUSES

BSC PHYSICS 1ST SEMESTER

Level: Semester I

Course: C-1

Title of the Paper: Mechanics

Subject Code: PHY012C101

L-T-P-C: 3-2-0-4 **Total credits: 4**

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

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remembe**r Newton's laws of motion and applications.	**BT 1**
CO 2	**understand** the concept of inertial reference frames and Galilean transformations, conservation of energy, momentum, angular momenta, the analogy between transnational and rotational dynamics, variable mass system and dynamics of a	**BT 2**
CO 3	**apply** the concept of moment of inertia about the given axis of symmetry for different uniform mass distributions, the phenomena of collisions and idea about center of mass and laboratory frames.	**BT 3**
CO 4	**analyze** the concept of different type of elastic constants, energy in a strained body, bending moment, cantilever, 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.	**12**
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 type of elastic constants and relation among them. Energy in a strained body, bending of beam, bending moment, cantilever, depression of a cantilever	**12**

	considering the weight of the beam.	
III.	**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. **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.	**12**
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 particle. Mass-energy Equivalence.	**12**
Total		**48**

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).
3. *Elements and properties of matter* - Mathur D.S., S. Chand Publication, 11th Edition (2016).

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).
3. Resnick R. *Introduction to Special Relativity*, John Wiley and Sons (2005).

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

Level: Semester I

Course: C-2

Title of the Paper: Mathematical Physics I

Subject Code: PHY012C102

L-T-P-C: 3-2-0-4 **Total credits: 4**

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

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remember** different topics like vectors, scalar, different types of matrices, gamma function, periodic function, Fourier series 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 conten	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 problem, 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.	**12**
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 ofmatrix.	**12**
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.	**12**
IV	**Fourier Series:** Concept of Periodicfunctions, Fourier series, Dirichlet's conditions for a Fourier series, Evaluation of related problems. **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.	**12**
	Total	**48**

Text:

I. *Mathematical Physics* by: Das H.K. S. Chand publishing 8th edition(2018).

II. *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://nptel.ac.in/courses/111106148

Level: Semester I

Course: C-3

Title of the Paper: Physics Lab I

Subject Code: PHY012C113

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

Course Objective:

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

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Find** different physical devices	**BT 1**
CO 2	**Demonstrate** different mechanisms like Searle'sApparatus, capillary tube etc.	**BT 2**
CO 3	**Apply** different methods in experiment.	**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 usingM.I.Table
2. To determine the Young's Modulus of a Wire using Searle'sApparatus
3. To determine g by Kater'sPendulum.
4. To determine surface tension capillary tubemethod.
5. Measurement of excitation and ionization potential using Frank and Hertzexperiment.
6. Determination of refractive index of a transparent liquid by using a travellingmicroscope.
7. To find the density of the material of a wire by employingsonometer.
8. To determine the frequency of a tuning fork of Melde'sexperiment.
9. Determination of spring constant using static and dynamicmethod.
10. Analysis of elliptically polarized light using BabinetCompensator.

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

Level: Semester I

Course: S-1

Title of the Paper: Physics workshop skills

Subject Code: PHY012S111

L-T-P-C: 0-0-2-2 **Total credits: 2**

Course Objective:

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

Course Outcome:

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

List of experiments:

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

Text

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

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th

edition(2012).
NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Level: Semester I

Course: G-1
Title of the Paper: Fundamentals of Physics

Subject Code: PHY012G101

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

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

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remember** the nature of differential equations, laws of rotational motion, laws of thermodynamics	**BT 1**
CO 2	**understand** a few primary concepts of mathematical physics, rotational motion,electricity, thermodynamics and modern physics	**BT 2**
CO 3	**apply** different laws of mathematical physics, electricity, rotational motion , thermodynamics to solve different physics related problems.	**BT 3**
CO 4	**analyze** the effect of different mathematical operations on a physical parameters, importance to rotational axis, effects of electricity in different circuit elements and 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	**9**
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.	**9**
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.	**9**
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, Plancks law, Photoelectric effect.	**9**

Total	36

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

Level: Semester I

Course: G-2
Title of the Paper: Physics of Earth

Subject Code: PHY012G102

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

Course Objectives: The course is an introduction to physics of the solid Earth intended for students with substantial background in physics. The course will provide an overview of the structure and evolution of the Earth as a dynamic planet within our solar system.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remember** the basic terms associated with the seismology, Earth magnetic field, geomagnetic files and Atmosphere	**BT 1**
CO 2	**understand** the theoretical basis for modern global seismology and employ methods based on such theory earthquake phenomena and the seismological probing of earth structure.	**BT 2**
CO 3	**apply** the governing dynamics of mantle and lithosphere, and use such understanding to make reliable estimates of the forces controlling plate motions and their temporal changes.	**BT 3**
CO 4	**analyze** the vertical structure of the atmosphere in connection to the basic thermodynamics and also about the climate dynamics: Present day climate-Climate variability –Climate sensitivity and feedback – Global warming – Climate monitoring and prediction etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**The Way the Earth Works: Plate Tectonics:** Concept of plate tectonics, sea-floor spreading and continental drift, Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs , Earthquake and earthquake belts, Volcanoes- types, products and their distribution.	**9**

II	**Earth's magnetic field:** Definition of Earth's magnetic field, Formation of core, mantle, crust, hydrosphere, atmosphere and biosphere, Convection in Earth's core and production of its magnetic field, Mechanical layering of the Earth.	**9**
III	**Geomagnetic Field:**Origin of geomagnetic field, secular variations and westward drift, reversals of geomagnetic field, geomagnetic storms, earth's current, sun spot, solar flares, lunar and solar variations. Electric field generation, solar wind and its impact on earth' atmosphere**.**	**9**
IV	**Atmospheric thermodynamics:** Gas laws, Hydrostatic equation, First law, Adiabatic processes, Water vapour in air, Static stability, Radiation laws, Physics of absorption, emission and scattering, Introduction to Remote Sensing, Atmospheric Boundary Layer.	**9**
	Total	**36**

Text Book:

1. *Physics of the Earth*– Frank D. Stacey and Paul M. Davis.: McGraw Cambridge University Press; 4 edition (25 August 2008)
2. Geophysics, Annette Bolger, OXFORD (1 January 2010).

Reference Books:

1. The Physics of Atmospheres, John Houghton, 3rd Edition, Cambridge University Press, Cambridge, 2002.
2. An Introduction to Atmospheric Thermodynamics, A.A.Tsonis, 2nd Edition, Cambridge University Press, Cambridge, 2007.

NPTEL LINK:https://onlinecourses.nptel.ac.in/noc23_ce55/preview

BSC PHYSICS 2ND SEMESTER

Level: Semester II

Course: C-1
Title of the Paper: Electricity and Magnetism

Subject Code: PHY012C201

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course Objective:
To develop the strong foundation for electricity and magnetism for application in practical field and analytical concept of electricity, basic laws of electricity, magnetism

Course Outcome:

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

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Electric Field and Electric Potential**: 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.	**12**
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.	**11**
III	**Magnetic Field**: Magnetic force between current elements and 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) Solenoid and (2) Toroid. 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.	**13**

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 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	**12**
	Total	**48**

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).
3. R.P. Feynman, *R.B. Leighton, M. Sands*, Feynman Lectures Vol.2, , 2008, Pearson Education
4. Arthur F. Kip, *Fundamentals of Electricity and Magnetism*, 2nd Edn.1981, Mc Graw Hill.
5. Dr. K.K.Tiwari , *Electricity and magnetism*, S.Chand publication

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

Level: Semester II

Course: C-2
Title of the Paper: Thermal and Statistical Physics

Subject Code: PHY012C202

L-T-P-C: 3-2-0-4 **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.

Course Outcomes:

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remember** the statistical nature of particles, concepts and laws in thermodynamics	**BT 1**

CO 2	**understand** entropy, temperature, Free energies, and partition functions, etc.	**BT 2**
CO 3	**apply** the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.	**BT 3**
CO 4	**analyze** the statistical physics methods, such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems.	**BT 4**

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.	**12**
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.	**13**
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).	**11**
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	**12**
	Total	**48**

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

Reference Books:

1. Lokanathan S. and Gambhi R.S.; Statistical and Thermal Physics- An introduction, P.H.I., 1st Ed., 2008, New Delhi
2. Gupta and Kumar; Statistical Mechanics; Pragati Prakashan, 24th Ed., 2015, Meerut

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

Level: Semester II

Course: C-3
Title of the Paper: Physics Lab II

Subject Code: PHY012C213

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

Course Objective:
To familiarize with different basic experiments of Physics and to understand the working of different devices like lenses, biprism, zener diode etc.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Find** different physical devices	**BT 1**
CO 2	**Demonstrate** different mechanisms like statical method, Newtons's ring method etc.	**BT 2**
CO 3	**Apply** different methods in experiments.	**BT 3**
CO 4	**Analyse** 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 PolarizedLight.
3. To determine wavelength of sodium light using FresnelBiprism.
4. Determination of Rigidity of Modulus of the material of the given rod by Staticalmethod.
5. To measure the Self Inductance of a Coil by Anderson's Bridgemethod.
6. To find the refractive index of a liquid with the help of a convex lens and a planemirror.
7. To study the response curve of a Parallel LCR circuit and determine its (a) Anti-Resonant Frequency and (b) Quality FactorQ.
8. To measure the mechanical equivalent of heat by an electricalmethod.
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 VoltageRegulator.
11. Study of Zeeman Effect and determination of e/m ofelectron.

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

Level: Semester II

Course: S-2
Title of the Paper: Electrical Circuit and Network Skills

Subject Code: PHY012S201

L-T-P-C: 0-0-2-2 **Total credits: 2**

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

Course Outcome:

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

List of experiments:

1. To draw the static characteristics curves of a PN junction diode in forward bias and hence determine its DC and AC resistances for a given current.

2. To determine thee.m.f. of a cell usinga cellof know e.m.f. with the help of potentiometer.

3. To study input and output characteristics of a npn Bipolar Junction Transistor (BJT) in Common- emitter configuration.

4. Assembling and testing of electrical switch boards

5. To study the RC characteristic using 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

Level: Semester II

Course: G-3
Title of the Paper: Basics of Practical Physics

Subject Code: PHY012G201

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

Course Objective:
To develop the foundation of physical laws and theory related to laboratory physics and to understand the use of vernier scale, screw gause, post office box, meter bridge, rigidity modulus instrument.

Course Outcome:

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Recall** vernier scale, screw gauge, post office box, meter bridge, rigidity modulus instrument etc.	**BT 1**
CO 2	**Understand** the logic gates and principles behind the measurement techniques	**BT 2**
CO 3	**Apply** the knowledge to measure small distances, diameter and radius of rods voltage drops, rigidity etc.	**BT 3**
CO 4	**Analyze** formula and solve numerical of small distance measurement, emf determination, unknown resistance determination, light intensity measurement, truth table of logic gates.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course conten**	**Periods**
I	General Physics: Diagonal Scale, Principle of Verneir Scale, Slide Callipers and its use, Principle of micrometer screw: its applications and defects, Screw Gauge and its use, Spherometer and its use, Travelling microscope, brief idea about types of Elasticity.	**9**
II.	Light: Optical bench and its uses, Sign convection, Determination of focal length of convex and concave lens, prism, Newton's ring, Polarimeter, Determination of refractive index.	**9**
III.	Electricity: Electrical cells and their uses, Shunt and its use, Ammeters and Voltmeters, Wheatstone Bridge Principle, Metre Bridge, P.O. Box, Galvanometer and their use, Potentiometer and its action, Magnetometer .	**9**
IV	Electronics: Semiconductors and p-n junction diode, Half-wave and full wave rectifier: study the performance using semiconductor diodes, Bridge rectifier, Zener diode, Transistor, Basic idea of digital electronics: OR, AND, NOT.	**9**
TOTAL		**36**

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).

Reference Books:

1. A text book on Practical Physics– Samir Kumar Ghosh, New Central Book Agency; 4th Revised edition (2017)

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

Level: Semester II

Course: G-4
Title of the Paper: Optics and AtomicPhysics

Subject Code: PHY012G202

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

Course Objective:

To develop the foundation of optical phenomena's such as reflection, refraction, interference, diffraction and atomic models and electronic transition to understand analytical concept of image formation, interference fringe formation and diffraction pattern formation.

Course Outcome:

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember**the differences between particle and wave theory of light,the differences between particle and wave theory of light.	**BT 1**
CO 2	**Understand**propagation of light in wave theory and image formation. Laws of reflection and refraction	**BT 2**
CO 3	**Apply** the knowledge of optics atomic physics to measure image distances, fring width of interference, intensity profile of diffracted light, electrons energy in its orbit wavelength of light emitted during atomic transition.	**BT 3**
CO 4	**Analyze** relationship of atomic radius, energy and transition equation and Huygens wave theory of light.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course conten**	**Periods**
I	Origin of wave theory, Huygen's principle, reflection of a plane wave front at a plan surface, reflection of a plan wave front at a spherical surface. Interference, coherent source, Theory of interference fringes, Young's double slit experiment and interference fringe widths. Interference by Loyyed mirror, Newtons ring and Michelson interferometer.	**9**
II	Diffraction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction due to single slit, Polarization of light, plane of polarization, linear and circular polarized light, polarization by reflection, Brewster's law, Malus law, Double refraction, Nicol prism and double refraction.	**9**
III	Atomic models, Rutherford's nuclear atom model, alpha scattering experiment, Failur of Rutherford model, Bohr's correction of Rutherford model, Bohr's postulates, deduction of atomic radius and atomic energy. Correspondence principle.	**9**

IV	Nuclear motion, Atomic excitation, critical and Ionization potential, electrons tradition in an atom, transition formula, Rydberg's constant, hydrogen energy spectrum, fine structures of spectrum, Sommerfield's extension of the Bohr's theory	**9**
	Total	**36**

Text Book:

1. A Text Book of Light, Mazumdar, K. G., 10th edition, Modern Book agency (P) LTd.,1970.
2. Concept of Modern Physics; BeiserA., Mahajan S., Choudhury S. R., 6th Edition; McGraw-Hill education, India; PrivateLimited; New Delhi; 2010.

Reference Books:

1. Subramanyam N. & Brij lal, A text book of optics, 25th Edition, S. chand and company. PVT ltd. Ram Nagar, New Delhi; 2015.
2. Chakraborty, P. K., Geometrical and Physical Optics, 5th Edition New Central Book Agency (P) Ltd, 2010.
3. Optics, Ghatak.A, 6th edition, Mc Graw Hill Education, Printed at Pashupati printers, 1/429/16, gali no. 1, G. T. Road, Shahdara, New Delhi, India, 2017.

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc23_ph16/preview

BSC PHYSICS 3RD SEMESTER

Level: Semester III

Course: C-1

Title of the Paper: Ray and Wave Optics

Subject Code: PHY012C301

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course Objectives:

The student shall master the geometrical approximation, including thin lens formula, Fermat's and Huygen's principles, Lens Aberration and the paraxial matrix formalism for refractive and reflective surfaces. The wave optics part of the course will give the student a basic knowledge within interferometer, polarization, diffraction and resolution, and the basics of coherent and non-coherent light sources. The student shall become able to analyze and calculate interference between plane waves and spherical waves, reflection and transmission of plane waves, and optical wave guiding within thin plates and optical fibers. The student shall understand how the polarization of light changes at reflection and transmission at interfaces.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** Fermat's principle, the ray equation, and the thick lenses equation as three equivalent statements of the laws of geometrical optics.	**BT 1**
CO 2	**Understand** optical phenomena such as interference, diffraction, polarisation, and birefringence.	**BT 2**
CO 3	**Solve** problems related to optical aberrations, image formation and wavelength determination, interferences fringes and intensity profile	**BT 3**
CO 4	**Identify** and **analyze** the use of normal and polarized light in thin film and birefringent materials.	**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.	**12**
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.	**12**
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	**12**

	experiment, interference in Fresnel's mirrors and Biprism, Lloyd's single mirror, Newton rings, Michelson interferometer.	
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.	**12**
	Total	**48**

Text:

3. *Fundamental of Optics; Jenkins F.A. and White H.E.: McGraw Hill, 4t edition, 2011.*
4. Text book of Optics, Subrahmaniyam N. & et Al., S Chand; 23rd Rev. Edn. 2006 edition (1 December 2006).

Reference Books:

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

NPTEL LINK:https://nptel.ac.in/courses/108106161

Level: Semester III

Course: C-2

Title of the Paper: Mathematical Physics-II

Subject Code: PHY012C302

L-T-P-C: 3-2-0-4 **Total**

credits: 4

Course objectives: This course will help the students to understand, apply, analyze, and evaluate different physical systems using the mathematical concepts like integration of vectors, complex variables, special techniques to solve numerical integration etc.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** different topics like ordinary integration of vectors, Argand diagram, modulus complex function, order and degree of differential equation, Linear differential equation, Understanding of Numerical Integration etc.	**BT 1**
CO 2	**Understand**Line integral, surface integral and volume integrals, complex numbers, differential equation, different integral problems using Trapezoidal rule etc.	**BT 2**
CO 3	**Apply** the topics like Gauss' divergence theorem, Green's theorem, Auxiliary equations , weights and arguments, etc.	**BT 3**

CO 4	**Analyze and evaluate** different problems of distinguished topics like Stoke's theorem, analyticity, Frobenius method, Simpson's 1/3 rd rule, etc.	**BT 4**

COURSE OUTLINE:

Modules	Course Contents	Periods
I.	**Integration of vectors:** Understanding of ordinary integration of vectors. Line integral, surface integral and volume integrals and their applications to simple physical problems. Flux of a vector field. Analysis of Gauss' divergence theorem, Green's theorem, Stokes Theorems and their applications and analysis for the evaluation of different problems.	**12**
II	**Complex variable:** Understanding of Algebraic notation (z), Argand diagram, modulus and argument, powers of iota (*i*), complex conjugate, complex numbers in cartesian, polar, and exponential forms, its application to analyze Euler's formula, De-Moiver's theorem, and evaluation of related problems. 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'.	**12**
III.	**Differential equations:**Concept of order and degree of differential equation, Linear differential equation, Exact differential equation and its application to analyze different physical systems, Evaluation of their solutions, Second order linear differential equation and its solution as sum of complementary function (C.F.) and particular integral (P.I.). Analysis of Auxiliary equations and methods to find out C.F. and P.I. for different types of functions. Homogeneous and Non-homogeneous differential equation, series solution of differential equation: Frobenius method and its application in evaluation of related problems.	**12**
IV	**Special techniques to solve Numerical integration (no rigorous derivations):**Understanding of Numerical Integration using Gauss Quadrature formula, 2 - point formula, 3 - point formula, analysis of weights and arguments, related problems. Application of different integral problems using Trapezoidal rule, Simpson's 1/3 rd rule, Simpson's 3/8 rule. Evaluation of related problems.	**12**
	Total	**48**

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:

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

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

Level: Semester III

Course: C-3

Title of the Paper: Atmospheric Physics

Subject Code: PHY012D301

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course Objectives: Upon completion of this course the student will be able to understand the different physical and chemical processes such as the origin of the atmosphere, atmospheric thermodynamics, atmospheric radiation and cloud precipitation.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember**various applications measuring methods for atmospheric parameters.	**BT 1**
CO 2	**Understand**atmospheric and climate-change processes.	**BT 2**
CO 3	**apply** knowledge of atmospheric and climate change processes to fundamental physical principles.	**BT 3**
CO 4	**Identify and analyze** the fundamental numerical methods found in predictive models of weather and atmospheric climate change, including parameterization of small scale processes.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Introductory survey of the Atmosphere:** Origin and Composition of the Atmosphere, Distribution of Pressure and Density, Ionosphere, Atmospheric Electric Field and Magnetosphere, Distribution of Temperature and Winds, Atmosphere as a Fluid and Fluid Continuum.	**12**
II	**Atmospheric Radar and Lidar:** Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques. **Thermodynamics:** First and Second law of thermodynamics, Clausius- Clapeyron equation. Adiabatic processes in the atmosphere and ocean, hydrostatic equation, thermodynamics of water, stability criteria of the atmosphere and ocean. Lapse rate, stability indices, thermodynamic diagram, thermodynamic feedbacks in the climate system, parcel theory.	**12**

III	**Clouds and Precipitation:** Atmospheric Aerosols, Aerosol Size and Concentration, Nucleation theory of Water Vapour Condensation, Droplet Growth in Warm Clouds, Formation and Growth of Ice Crystals in Cold Clouds, Mechanism of Cloud Formation, Types of Clouds, Convective Clouds and Cloud Seeding, Distribution of Charges in a thunderstorm, Lightning Discharge.	**12**
IV	**Atmospheric Motion:** Rotating Frame of Reference, Equation of Motion in an Inertial Frame of Reference, Pressure Gradient Force, Effect of Coriolis Force due to Relative and Vertical Motion, Continuity Equation (Eulerian and Lagrangian Approach), Thermal Wind, Thermodynamic Energy Equation, Circulation and Vorticity, Atmospheric Boundary Layer, Atmospheric oscillations, Quasi biennial oscillation, annual and semi-annual oscillations, Mesoscale circulations, The general circulations, Tropical dynamics.	**12**
	Total	**48**

Text:

1. *An Introduction to Atmospheric Physics*, Andrews David G., Cambridge University Press; 2nd edition (29 April 2010).
2. *Atmospheric Science: An Introductory Survey*, John M. Wallace, Academic Press; 2nd edition (24 March 2006)

References:

1. Anastasios Tsonis, *An Introduction to Atmospheric Thermodynamics*, Cambridge University Press; 2nd edition (2 August 2007)
2. Radar for meteorological and atmospheric observations – S Fukao and KHamazu, Springer Japan, 2014.

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc23_ph20/preview

Level: Semester III

Course: C-4

Title of the Paper: Geophysics

Subject Code: PHY012D302

L-T-P-C: 3-2-0-4 **Total**

credits: 4

Course Objectives: Upon completion of this course the student will be able to understand, apply, analyze and evaluate the different application of geophysics like the physical conditions of the Earth's multi-layered interior, Earth's magnetism, occurrence of earthquake and volcanoes etc.

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 the basics composition of different layers inside the earths crust and above the lithosphere	**BT 1**

CO 2	**Understand** the principles of physical and historical geology with special emphasis on the unifying theory of plate tectonics and the linkage between geological processes and global biogeochemical cycles.	**BT 2**
CO 3	**Apply** geological observations and measurements to problems involving the timing of geological events in Earth history.	**BT 3**
CO 4	**Analyze** the key biological, chemical and physical Earth structures, processes, the interactions between them, and the roles that they play in determining the state of the Earth system.	**BT 4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I	**Earth's magnetic field:** History of development and scope of geophysics, Kepler's law of planetary motion, planet and satellites of the system and their characteristics, shape and size of the earth, international gravity formula and rotation of the earth. Definition of Earth's magnetic field, Formation of core, mantle, crust, hydrosphere, atmosphere and biosphere, Convection in Earth's core and production of its magnetic field, Mechanical layering of the Earth.	**12**
II	**Plate Tectonics** :Concept of plate tectonics, sea-floor spreading and continental drift, Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs, Origin of oceans, continents, mountains and rift valleys, Earthquake and earthquake belts: seismic waves and internal constitution of the Earth, Volcanoes- types, products and their distribution	**12**
III	**Cosmic abundance of elements**: Distribution of elements in solar system and in Earth. Composition of the Earth. General concepts about geochemical cycles. Properties of common elements in Earth. Concepts of geochemical cycles. **Hydrosphere and Atmosphere:** Oceanic current system and effect of Coriolis force. Concepts of eustasy. Land-sea interaction: Wave erosion and beach processes. Atmospheric circulation. Weather and climatic changes	**12**
IV	**Geomagnetism:** Origin of geomagnetic field, polar wandering, secular variations and westward drift, reversals of geomagnetic field, geomagnetic storms, earth's current, sun spot, solar flares, lunar and solar variations, palaeomagnetic studies of rock samples and their applications in geophysics, radiometric dating principles and ages of rocks and the earth.	**12**
	Total	**48**

Text:

1. *Physics of the Earth*– Frank D. Stacey and Paul M. Davis.: McGraw Cambridge University Press; 4 edition (25 August 2008).
2. *Introduction to Geophysics: Mantle, Core and Crust, George D. Garland*, W.B. Saunders Company; 2nd Revised edition

References:

1. GEOPHYSICS: A VERY SHORT INTRODUCTION, William Lowrie, OUP Oxford (22 March 2018)
2. Textbook Of Physical Geology, Mahapatra G. B. , CBS (30 March 2018).

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc23_ce02/preview

Level: Semester III

Course: C-5

Title of the Paper: Theory of Relativity

Subject Code: PHY012D303

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course Objectives:

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. To impart the elementary concept of General Theory of Relativity.

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 the concept of space, time and mass, frame of reference, Newtonian relativity, Michelson-Morley experiment, the elementary concept of General Theory of Relativity.	**BT 1**
CO 2	**Understand** Postulates of special theory of Relativity, Lorentz transformation, Doppler Effect, Space-time diagram, General Theory of Relativity (Elementary).	**BT 2**
CO 3	**Apply** the concepts of length contraction and time dilation to solve problems.	**BT 3**
CO 4	**Analyze** the special and general theory of relativity **.**	**BT 4**

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.	**12**
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.	**12**
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.	**12**

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 ona ray light, gravitational red shift.	**12**
Total		**48**

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 III

Course: C-6

Title of the Paper: Electricity and Magnetism

Subject Code: PHY012G301

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

Course Objectives: To develop strong foundation in the field of electric and magnetic phenomena, both in their physical basis and in the mode of mathematical description.

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 the principles of electric and magnetic field and their properties	**BT 1**
CO 2	**Understand** the concept of alternating current in LR, CR and LCR circuits.	**BT 2**
CO 3	**Solve** problems relating to Kirchhoff's law, LCR, CR and LR circuits.	**BT 3**
CO 4	**Analyze** the concept of electric and magnetic field to different condition.	**BT 4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I	**Electro-Magnetic Induction:** Magnetic Flux, Faraday's Law, Lenz's Law, Lenz's Law in accordance with the law of conservation of Energy, Self Induction, Co-efficient of Self Induction, Mutual Induction, Co-efficient of Mutual Induction, Reciprocity Theorem.	**9**
II	**Transient and Alternating Currents:** Transient growth and decay of current in LR, CR and LCR circuits. Alternating current: Generation of alternating current, current and potential across resistive, inductive and capacitive elements and their phase relationships.	**9**
III	**Electrostatics** : Gauss's theorem and its applications to determine field due to linear, plane and spherical charge distribution. Dielectrics, Electric polarisation of dielectrics, polarizability. Gauss's law in dielectric. Electrostatic boundary conditions in dielectric medium.	**9**
IV	**Magnetism:** Concept of field, Magnetic field due to a straight conductor, Magnetic field due to a current loop, Biot-Savart's Law, Application of Biot-savart's law to circular coil carrying current, a solenoid carrying current, Magnetic dipole, Magnetic dipole its field and potential, Intensity of magnetisation, Permeability & susceptibility, Hysteresis & Hysteresis loss, Distinguishing features of para, dia & Ferro magnetic materials.	**9**
	Total	**36**

Text:

1. Electricity and Magnetism: Chattopadhyay .D. and Rakshit. P.C. Published by New Central Book Agancy (P) Ltd, 2011.
2. Electricity And Magnetism, R Murugeshan, S Chand Publishing (1 January 2019); S Chand Publishing.

References:

1. Vasudeva D.N. : Electricity and Magnetism.: Publisher, S. Chand Co.

NPTEL LINK: https://nptel.ac.in/courses/115105122

Level: Semester III

Course: C-7

Title of the Paper: Introduction to Astrophysics

Subject Code: PHY012G302

L-T-P-C: 3-0-0-3 **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 the 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.	**R**
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.	**9**
II	**Telescopes and Detectors**: Different types of astronomical telescopes, Mounting of telescope, Radio Telescope, Space based telescope, 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; Baidyanath 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

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

BSC PHYSICS 4TH SEMESTER

Level: Semester IV

Course: C-1

Title of the Paper: Quantum Mechanics

Subject Code: PHY012C401

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course objectives: This course will help the students to understand, apply, analyze, and evaluate different physical systems of micro-world using different topics of quantum mechanics like Planck's hypothesis, de-Broglie hypothesis, probability density, quantum harmonic oscillator etc.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember**different topics like Inadequacies of classical Physics, wave function, Schrodinger's equation, particle in a box etc.	**BT 1**
CO 2	**Understand**Planck's formula for black body radiation, Uncertainty principle, operator, Potential step, potential barrier etc.	**BT 2**
CO 3	**Apply** the topics Einstein's photoelectric equation, Compton effect, wave-particle duality, commutator of two operators, hermitian operator, tunneling effect etc.	**BT 3**
CO 4	**Analyze**and evaluate different problems of distinguished topics like Compton shift, Uncertainty in position, time, probability current density, orthonormal condition of wave function, expectation value, constructive and destructive operator etc.	**BT 4**

COURSE OUTLINE:

Modules	**Course Contents**	**Periods**
I.	Understanding of Inadequacies of classical Physics with examples. Black body radiation spectrum, Planck's Quantum Hypothesis, Planck's formula for black body radiation, and its applications, Rayleigh-Jeans law and Wein's law as limiting cases, Photoelectric effect and Einstein's formula, and its analysis to get Planck's constant, Compton effect, Evaluation of Compton shift, Dual nature of light, Concept of photons.	**12**
II	Understanding of wave properties of matter, de Broglie hypothesis, and its applications, Davisson Germer's experiment and validation of de-Broglie hypothesis, Wave particle duality of matter, Uncertainty principle and some applications. Evaluation of related problems.	**11**
III.	Concept of wave function, Schrodinger's equation (time dependent and time independent), physical significance of wave function, well behaved wave function, Application of wave function in the analysis of Probability and Probability density, equation of continuity, Probability Current density, Evaluation of related problems, expectation value of any Physical property, Operators, position, linear momentum, Energy operator, unitary operator,	**13**

	Hermitian operator, commutation relation, Schrodinger's wave equation in operator form, Eigen function and Eigenvalue, angular momentum operator and its Eigen function and Eigen value. Evaluation of related problems.	
IV	Application of Schrodinger's equation in different systems: Understanding the concept of particle in one dimensional box, potential step, potential barrier and tunnelling effect. Their applications and analysis in different physical micro-systems. One dimensional harmonic oscillator and evaluation of related problems.	**12**
	Total	**48**

Textbook:

1. *Quantum Physics,* H.C. Verma, Surya Publications,2nd edition, 2012.
2. Nouredine Zettili, *Quantum Mechanics*, Wiley publications, 2nd edition, 2009

Reference Books:

1. Biswas S.N., *Quantum Mechanics,* Books and Allied ltd., 2nd revised edition, 2012.
2. David J Griffiths, *Introduction to Quantum Mechanics*, Pearson Education,2015

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

Level: Semester IV

Course: C-2

Title of the Paper: Nuclear & Particle Physics

Subject Code: PHY012C402

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course Objectives:

To impart the understanding of subatomic particles and their properties, and 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.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember**the basic properties of nuclei, the concept of fundamental forces, classification of elementary particles.	**BT 1**
CO 2	**Understand**the formulations and contrasts between different nuclear models such as Liquid drop model, Fermi gas model and Shell Model, the nature and magnitude of different forces, particle interactions, families of sub- atomic particles with the different conservation laws, concept of quark model.	**BT 2**
CO 3	Apply the concepts of binding energy, nuclear models, nuclear reactions, accelerators, with scientific reasonings and critical thinking skills.	**BT 3**

CO 4	Analyze different types of nuclear reactions, Q- values, radioactivity and decay laws, energy losses due to ionizing radiations, gamma ray interactions through matter, the comparative study of a range of detectors and accelerators.	**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.	**11**
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, nuclearreactors, Energy loss due to ionization (Bethe-Block formula), Gamma ray interaction through matter (photoelectric effect, Compton scattering, pair production).	**11**
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.	**13**
IV.	Radioactivity decay, Nuclear detectors and Particle physics: Discovery of Radioactivity, nature of nuclear radiations, properties of alpha, beta and gamma rays, theory of alpha decay, natural and artificial radioactivity, fundamental laws of radioactivity, concept of half-life and disintegration constant, Ionization chamber, Geiger-Muller counter, Scintillation counters and Solid state detectors, classification of elementary particles, particle interactions (concept of different types of forces), Conservation Laws (energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness) concept of quark model.	**13**
Total		**48**

Text Book:

1. *Introductory Nuclear Physics*, K S Krane, Wiley-India Publication, 3rd edition, 2008.
2. *Nuclear Physics*, D C Tayal, Himalaya Publishing House, 5th edition, 2011.
3. *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.

NPTEL LINK:https://nptel.ac.in/courses/115/104/115104043

Level: Semester IV

Course: C-3

Title of the Paper: Physics of non-conventional sources of energy

Subject Code: PHY012D401

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course Objective:

To familiarize the student with the fundamental working principle of of biomass, wind energy, fuel cell and solar cells

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** various terms associated with different sources of renewable energy like biomass, wind, solar and fuel cell	**BT 1**
CO 2	**Understand** the geometry between Earth and Sun, working of fuel cell and solar cell	**BT 2**
CO 3	**Apply** the Sun-Earth geometry to estimate the amount of solar radiation in different location on the earth surface at different time and day of the year and calculate the potential of solar cell and finally extended to fuel cell	**BT 3**
CO 4	**Analyze** the output characteristics of solar cells and fuel cell	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	Biomass: Introduction, Composition of Biomass, Biomass as Fuel: Wood Gasifies , Ethanol: Ethanol Production , Fermentation, Anaerobic Digestion; Principles of Aerodynamics: Flux, Power in the Wind , Dynamic Pressure , Wind Pressure , Available Power, Efficiency of a Wind Turbine	**12**
II	Fuel cell: Introduction; Fuel Cell Classification: Temperature of Operation, State of the Electrolyte, Type of Fuel, Chemical Nature of the Electrolyte ; The Thermodynamics of Fuel Cells: Heat of Combustion, Free Energy, Efficiency of Reversible Fuel Cells, Effects of Pressure and Temperature on the Enthalpy and Free Energy of a Reaction; Application of fuel cell	**12**
III	Solar Resource: Sun–Earth Geometric, Apparent Path of the Sun, Earth and Celestial Coordinate Systems, Equation of Time, Solar Spectral Distribution, Extraterrestrial Solar Radiation, Measurement of Solar Radiation, Terrestrial Isolation on Tilted Collectors, Instantaneous and Hourly Radiation, Monthly Average Daily Insolation	**12**

IV	Photovoltaic cell: Solar Cell Equations, Efficiency, Temperature, Light, Type and Purity of Material, Parasitic Resistances; PV module Electrical Characteristics; Common PV Terminology; I-V Curves, PV Array Tilt, PV array connections, PV Balance of Systems; PV System Utility; Net Metering; PV System Safety ; PV System Testing Rules	**12**
	Total	**48**

Text:

1. *Renewable Energy in Power Systems***,** Leon Freris, David Infield, John Wiley & Sons Ltd, 1st Ed., UK,2008
2. *Physics of Energy Sources,*George C. King, John Wiley & Sons,1stEd., New Jersey,2018

Reference Books:

1. Md. Rabiul Islam, Naruttam Kumar Roy, Saifur Rahman ; *Renewable Energy and the Environment*,, Springer , 1st Ed., Singapore, 201

Study material: https://nptel.ac.in/courses/103103206

Level: Semester IV

Course: C-4

Title of the Paper: Plasma and Space Physics

Subject Code: PHY012D402

L-T-P-C: 3-2-0-4 **Total credits: 4**

Course objectives: This course will help the students to understand, apply, analyze, and evaluate different topics of plasma and space physics like plasma oscillations, Debye shielding, ionosphere and magnetosphere, etc.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** different topics like plasma oscillations, fluid equation of motion, magnetospheric exploration, planetary and interplanetary exploration, ionospheric density etc.	**BT 1**
CO 2	**Understand** plasma parameters, Debye shielding, coronal heating, magneto-sonic and Alfven waves, etc.	**BT 2**
CO 3	**Apply** the topics Plasma confinement: single particle motion, equation of continuity, equation of state, Solar phenomena: structure of the Sun, Solar activity etc.	**BT 3**
CO 4	**Analyze and evaluate** different problems of distinguished topics like time-varying B Field, phase velocities, wave normal surfaces, solar wind formations, Ionosphere-Magnetosphere coupling etc.	**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-Bdrift,curvaturedrift, their applications and analysis. ∇B ll B: magnetic mirrors, non-uniform E Field, time-varying E Field, time-varyingB Field, adiabatic invariants: first, second and third adiabatic invariant (Pinch effect, magnetic mirrors); Evaluation of related problems.	**12**
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; plasmaapproximation. 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.	**12**
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, solarwind formations, interaction of Solar wind with magnetized and unmagnetized planets. Evaluation of related problems.	**12**
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.	**12**
	Total	**48**

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)

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

NPTEL LINK : https://nptel.ac.in/courses/115102020 and https://nptel.ac.in/courses/115107121

Level: Semester IV

Course: C-5

Title of the Paper: Basic Instrumentation Skill

Subject Code: PHY012S401

L-T-P-C: 0-0-2-2 **Total credits: 2**

Course Objective:
To acquaint the student with the measurement of some selected electrical parameters and design of basic circuits

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember various terms associated with 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	Analyze 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 ammeter into voltmeter
5. To design a multi-range ammeter and voltmeter
6. To design a Wheatstone bridge

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

Level: Semester IV

Course: C-6

Title of the Paper: General Physics Lab

Subject Code: PHY012G411

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

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

Course Outcomes:

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

LIST OF EXPERIMENTS

1. Determination of Resistance of a Galvanometer using Post Office Box.
2. Determination of E.C.E. of copper by using an ammeter and a copper voltmeter.
3. Determination of Young's modulus of the material of a given wire Searle's apparatus.
4. Determination of the value of acceleration due to gravity by using the given barPendulum.
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

Level: Semester IV

Course: C-7

Title of the Paper: Thermal Physics

Subject Code: PHY012G401

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

Course Objectives: To familiarize the students with the fundamental principles of thermodynamics and kinetic theory by demonstrating the simplified model of real systems and to explain, analyze, and predict a variety of natural phenomena.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the basic thermodynamics in relation to the study of various kinds of energy and its inter conversion.	**BT 1**
CO 2	Understand and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, Free energies, and partition functions.	**BT 2**
CO 3	Apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.	**BT 3**
CO 4	Analyse the effects of temperature, pressure, volume and some other physical parameters on the working of different thermodynamics systems.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Introduction to Thermodynamics :** Zeroth and First law of thermodynamics, Reversible and Irreversible process with examples, Carnot's Theorem, Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Third Law of Thermodynamics.	**9**
II	**Thermodynamic Potentials:** Extensive and Intensive Thermodynamic Variables, Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy, Their Definitions, Properties and Applications. Phase Transitions: First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.	**9**
III	**Kinetic Theory of Gases** Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Sterns Experiment, Mean, RMS and Most Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (No proof required), Specific heats of Gases.	**9**

	Molecular Collisions: Mean Free Path, Collision Probability, Estimates of Mean Free Path, Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.	
IV	**Real Gases:** Behavior of Real Gases: Deviations from the Ideal Gas Equation, Andrews Experiments on CO2 Gas. Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van der Waals Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joules Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule- Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule-Thomson Cooling	**9**
	Total	**36**

Textbook:

1. *Thermal Physics*, A.B Gupta, Books & Allied P Ltd (1 January 2020)
2. *Fundamentals of Statistical and Thermal Physics*; F. Reif, Sarat Book House Pvt. Ltd, 1st Ed., 2009, Kolkata

Reference Books:

1. S.C. Garg.; Thermal Physics, McGraw Hill Education; Second edition (1 July 2017)
2. K.K. Pathak; Thermal Physics; Vishal Publishing Co.; 1st edition (1 January 2020)

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

BSC PHYSICS 5TH SEMESTER

Level: Semester-V

Course: C-1

Title of the paper: Solid State Physics

Subject Code: PHY012C501

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

Course Objective:

To develop basic concepts of solids and to understand the electron transport in matter. Also To learn the principles of lattice vibration and their macroscopic impact on materials. To understand the properties of different materials such as superconductors, semiconductors, magnetic, and dielectrics.

Course Outcomes:

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember different crystal structures and measure their physical parameters.	**BT1**
CO2	Understand the difference between conductors, semiconductors and insulators.	**BT2**
CO3	Apply the knowledge to track the transport behavior in conductors, semiconductors and superconductors.	**BT3**
CO4	Analyze the facts to identify appropriate materials for suitable applications.	**BT4**

COURSE OUTLINE:

Modules	Topics & Course Contents	Periods
I.	Crystal Structure of Solids: Amorphous and Crystalline Materials; Crystal lattices, Lattice with a Basis, Lattice Translation Vectors; Unit cells: Primitive and nonpremitive unit cells, atomic packing fraction of unit cells; Miller indices, crystal planes, distance between two adjacent planes, Bragg's plane and X-ray diffraction by crystal; Crytal structuresandsymmetryofcrystals;Conceptofreciprocallatticeanditsrelationtoreallattice, Brillouin Zones.	**12**
II.	Free electron theory of metals: Drude model, Electrical Properties of Materials: electrical conductivity of metals, mean free path, thermal conductivity, Wiedemann - Franz law. Concept of fermi level and fermi distribution function; Hall effect. Elementary Band Theory of Solids; Bloch Theorem; Kronig-Penney Model; Band Gaps; Energy Band Diagram and Classification of Solids; Effective Mass of Electron; Concept of Holes, Distinction between insulators, semiconductors and conductor; Intrinsic and Extrinsic semiconductors, p- and n- type semiconductors, fermi level in semiconductors; Conductivity in Semiconductors.	**12**
III.	Lattice Vibrations and Phonons:- Linear Monoatomic and Diatomic chains; acoustical and optical phonon; Classical phonon dispersion relation; Einstein and Debye theories of specific heat of solids. Superconductivity: Introduction to super conductivity; critical temperature; Critical magnetic field; Meissner effect; Type-I and type-II superconductors, London's equation. Idea of BCS theory (No derivation): Cooper Pair and coherence length; Experimental evidence of phonons (Qualitative); Josephson effect.	**12**

IV	Dielectric Properties of Materials: Electrostatic polarization, sources of polarization; Dielectric constant, electric susceptibility. Polarizability; Classical theory of electric polarizability, Clausius Mosotti equation. Magnetic Properties of Matter: Atomic origin of magnetism and magnetic moment, Dia, Para-, Ferri- and ferromagnetic materials; Theory of magnetic domains; Curie's law, introduction to ferromagnetism and ferromagnetic domains; Concept of magnetic field and magnetization, relationship between B, H and M, Discussion of B-H Curve, hysteresis and energy Loss.	**12**
TOTAL		**48**

Text Book:

4. *Introduction to Solid State Physics*, Charles Kittel, 7th Edition, John Wiley and Sons,Inc., 2012.
5. *Elements of solid state physics*, Srivastava, J. P. Prentice Hall of India Pvt. Ltd, 2006 2nd Ed.

Reference Books:

6. Dekkar A. J., *Solid State Physics*, Macmillan India Limited,2008.
7. Blackmore J. S., *Solid State Physics*, Cambridge University Press,Cambridge, 2012.
8. Ascroft N. W. and Mermin N. D., *Solid State Physics*, Harcourt Asia, Singapore,2003.
9. Omar M. A., *Elementary solid state physics: principles and applications*, Pearson Education,1999.

Level: Semester-V

Course: C-2
Title of the paper: Mathematical Physics III
Subject Code: PHY012C502
L-T-P-C:3-1-0-4 **Total Credit: 4**

Course objectives: This course will help the students to understand, apply, analyze, and evaluate different physical systems using the mathematical concepts like integration of vectors, Taylor's series and Laurent's series, forward and backward difference, wave equation, tensor etc.

Course Outcomes:

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember different topics like Cauchy's integral theorem, Interpolation, Solution of Wave Equation in 1 Dimension, **t**ransformation of coordinates, tensorial character of physical quantities etc.	**BT1**
CO2	Understand Cauchy integral formula for complex functions, Newton's Formula, Lagrange formula, outer multiplications, contractions and inner multiplications, etc.	**BT2**
CO3	Apply the topics Cauchy's residue theorem, Taylor series method, Euler method, symmetric and anti-symmetric tensors, fundamental operations with tensors etc.	**BT3**
CO4	Analyze and evaluate different problems of distinguished topics like Complex integrals: Simple contour integrals, integration round unit circle, Euler method, Runge- kutta methods, Laplace's Equation, tensors etc.	**BT4**

COURSE OUTLINE:

Modules	Course Contents	Periods
I.	**Advanced Complex variable analysis:** Understanding ofCauchy's integral theorem and proof, Cauchy integral formula for complex functions and its derivatives, and their applications, and analysis for the evaluation of related problems. Taylor's series and Laurent's series. Methods to find out poles, residues and problems. Cauchy's residue theorem, Complex integrals: Simple contour integrals, integration round unit circle, and complex function in the -ve infinte to +ve infinte limit.	**12**
II	**Finite difference and numerical methods:**Concept of The forward difference operator,Backward difference operator, and related problems. Interpolation, Extrapolation, Newton's Formula for equal interval, Lagrange formula for unequal interval and their applications, analysis for the evaluation of related problems. **Methods for Numerical solution of ordinary differential equation:** Taylor series method, Euler method, Runge- kutta methods, and their applications and analysis. Evaluation of related problems (proofs not required)	**12**
III.	**Wave equation:**Understanding of general Solution of Wave Equation in 1 Dimension. Transverse Vibrations of Stretched Strings and its applications. Oscillations of Hanging Chain. Wave Equation in 2 Dimensions. Vibrations of Rectangular and Circular Membranes and their analysis. **Laplace equation:** Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and Spherical symmetry.	**12**
IV	**Tensor analysis:**Concept of **t**ransformation of coordinates, tensorial character of physical quantities, Co-variant and contra variant tensors, symmetric and anti-symmetric tensors, fundamental operations with tensors: additions,subtractions, outer multiplications, contractions and inner multiplications, and their applications. Analysis of Metric tensor. Line element, Christoffel's symbol, covariant derivative. Evaluation of related problems.	**12**
	Total	**48**

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:

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

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

Level: Semester-V

Course: C-3

Title of the paper: Nanophysics

Subject Code: PHY012D501

L-T-P-C: 3-1-0-4

Total Credit: 4

Course Objectives:

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:		
Sl. No.	**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.	**12**
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.	**12**
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.	**12**
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.	**12**
Total		**48**

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

Level: Semester-V

Course: C-4
Title of the paper: Fibre Optics and Laser Basics
Subject Code: PHY012D502
L-T-P-C:3-1-0-4 **Total Credit: 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:		
Sl. No.	**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	**12**
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.	**12**
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.	**12**
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)	**12**
	TOTAL	**48**

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-V

Course: C-5
Title of the paper: Classical Mechanics
Subject Code: PHY012D503
L-T-P-C:3-1-0-4 **Total Credit: 4**

Course Objective: This course will help the student in understanding the basics of central forces and the concepts leading to the development of 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 Outcome:

Upon successfully completing the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the different constrains of motions	**BT1**
CO2	Understand the basic concepts of central forces, Lagrangian and Hamlitonian dynamics	**BT2**
CO3	Apply the basic concepts of Lagrangian and Hamlitonian dynamics to a few physical systems	**BT3**
CO4	Analyse the effects of various constrains in the motion of a few physical systems	**BT4**

COURSE OUTLINE:

Modules	Topics & Course Contents	Periods
I.	Mechanics of a particle and a system of particles; linear uniformities of space and conservation of linear momentum, rotational invariance of space and conservation of angular momentum, homogeneity of time and conservation of energy; laboratory and centre of masssystems	**12**
II	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	**12**
III	Hamilton's principle, shortest distance between two points; Lagrange's equations from Hamilton's principle; Hamilton's canonical equations of motion; applications of Hamilton's equations to simple problems; Poisson brackets.	**12**
IV	Central force motion and general properties, two body motions as one body problem, energy and momentum as constants of motion in central force, energy diagram and nature of orbits; motion in an inverse square law force field; Kepler's laws of planetary motion.	**12**

TOTAL	48

Textbook:

1. *Classical Mechanics*; Goldstein H., Narosa Publishing House, 3rdEd., New Delhi,2011.

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

Study material:

https://archive.nptel.ac.in/courses/122/106/122106027/

BSC PHYSICS 6TH SEMESTER

Level: Semester-VI

Course: C-1

Title of the paper: Atomic and Molecular Spectroscopy

Subject Code: PHY012C601

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

Course Objectives:

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

Course Outcome:

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the atomic structures, electrons motion in an atom and energy, momentum and quantum numbers associated with them.	**BT1**
CO2	Understand problems related to atomic and molecular transitions and corresponding spectrums.	**BT2**
CO3	Apply the knowledge to identify allowed transitions and measure the wavelength of corresponding emitted spectrum.	**BT3**
CO4	Analyze the couplings of angular momentum vectors and transition rules in atoms and molecules.	**BT4**

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.	**10**
II.	Somerfield model (elliptical orbit and relativistic correction) Vector atom model (Space quantization and spinning electron). Quantum number associated with vector atom model. Spin – Orbit interaction, Spectral term, Fine structure of hydrogen atom, Stern- Gerlach experiment.	**12**
III.	Spectra of alkali elements: general features, spectral series, spectra of sodium atom, selection and intensity rules. LS-jj coupling, spectra of alkaline earth elements: general features, singlet, triplet series. X-ray spectra: continuous spectra, Duane-Hunt law, characteristics lines, Mosley law, Absorption spectra, fine structure.	**14**
IV.	Molecular Spectra: The Born-Oppenheimer approximation, rotational spectra, rigid diatomic molecule, rotational energy of the diatomic molecule, simple harmonic oscillator, and Anharmonic oscillator. Electronic spectra: Franck-Condon principle, Vibrational coarse structure (sequence and progressive)	**12**
Total		**48**

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. KedarnathRamnath:*Atomic and MoleculerSpectra* :Laser: publisher ,Raj Kumar,(2012).
4. Gupta. S.L., V.Kumar,R.C.Sharma;*Elements of Spectroscopy* ; Pragati Prakashan.(2016).
5. . RajamJ.B;*Atomic physics* ; Publisher, S. Chand(2010)

Level: Semester-VI

Course: C-2
Title of the paper: Electrodynamics
Subject Code: PHY012C602
L-T-P-C: 3-1-0-4 **Total Credit: 4**

Course Objective: 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 analyzing the interaction between e.m wave and matter.

Course Outcome:

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember determining factors of electromagnetic forces and fields	**BT1**
CO2	Understand the relationship between electric and magnetic fields	**BT2**
CO3	Apply the concepts of space and time varying electromagnetic fields	**BT3**
CO4	Analyze the behavior of electromagnetic wave in a matter	**BT4**

COURSE OUTLINE:

Modules	Topics & Course Contents	Periods
I.	Coulomb's law, concept of electric force, filed and flux; Gauss's law and its application; 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.	**12**
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'slaw	**12**
III.	Motional electromotive force; Faraday's law, electromagnetic field equation in integral and differential form, displacement current, Maxwell's equations, energy conservation law, Poynting theorem.	**12**
IV	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'slaw.	**12**
TOTAL		**48**

Text Book:

1. *Introduction to Electrodynamics,* Griffiths D.J., PHI, 4th Ed., 2016, NewDelhi
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

Study Materials:

https://www.digimat.in/nptel/courses/video/115101005/L21.html

Level: Semester-VI

Course: C-3

Title of the paper: Basic Electronics

Subject Code: PHY012D601

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

Course Objective:

To provide the student with the fundamental skills to understand the basics of semiconductor and components, apply, analyze and evaluate different biasing techniques to operate transistors , FET , MOSFET and operational amplifiers in different modes.

Course Outcome

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXANOMY LEVEL**
CO1	Remember basics of semiconductor & devices and their applications in different areas	**BT1**
CO2	Understand the principles of semiconductor devices and their applications.	**BT2**
CO3	Apply logic gates, flip flop in building block of digital systems.	**BT3**
CO4	Analyze output in different operating modes of different semiconductor devices	**BT4**

COURSE OUTLINE:

Modules	Topics & Course Contents	Periods
I.	Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier	**12**
II	Operational amplifier and its applications: Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.	**12**
III	Digital Electronics Fundamentals :Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters.	**12**

IV	Oscillators: RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.	**12**
	TOTAL	**48**

Textbook:

1. Floyd ," *Electronic Devices"* Pearson Education 9th edition, 2012.
2. R.P. Jain , "*Modern Digital Electronics*" , Tata Mc Graw Hill, 3rd Edition, 2007.

Reference Books:

4. S.Kal, *Basic Electronics*.PHI Pvt Ltd, 2008
5. Frenzel, " *Communication Electronics: Principles and Applications*" , Tata Mc Graw Hill, 3rd Edition, 2001

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

Level: Semester-VI

Course: C-4
Title of the paper: Astronomy
Subject Code: PHY012D602
L-T-P-C: 3-1-0-4 **Total Credit: 4**

Course Objective:

This course will help the students to understand, apply, analyze and evaluate important theoretical and practical aspects of astronomy.

Course Outcome

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the fundamentals in the Astrophysics like the classification of stars, stellar evolution, interstellar matter, galaxies etc	**BT1**
CO2	Understand theoretical and practical aspects of modern observational astronomy, Photometry, spectroscopy, stellar classification, detectors, and basic information of telescopes.	**BT2**
CO3	Apply knowledge of astrophysics to practical application of observational techniques	**BT3**
CO4	Analyze problems with scientific reasoning and critical thinking skills	**BT4**

COURSE OUTLINE:

Topics / Course content	**Periods**
Celestial Sphere and Celestial Coordinate: The celestial sphere, Altitude and Azimuth, Right ascension and declination, coordinate systems and transformation equations. Concept of time —Apparent solar day, Mean solar day, Local mean time and sidereal times, HR Diagram, Basics of different branches of astronomy (Radio Astronomy, Infrared Astronomy, Ultraviolet, X-ray and Gamma-ray astronomy).	**12**

Astronomical Instruments and Distance Measurement: Different types of astronomical telescopes, Mounting of telescope, Optical Telescopes, Radio Telescope, The Hubble Space Telescope, Astronomical Spectrograph, Photographic Photometry, Magnitude scales, apparent, absolute, The Colour-index, Luminosity of Stars, Stellar Parallax (Trigonometric) and the Units of Stellar Distances.	**12**
Stellar Structure and Evolution: Binary Star System, Internal Structure of Star, Energy Production in Stars (PP chain and CNO cycle), triple alpha reaction, Protostar and pre-main sequence stars, Supernova Explosion, Stellar Demise – White Dwarfs, Neutron Stars and Black Holes, Pulsar, X-ray Sources, Classification of Galaxies, The Milky way Galaxy, Normal galaxies and AGNs.	**12**
Cosmology: Expanding Universe, Newtonian cosmology, Mass density of the universe, Cosmological principle, Friedman-Robertson-Walker Model, Homogeneous and isotropic universe, Cosmic Microwave Background radiation, Elementary ideas on structure formations, Age of the Universe	**12**
Total	**48**

Text Book:

1. An Introduction to Astrophysics; Baidyanath 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)

Reference Book:

1.V.B.Bhatia; Text Book on Astronomy and Astrophysics with elements of cosmology, Narosa Publishing House, 2nd Ed.,2001, New Delhi

2.K. D. Abhayankar; Astrophysics: Stars and Galaxies, Abe Books,1st Ed., 2002, Hyderabad

NPTEL LINK: https://nptel.ac.in/courses/115105046

Level: Semester-VI

Course: C-5

Title of the paper: Wave Oscillation and Sound

Subject Code: PHY012D603

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

Course Objective:

Through this chapter, students are brought to understand about Simple Harmonic Motion and particles executing S.H.M. Students are also made to apply, analyze and evaluate S.H.M. on the velocity of sound and the things that affect the velocity of sound and ultrasonic waves.

Course Outcome

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the production and propagation of sound waves in a medium.	**BT1**
CO2	Understand how sound, as a form of energy, is produced and transmitted, giving examples.	**BT2**
CO3	Apply S.H.M to some practical problems and know how the transmission of sound is dependent on the medium.	**BT3**
CO4	Analyze the value of air temperature or the speed of sound in air given either variable	**BT4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I	**Simple harmonic motion:** Periodic motion, Simple harmonic motion, Characteristics of 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.	**12**
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.	**12**
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.	**12**
IV	**Sound:**Musical sounds and noise, characteristics of musical sounds, Intensity of sound, Acoustics of buildings, Reverberation and time of reverberation, Sabine's formula for reverberation time, Absorption coefficient and its measurement, Transmission of sound and transmission loss. **Ultrasound:** Ultrasonic waves, Production of ultrasonic waves, Detection of ultrasonics, Properties and application of ultrasonic waves.	**12**
	Total	**48**

Text Book:

3. 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

Level: Semester-VI

Course: C-6

Title of the paper: Research Methodology & minor project

Subject Code: PHY012D604

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

Course objectives: This course will help the students to understand, apply, analyze, different basic concepts of project and research. Students will learn distinguished topics like the Meaning of Research, Objectives of Research, Bi-section method, **N**ewton-Raphson method etc.

Course Outcome

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**

CO1	Remember different topics like Research and Scientific Method, importance of knowing how research is done, hypothesis, least square fitting etc.	**BT1**
CO2	Understand Need for Research Design, Features of a Good Design, standard deviation etc.	**BT2**
CO3	Apply the topics Basic Concepts Concerning Testing of Hypothesis, Newton's Interpolation, Chi-Square fit, etc	**BT3**
CO4	Analyze and evaluate different problems of distinguished topics like trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rule for numerical integration, etc.	**BT4**

COURSE OUTLINE:

Modules	Course Contents	Periods
I.	**Introduction of Research methodology:** Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India	**12**
II	**Defining the Research Problem:** What is a Research Problem? Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem. **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs	**12**
III.	**Hypothesis:**What is a Hypothesis? Basic Concepts Concerning Testing of Hypotheses, Tests of Hypotheses, Important Parametric Tests. Numerical techniques: Bi-section method, Newton-Raphson method, Trapezoidal rule, Simpson's 1/3rd and 3/8th rule for numerical integration.	**12**
IV	**Error analysis and experimental techniques**:Least Square Fitting. Newton's Interpolation, Chi-Square fit, Standard Deviation, Statistical Evaluation - Solution of Differential Equations using Runge-Kutta method. **Report writing**: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation	**12**
	Total	**48**

Text:

1. *Research Methodology, methods and techniques* by C. R. Kothari, New Age international Publishers: 4^{th} edition (2019).

Reference Books:

2. *Research Methodology, methods and techniques* by Ranjit Singh, RT Publications: 1^{st} edition (2021).

NPTEL LINK https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Level: Semester-VI

Course: C-6
Title of the paper: Biophysics
Subject Code: PHY012D605
L-T-P-C:3-1-0-4 **Total Credit: 4**

Course Objective:
To develop the basic foundation of physical laws. To learn the analytical concept of thermodynamics, mechanics and electricity to relate to biological systems and how the physical laws govern biological

processes.

Course Outcome:

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the basic physical laws that are essential in biological processes laws such as law of thermodynamics, fluid mechanics, diffusion, transport etc, which are.	**BT1**
CO2	Understand the physics behind heat transfer, change in viscosity, change in concentration and transport through members in a biological system.	**BT2**
CO3	Apply the knowledge to derive formulas and solve numerical problems related to optics, fluid dynamics and heat transfer.	**BT3**
CO4	Analyze the technical asspects of lasers, optical instruments and other diagnostics instruments used in medical imaging.	**BT4**

COURSE OUTLINE:

Modules	**Course Contents**	**Periods**
I.	Thermodynamics: Thermodynamics of Biological system: Zeroth law, First law and Second laws of thermodynamics, activation energy. Biological systems as open, non-equilibrium systems, Concept of free energy and entropy, heat content of food, Concept of energy coupling in biological processors,	**10**
II	Membrane transport: Transport system with non-electrolytes and electrolytes. Differences between osmosis and diffusion, diffusion of gases and liquids, Capillary movement. Concept of pressure in blood transport. Viscometry: Origin of viscosity of gases and liquids, factors affecting viscosity: temperature dependence of viscosity. Concept of elasticity, stress and train, Physics of body movement, flexibility and elasticity in bones and muscles.	**14**
III.	Basic Electrophysiology: Fundamental concepts in bioelectricity & bioelectronics. Fundamental principles of electrocardiography. Medical Imaging: Physical aspects of medical imaging, Medical lasers (CO_2, Nd:YAG Laser,), Applications of Lasers in therapy and diagnosis, Physics of X-ray imaging, MRI and Ultrasound imaging.	**12**
IV	Optical Techniques: Reflection, Refraction, refractive index, optical aberrations, Light microscopy: Simple ,compound optical microscope, Phase contrast and interference contrast microscope, Fluorescence and polarizing microscope, contrast, magnification, resolution and numerical aperture of a microscope, Polarimetry: Polarization of light, optical activity of some bio-molecules and its significance.	**12**
	Total	**48**

Text:

1. *Biophysics, concepts and mechanisms.*Casey E.J. Affiliated East west press. (1967).
2. *Elements of Properties of Matter,* Mathur D.S., By Nirja Publishers & Printers Pvt. Ltd., Kashipur Road, Rudrapur-263153, 2012.

Reference Books:

1. *Optics*, Ghatak.A, 6th edition, Mc Graw Hill Education, Printed at Pashupati printers, 1/429/16, gali no. 1, G. T. Road, Shahdara, New Delhi, India, 2017.
2. *A Text Book of Light*, Mazumdar, K. G., 10th edition, Modern Book agency (P) LTd.,1970.
3. *Heat and Thermodynamics and Statistical Physics*, lal B, Subrhmanyam N, and Hemne P.S., Vikas Publishing House, Sahibabad, Ghaziabad 2022.

Level: Semester-VI

Course: C-7

Title of the paper: Computational Physics Skill

Subject Code: PHY012S601

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

Course Objective:

The aim of the course is to make the student aware of major computational techniques for solving a comprehensive range of multidimensional problems involving fluids, solids, waves, quantum systems, as well as biological and social systems.

Course Outcome

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Understand the basics of binary computation. Develop deep knowledge of programming with PYTHON.	**BT1**
CO2	Have introductory knowledge of PYTHON. Readily use the Python programming language.	**BT2**
CO3	Learn various numerical methods to solve mathematical problems. Apply various data types and control structure	**BT3**
CO4	Find solutions of numerical problems through computational software. Understand and begin to implement code	**BT4**

COURSE OUTLINE:

Relationship between computers and programs; Basic principles of computers; File systems; using the Python interpreter;

Introduction to binary computation; Input / Output; Data types and control structures; Operators (unary, arithmetic, etc.);

Data types, variables, expressions, and statements; Strings and string operations; Control Structures: loops and decision; Standard modules; Packages;

Defining Classes ; Defining functions; Functions and arguments (signature) ; Exceptions and data structures; Data Structures (array, List, Dictionary); Error processing;

Introduction to numerical analysis, the need for numerical analysis and its limitation; Solution of linear systems**;** Solution of nonlinear equations**;** Solution of differential equations**;** Numerical integration**.**

Books Recommended:

1. Python Crash Course: Eric Matthes
2. Introduction to Computation and Programming Using Python, Second Edition With Application to Understanding Data: John V. Guttag
3. Flask Web Development: Developing Web Applications with Python: Miguel Grinberg
4. Learning with Python: How to Think Like a Computer Scientist: Allen Downey

5. Learn Python the Hard Way (3rd Edition): Zed A. Shaw