MINUTES OF MEETING OF THE BOARD OF STUDIES IN PHYSICS
HELD ON 17th APRIL, 2023 at 10:00 am
Parvatibai Chowgule College of Arts & Science
(Autonomous)
Margao – Goa

Vide Chowgule College notice F.133(C)/27 dated 3rd April, 2023) a meeting of this BOS was convened on 17th April, 2023 at 10:00 a.m. through online Google meet, Parvatibai Chowgule College of Arts & Science, Margao – Goa. Since the number of members present represented the Quorum, the BOS began its proceedings.

Members present:

1. Dr. Ashish M. Desai (Chairman)
2. Mrs. Malati Dessai
3. Mr. Yatin P. Desai (Member Secretary)
4. Mr. Mohanlal Mali
5. Ms. Valencia Fernandes
6. Dr. Bholanath Pahari (Academic Council Nominee)
7. Dr. Sudhir Cherukulappurath (Vice-Chancellor Nominee)

Member Absent with Intimation

1. Dr. Ananya Das
2. Dr. Tarun Kumar Jha (Academic Council Nominee)
3. Mr. Mangrish Salelkar (Industry Representative)
4. Mr. Harison Cota (Postgraduate Alumni)

Proceedings

The Chairperson welcomed the members of the Board of Studies (BOS). The Chairperson introduced and explained the agenda for the meeting and read out the minutes of the previous B.O.S meet. The meet continued taking up the following agenda.

Agenda Items:

1. To apprise the New Course structure as per the new UGC guidelines based on NEP
2. To approve the list of courses under the nomenclatures: Discipline Core (Major & Minor), Skill enhancement course, and Multidisciplinary course.
3. To approve syllabi of Semester I & II courses under new course structure.
4. To review and revise the Course Learning Outcomes (CLO), of the courses offered in even semesters, as per the suggestions given in the Governing Body meeting.
5. Any Other Business (A.O.B.)

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PART A: The BOS passed the resolutions as follows:

1. The BoS approved the list of courses under the nomenclatures Discipline Core (Major & Minor), Skill Enhancement course, and Multidisciplinary course offered by the Department of Physics under the NEP 2020. The list of courses for all eight semester is presented in Annexure A.
2. The syllabi of Semester I and II courses under new course structure were discussed and approved by the BoS during the meeting. The syllabi of the Semester I and II courses to be offered under NEP 2020 are given in Annexure B.
3. The Course Learning Outcomes for some of the Semester IV and Semester VI courses were revised. The revised course learning outcomes are presented in Annexure B.
4. Under A.O.B, the syllabus of the course Nuclear and Elementary Particle Physics and Introduction to Material Science offered in Semester VI was revised and approved by the BoS. The syllabus of the modified Nuclear and Elementary Particle Physics course is presented in Annexure B.

PART B: Important Points/ recommendations of BOS that require consideration / approval of Academic Council:

1. The list of courses under the nomenclatures Discipline Core (Major & Minor), Skill enhancement course, and Multidisciplinary course to be offered by the Department of Physics under NEP 2020 presented in Annexure A.
2. The syllabi of the Semester I and II courses to be offered under NEP 2020 presented in Annexure B.
3. The syllabus of the course Nuclear and Elementary Particle Physics and Introduction to Material Science offered in Semester VI presented in Annexure B.
4. Revised course learning outcomes of Semester IV and Semester VI courses presented in Annexure B.

Mr. Yatin P. Desai
Member Secretary
Board of Studies

Dr. Ashish M. Desai
Chairperson
Board of Studies

Dated: 24th April 2023

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PART C: The remarks of the Dean of the Faculty:-

a. The minutes are in order.
b. The minutes may be placed before the Academic Council with remark, if any.
c. Important points of the minutes which need clear policy decision of the Academic Council to be recorded.

Date: 24th April 2023

Signature of the Dean:
(Faculty of Science)

Dr. Meghana Devli

PART D: The remarks of the Members Secretary of the Academic Council:-

a. The minutes are in order.
b. The minutes may be placed before the Academic Council with remark, if any.
c. Important points of the minutes which need clear policy decision of the Academic Council to be recorded.

Date: 25th April 2023

Signature of the Member Secretary
Academic Council

Mr. V. C. Kumaresh

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Annexure A

B.Sc. PHYSICS 3 YEARS AND 4 YEARS HONOURS LIST OF COURSES 2022-23 UNDER NEP 2020 COURSE STRUCTURE

SEMESTER	COURSE CODE	TITLE OF THE COURSE	TYPE OF COURSE	CREDITS
1	**UG-PHY-101**	Mechanics-I	DSC	4
	UG-PHY-102	Mechanics, Sound and Properties of Matter	DSC (MINOR)	4
	UG-PHY-MDC1	General Physics: Fluids and Heat	MDC	3
	UG-PHY-SEC1	Introduction to Mathematical Physics-I	SEC	3
2	**UG-PHY-103**	Electricity and Magnetism	DSC	4
	UG-PHY-104	Electricity, Magnetism and Electronics	DSC (MINOR)	4
	UG-PHY-MDC2	General Physics: Light and atoms	MDC	3
	UG-PHY-SEC2	Introduction to Mathematical Physics-II	SEC	3
3	**UG-PHY-201**	Electromagnetic Theory-I	DSC	4
	UG-PHY-202	Optics	DSC	4
	UG-PHY-203	Modern Physics*	DSC	4
	UG-PHY-204	Oscillation, Waves and Sound*	DSC	4
	UG-PHY-205	Elementary Modern Physics	DSC (MINOR)	4
	UG-PHY-MDC3	General Physics: Nucleus, Relativity and Beyond	MDC	3
	UG-PHY-SEC3	Introduction to Error Analysis	SEC	3
4	**UG-PHY-206**	Quantum Mechanics*	DSC	4
	UG-PHY-207	Heat and Thermodynamics*	DSC	4
	UG-PHY-208	Electronics-I	DSC	4
	UG-PHY-209	Properties of Matter and Acoustics*	DSC	4
	UG-PHY-210	Introduction to Astronomy and Astrophysics	DSC	4
	UG-PHY-211	Heat and Optics	DSC (MINOR)	4
	UG-PHY-VOC1	Computational Physics	VOC	4
5	**UG-PHY-301**	Electromagnetic Theory-I	DSC	4
	UG-PHY-302	Solid State Physics*	DSC	4

	UG-PHY-303	Thermodynamics and Statistical Mechanics*	DSC	4
	UG-PHY-304	Solid State Devices	DSC	4
	UG-PHY-305	Statistical Physics and Solid State Physics	DSC (MINOR)	4
	UG-PHY-VOC2	Basics of Visualization and Scientific word processing	VOC	4
6	**UG-PHY-306**	Atomic and Molecular Physics	DSC	4
	UG-PHY-307	Mechanics II*	DSC	4
	UG-PHY-308	Nuclear and Elementary Particle Physics	DSC	4
	UG-PHY-309	Introduction to Material Science	DSC	4
	UG-PHY-PRJ	Project	DSC	4
	UG-PHY-310	Atomic and Nuclear Physics	DSC (MINOR)	4
	UG-PHY-VOC3	Instrumentation	VOC	4
7	**UG-PHY-401**	Mathematical Physics	DSC	4
	UG-PHY-402	Classical Mechanics*	DSC	4
	UG-PHY-403	Electronics-II	DSC	4
	UG-PHY-404	Laboratory (Electronics and Computer Programming)	DSC	4
8	**UG-PHY-405**	Advanced Electromagnetic Theory	DSC	4
	UG-PHY-406	Introduction to Special Theory of Relativity*	DSC	4
	UG-PHY-407	Quantum Mechanics II	DSC	4
	UG-PHY-408	Laboratory (General Physics)	DSC	4
	UG-PHY-409	Advanced Solid State Physics	DSC	4

***** Courses maybe offered to the minor students

Annexure B

DEPARTMENT OF PHYSICS

SYLLABUS FOR FOUR YEAR UNDERGRADUATE DEGREE
HONOURS
PROGRAMME IN B. Sc. PHYSICS

(Implemented from the Academic Year 2023-2024 onwards)

COURSE STRUCTURE

SEMESTER	MAJOR CORE	MINOR/ VOCATIONAL	MULTI-DISCIPLINARY COURSE (MDC)	SKILL ENHANCEMENT COURSE (SEC)
I	**UG-PHY-101:** Mechanics-I	**UG-PHY-102:** Mechanics, Sound and Properties of Matter	**UG-PHY-MDC1:** General Physics: Fluids and Heat	**UG-PHY-SEC1:** Introduction to Mathematical Physics-I
II	**UG-PHY-103:** Electricity and Magnetism	**UG-PHY-104:** Electricity, Magnetism and Electronics	**UG-PHY-MDC2:** General Physics: Light and atoms	**UG-PHY-SEC2:** Introduction to Mathematical Physics-II
III	**UG-PHY-201:** Electromagnetic Theory-I	**UG-PHY-205:** Elementary Modern Physics	**UG-PHY-MDC3:** General Physics: Nucleus, Relativity and Beyond	**UG-PHY-SEC3:** Introduction to Error Analysis
	UG-PHY-202: Optics			
	UG-PHY-203: Modern Physics*			
	UG-PHY-204: Oscillation, Waves and Sound*			
IV	**UG-PHY-206:** Quantum Mechanics*	**UG-PHY-211:** Heat and Optics		
	UG-PHY-207: Heat and Thermodynamics*	**UG-PHY-VOC1:** Computational Physics		
	UG-PHY-208: Electronics-I			
	UG-PHY-209: Properties of Matter and Acoustics*			
	UG-PHY-210: Introduction to Astronomy and Astrophysics			
V	**UG-PHY-301:** Electromagnetic Theory-II	**UG-PHY-305:** Statistical Physics and Solid State Physics		
	UG-PHY-302: Solid State Physics*	**UG-PHY-VOC2:** Basics of Visualization and Scientific word processing		
	UG-PHY-303: Thermodynamics and Statistical Mechanics*			
	UG-PHY-304: Solid State Devices			
VI	**UG-PHY-306:** Atomic and Molecular Physics	**UG-PHY-310:** Atomic and Nuclear Physics		

	UG-PHY-307: Mechanics II*	**UG-PHY-VOC3:** Instrumentation		
	UG-PHY-308: Nuclear and Elementary Particle Physics			
	UG-PHY-PRJ: Project			
	UG-PHY-309: Introduction to Material Science			
VII	**UG-PHY-401:** Mathematical Physics			
	UG-PHY-402: Classical Mechanics*			
	UG-PHY-403: Electronics-II			
	UG-PHY-404: Laboratory (Electronics and Computer Programming)			
VIII	**UG-PHY-405:** Advanced Electromagnetic Theory			
	UG-PHY-406: Introduction to Special Theory of Relativity*			
	UG-PHY-407: Quantum Mechanics II			
	UG-PHY-408: Laboratory (General Physics)			
	UG-PHY-409: Advanced Solid State Physics			

* Courses maybe offered to the minor students

SEMESTER-I

Course Title : Mechanics I

Course Code: UG-PHY-101

Credits : 3 (Theory) + 1 (Practical)

Marks : 75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives : This course provides an introduction to topics in mechanics, which are essential for advanced work in physics. An objective of this course is to train students to think about some of the physical phenomenon in mathematical terms.

Course Learning Outcomes: At the end of this course students will be able to:
CLO1: Develop understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations.
CLO2: Understand the Law of Conservation of Linear Momentum and Angular Momentum and apply these laws to understand elastic and inelastic collision.
CLO3: Apply the knowledge of work and energy theorems in kinematics through examples.
CLO4: Understand the Principle of Conservation of Mechanical Energy (for conservative forces) and apply this law to problems of objects moving under the influence of conservative forces.
CLO5: Understand ideas of Newton's Law of gravity, gravitational field and potential energy by solving various problems.

Course Content

Theory:

Module I: **Elements of Newtonian Mechanics, Motion of Particle in one dimension [15 h]**

1. **Elements of Newtonian Mechanics [7 h]**

Mechanics an exact science, Brief description of classical view of Space and Time. Kinematics, the description of motion. Dynamics, the concept of Mass and Force. Newton's First and Second Laws; Inertial frames. Equations of motion. Interpretation of Newton's third Law as Conservation of Momentum. Units and dimensions, Some elementary problems in Mechanics (Applications of Newton's Laws) - Atwood Machine, Forces acting on a brick sliding down an inclined plane.
[Symon 1.1, 1.2, 1.3, 1.4, 1.6, 1.7, Taylor 1.1-1.7, Kleppner 2.4]

2. **Motion of Particle in one dimension [8 h]**

Momentum and Energy theorems, Discussion of the general problem of one dimensional motion, Applied force dependent on time, Damping force dependant on the velocity. Conservative force depending on position. Potential Energy, Falling bodies.
[Symon 2.1, 2.2, 2.3, 2.4, 2.5, 2.6]

Module II: **Motion of a particle in two dimensions** **[15 h]**

1. Motion of a particle in two dimensions **[15 h]**

Vector algebra, Applications to set of forces acting on a particle, differentiation and integration of vectors, kinematics in a plane, momentum and energy theorems, plane and vector angular momentum theorems, The harmonic oscillator in two dimensions, projectiles, potential energy.
[Symon 3.1, 3.2, 3.3, 3.4, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12]

Module III: **Motion of system of particles, Gravitation** **[15 h]**

1. **Motion of system of particles** **[8 h]**

Conservation of linear momentum, conservation of angular momentum,conservation of energy.
[Symon 4.1, 4.2, 4.3]

2. Gravitation **[7 h]**

Centres of gravity for extended bodies, Gravitational field and gravitational potential, Gravitational field equations.
[Symon 6.1, 6.2, 6.3]

Practicals: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Atwood Machine
4. Verification of Newton's Second Law using Air Track
5. Conservation of linear momentum using Air Track
6. Spring Mass System: Determining the Spring Constant
7. Simple Pendulum
8. Determining "g" using time of flight method using Python

List of books recommended for reference

Mandatory Reading:

1. Symon Keith, 2016, Mechanics, Pearson Education
2. Taylor J. R., 2005, Classical Mechanics, University Science Books, USA
3. Kleppner, Kolenkow, 2013, Introduction to Mechanics, Cambridge University Press, UK

Supplementary Reading:

1. Kittle, Knight, 2011, Mechanics, Berkeley Physics Course, Vol. 1, McGraw Hill Education,
2. .Mathur D. S, 2005, Mechanics, S. Chand & Co., New Delhi
3. Takwale R. G., and Puranik P. S., 1997, Introduction to Classical Mechanics, Tata Mc-Graw Hill, New Delhi
4. Javier E. Hasbun, 2010, Classical Mechanics, Jones and Bartlett India Pvt. Ltd.
5. Atam Arya, 1997, Introduction to Newtonian Mechanics, Addison-Wesley
5. Symon K. R., 1971, Mechanics, Addison Wesley, New York
6. Brij Lal and N. Subramanyam, 2005, Mechanics and Electrodynamics, S. Chand and Company Ltd., New Delhi.

Online resources:

1. https://nptel.ac.in/courses/122106027/
2. https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
3. https://www.khanacademy.org/science/ap-physics-1/
4. https://www.feynmanlectures.caltech.edu/I_13.html
5. http://hep.physics.wayne.edu/~harr/courses/5200/f07/lecture06.htm

Course Title : Mechanics, Sound and Properties of Matter

Course Code : UG-PHY-102

Credits : 3 (Theory) + 1 (Practical)

Marks : 75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: This course provides an introduction to topics in mechanics, sound and properties of matter. An objective of this course is to build up an understanding of fundamental physical principles which are required for most of other physical sciences.

Course Learning outcomes: After successful completion of this course students will be able to:

CLO1: gain an introductory knowledge of Newtonian mechanics, its conservation laws and its applications to basic physical problems.
CLO2: gain knowledge of waves, sound and ultrasonic waves and its applications.
CLO3: Explain the concept of elasticity, including its various types and its applications.
CLO4: Explain the concept of surface tension, analyse and explain the role of surface tension in various natural phenomena such as capillary action.
CLO5: Interpret the concept of viscosity and its applications, describe the properties of fluids that determine their viscosity.

Course Content

Theory:

Module I: [20 h]

1. **Elements of Newtonian Mechanics [5 h]**
   Newton's Laws of motion, equation of motion. Elementary problems in mechanics: Atwood machine and motion along a rough inclined plane and free fall.
   [Symon 1.4, 1.7]

2. **Motion of a particle in one dimension [10 h]**
   Momentum and energy conservation theorems. Discussion of the general problem of one dimensional motion. Applied force depending on time. Motion under damping force depending on velocity. Conservative force depending on position. Brief review of simple harmonic motion and potential energy curve. Body falling under gravity in a resistive medium proportional to velocity.
   [Symon 2.1 - 2.7]

3. **Gravitation Field and potentials: [5 h]**
   Newton's Law of Gravitation. Gravitation field and Gravitation potential energy, Gravitational potential and field due to a thin spherical shell.
   [Brij Lal 5.5-5.8]

Module II: **[10 h]**

1. **Sound** **[10 h]**

   Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace's correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel. Doppler Effect. Source and listener in relative motion (Normal incidence only). Production and detection of Ultrasonic waves and its applications.

   [Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subra. 11.23 11.25,11.27]

Module III: **[15 h]**

1. **Elasticity** **[9 h]**

   Modulii of elasticity, Poisson's ratio and relationship between them. Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. A vibrating cantilever. Torsion in a string-couple per unit twist, Torsional Pendulum.

   [Mathur 8.8, 8.9, 8.12 -8.18, 8.22, 8.26, 8.29, 8.30]

2. **Surface Tension** **[3 h]**

   Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Angle of contact. Capillarity-rise of liquid in a capillary tube.

   [Mathur 14.1-14.4, 14.6, 14.14, 14.15 and 14.17]

3. **Viscosity** **[3 h]**

   Streamline flow, Turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube.

   [Mathur 12.1, 12.2, 12.7, 12.11]

Practicals: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Spring Mass System: Determining the Spring Constant
4. Velocity of sound by Helmholtz Resonator
5. Young's Modulus by Vibration
6. Young's Modulus by Bending
7. Surface Tension by rise of a liquid in a capillary tube.
8. Coefficient of Viscosity by Poiseuille's Method.

List of books recommended for reference

Mandatory Reading:

1. K. R. Symon, *Mechanics (*Addison Wesley, 1971)
2. Brij Lal and N. Subrahmanyam, *Mechanics and Electrodynamics*, (S. Chand and Company LTD , 2005)
3. D. R. Khanna and R. S. Bedi ,*A Textbook of Sound* (Atma Ram and Sons, 1992)
4. N. Subrahmanyam and Brijlal,*Waves and Oscillation* (Vikas Publishing House 1994)
5. D. S. Mathur, *Elements of Properties of Matter* (S.Chand& Co. 2005

Supplementary Reading:

1. John Taylor, Classical Mechanics (University Science Books, 2004)
2. Atam Arya, *Introduction to Newtonian Mechanics*, (Addison-Wesley, 1997)
3. Kittle and Knight, Mechanics (Berkeley Physics Course, Vol. 1), (McGraw Hill Education, 2011)
4. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics*, (Tata McGraw-Hill, 1997)
5. R. Murugeshan and Er. KiruthigaSivaprasath, *Properties of Matter and Acoustics* (S. Chand & Co., 2011)

Online resources:

1. https://www.youtube.com/watch?v=ZFEExw-qUSk&list=PLVFqK_9GOGXnSnuU-x2qgX68mWyBqn6O8
2. https://www.youtube.com/watch?v=47bEFVyczLk&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw
3. https://www.youtube.com/watch?v=fa0zHI6nLUo&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGyBEm
4. https://www.youtube.com/watch?v=yyqhgnc5cWI&list=PLbRMhDVUMngeGSqPVkrc8G_kApltxEEos
5. https://www.youtube.com/watch?v=CIws3dZEHMU&list=PL546CD09EA2399DAB&index=7

Course Title : General Physics: Fluids and Heat

Course Code : UG-PHY-MDC 1

Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: The objective of this course is to build up an understanding of the fundamental laws and principles that govern the physical world. The course will help the students to understand the principles of fluid dynamics and the concepts of temperature, heat engines and laws of thermodynamics.

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

CLO1: Get an insight into the importance of measurement and mathematics in physics

CLO2: Identify and explain the physics behind every day phenomena such as the behaviour and motion of fluids.

CLO3: Understand the fundamental concepts of pressure, exploring the behavior of gases and liquids.

CLO4: Understand Pascal's principle, Archimedes' principle and Bernoulli's principle along with its applications.

CLO5: Understand the concept of temperature and its measurement, including the different temperature scales.

CLO6: Understand the basic concepts of thermodynamics, including the laws of thermodynamics, thermodynamic systems, thermodynamic properties and heat engines.

Course Content

Theory:

Module I: **[10 h]**

Physics, the Fundamental Science

Scope of Physics. Role of measurement and mathematics in Physics. Physics and Everyday Phenomenon.

[Griffiths: 1.2 - 1.4]

The Behavior of Fluids

Pressure and Pascal’s Principle. Atmospheric pressure and the behavior of gases. Archimedes principle. Fluids in motion. Bernoulli’s principle.

[Griffiths: 9.1 - 9.5]

Module II: **[20 h]**

Temperature of Heat

Temperature and its measurement, Heat and specific capacity, Joule’s experiment and the First Law of thermodynamics. Gas behavior and the First Law. The Flow of heat.

[Griffiths: 10.1 - 10.5]

Heat Engines and Second Law of Thermodynamics
Heat engines. The second Law of Thermodynamics. Refrigerators, Heat Pumps and Entropy. Thermal Power plants and Energy Resources. Perpetual motion and Energy Frauds.
[Griffiths: 11.1 - 11.5]

Practicals: (Minimum Six)

1. Thermal conductivity of copper.
2. Jaegger's Method: Determination of Surface Tension
3. Viscosity of a liquid by Poiseuilles method
4. Capillarity: determination of Surface tension
5. Specific heat of Graphite
6. Thermal conductivity by Lee's method.
7. Silicon Diode as a thermometer
8. Pt-100 as a temperature sensor.

List of books recommended for reference
Mandatory Reading:

1. Griffiths Thomas and Brosing Juliet, 2009, *The Physics of Everyday Phenomenon: A conceptual introduction to Physics*, 6th Edition. McGraw-Hill Companies.

Supplementary Reading

1. Halliday, Resnick , Walker, 2008, *Fundamentals of Physics* Extended, 8th Edition, Wiley India Pvt Ltd.
2. H.C. Verma , 2021, *Concept of Physics* by H.C Verma, 1st Edition, Bharati Bhawan (Publishers & Distributors).
3. Hugh Young, Roger Freedman, 2019, *University Physics with Modern Physics*, 15th Edition, Pearson.
4. Yunus Cengel, 2007, *Introduction to Thermodynamics and Heat Transfer*, 2nd Edition, McGraw-Hill Education.
5. Feynman, R. 2012, *Feynman Lectures on Physics: Mechanics, Radiation and Heat (Volume - 1)*, Pearson Education, India.

Online resources

1. https://www.youtube.com/watch?v=wF0V51Imxx4
2. https://www.youtube.com/watch?v=clVwKynHpB0&list=RDQMf63I7XSVFD8&start_radio=1
3. https://www.youtube.com/watch?v=mb8LqNlHeLY
4. https://www.youtube.com/watch?v=YxGHbnwqd14
5. https://www.youtube.com/watch?v=DeNBWsZHXTE
6. https://www.youtube.com/watch?v=kLqduWF6GX

Course Title : Introduction to Mathematical Physics-I

Course Code : UG-PHY-SEC 1

Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives : To develop basic competence in certain areas of mathematics required for understanding several important topics in physics.

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

CLO1: Understand various tests used to examine the convergence and divergence of different kinds of series and learn how to expand a function in power series.

CLO2: Understand the basics of complex numbers.

CLO3: Learn basics of partial differentiation and its application in physics.

CLO4: Solve ordinary first and second order differential equations important in the physical sciences,

CLO5: Use mathematical and computational techniques to solve several problems in physics and enhance problem solving skills.

Theory:

Module I: [15 h]

1. **Infinite Series and Power Series [10 h]**

   Geometric Series and other infinite series. Convergent and Divergent Series. Testing series for convergence. Power series. Expanding functions in power series. Techniques for obtaining power series expansion.

   [Boas 1.1-1.7, 1.10-1.13]

2. **Complex Numbers [5 h]**

   Real and imaginary Parts of a complex number. Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. Exponential and trigonometric functions.

   [Boas 2.1-2.5, 2.9-2.11]

Module II: [15 h]

1. **Partial Differentiation [6 h]**

   Definition of the partial derivative. Total differentials. Exact and inexact differentials. Theorems of partial differentiation. Chain rule. Thermodynamic relations. Differentiation of Integrals.

   [Boas 4.1-4.5, 4.7, Riley 5.11, 5.12]

2. **Ordinary Differential Equation [9 h]**

   Introduction. Linear differential equation of the first order. Homogenous and inhomogeneous linear differential equation of the second order.

   [Boas 8.1-8.6 and Harper 5.1-5.2]

Practicals: (Minimum Six)

1. Introduction to a programming language.
2. Programs that involve the management of program flow using conditional statements such as "if" and "elif".
3. Programs that require looping and iteration using control structures such as "for" and "while" loops.
4. Programs that employ built-in functions as well as functions that are created by the user.
5. Programs that utilize standard libraries like Numpy and Scipy.
6. Exploring series expansions using a programming language and its applications in physics.
7. Exploring complex numbers in Physics analysis using a programming language.
8. Using programming to solve Partial Differentiation.
9. Applying programming techniques to solve ordinary differential equations.
10. Simulation of radioactive decay using rolling of dice
11. Curve fitting using Excel.

List of books recommended for reference

Mandatory Reading:

1. Riley K. F., Hobson M. P., Bence S . J., 1998, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, UK
2. Mary L. Boas, *Mathematical Methods in Physical Sciences* 3rd Edition, John Wiley and Sons, USA
3. Charlie Harper, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi

Supplementary Reading:

1. B. D. Gupta, 2004. *Mathematical Physics*, Vikas Publishing House, New Delhi
2. C. Hill, Learning. 2020, *Scientific Programming with Python*, 2nd Edition, Cambridge University Press.

Online resources:

1. https://ocw.mit.edu/resources/res-18-007-calculus-revisited-multivariable-calculus-fall-2011/
2. https://www.youtube.com/watch?v=BP7Ujbyu-NE
3. https://nptel.ac.in/courses/111108081/
4. https://www.math.upenn.edu/~deturck/m104/notes/week6.pdf
5. http://tutorial.math.lamar.edu/Classes/CalcIII/CalcIII.aspx

Semester II

Course Title : Electricity and Magnetism

Course Code : UG-PHY-103

Credits : 3 (Theory) + 1 (Practical)

Marks : 75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives : The objective of this course is to introduce fundamentals of electricity and magnetism to the students, which is an essential preparation for more advanced courses like Electromagnetic theory.

Course Learning Outcomes: After successful completion of this course, student will be able to:

CLO1: Understand and apply Gauss law, Coulomb's law and apply it to determine electric field of systems of point charges, surface, and volume distributions of charges.
CLO2: Understand and differentiate the vector (electric fields) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
CLO3: Understand and determine the dielectric properties, magnetic properties of materials, and also the phenomena of electromagnetic induction.
CLO4: Analyse and understand the working of DC circuits, AC circuits and AC bridges using appropriate theoretical tools.
CLO5: In the laboratory course the student will be able to construct and understand the working and use of DC circuits, AC circuits with help of various measuring instruments.
Course Content

Theory:

Module I: **[15 h]**

1. **Electrostatics** **[10 h]**

Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges, Variation of force with distance (F.vs.r graph), Concept of electric field and Electric Field Lines: Electric field, Electric field due to (i) a Point Charge, (ii) an Electric Dipole, (iii) a Line of Charge and (iv) a Charged Disk, Concept of electric flux: Gauss' Law of electrostatics (Conceptual explanation), Applications of Gauss law: Coulomb's Law from Gauss' Law, Electric Field due to (i) an isolated uniformly charged sphere, (ii) an uniform distribution of charge throughout the sphere and (iii) an uniformly charged hollow cylinder, Electric Field near (i) a charged infinite cylindrical conductor or a cable and (ii) a plane of sheet charge, Concept of Electric Potential: Electric Potential Energy, Equipotential

Surfaces, Calculating the Potential from the Field Potential due to (i) a Point Charge, (ii) a Group of Point Charges and (iii) an Electric Dipole Calculating the Field from the Potential **[Halliday: 22.4, 23.2-23.7, 24.1-24.5, 25.1-25.7, 25.9] [Vasudeva: 2.4(1-6)]**

2. **Capacitors and Dielectrics** **[5 h]**

Capacitance: Calculation of capacitance of (i) a Parallel-Plate Capacitor, (ii) a Cylindrical Capacitor and (iii) a Spherical Capacitor; Energy stored in an electric field, Capacitor with a Dielectric, Dielectrics: An Atomic View, Dielectrics and Gauss' Law, Relation between three electric vectors (E, D and P)(Without derivation, qualitative discussion only)

[Halliday: 26.1- 26.3, 26.5-26.8]

Module II: **[15 h]**

1. **Magnetostatics** **[6 h]**

Concept of magnetic field: Definition and properties of magnetic field Biot–Savart's law and its applications: (i) a long straight wire and (ii) a current carrying circular loop (for a point on the axis only) Ampere's circuital law and its applications: (i) Field of solenoid and (ii) Field of toroidal solenoid Magnetic Field lines and Magnetic flux; Gauss' law for magnetism

[Halliday: 29.1, 29.2, 30.1, 30.3, 30.4, 32.2][Young:27.2, 27.3]

2. **Self and Mutual Inductance** **[9 h]**

Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable, Mutual inductance, Coefficient of coupling; Calculation of mutual inductance between two coaxial solenoids, Mutual inductance of two coils in series, Energy stored in a magnetic field and Energy density of a magnetic field

[Fewkes: 5.1, 5.2, 5.8, 5.9] [Halliday:31.8, 31.10, 31.11, 31.12]

Module III: **[15 h]**

1. **Transient Circuits** **[6 h]**

Transient currents, Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time constant, Charging and Discharging of a capacitor through resistor in C-R circuit, Physical meaning of time constant, Charging and Discharging of a capacitor

through resistor and inductor in L-C-R circuit: Over damped, Critically damped and Under damped conditions of L-C-R circuit.

[Fewkes:5.3, 5.4, 5.13, 5.14]

2. **Alternating Current Circuits** **[9 h]**

   Inductive and Capacitive reactance, Variation of inductive reactance and capacitance reactance with frequency Introduction to vector or phasor diagrams method and its application to A.C. circuits(Series L-R, Series C-R, Series L-C-R and Parallel L-C-R) Introduction to j-operator method and its application to A.C. circuits (Series L-C-R and Parallel L-C-R) Physical significance of Series resonance, Parallel resonance, Quality factor and Bandwidth, Graphical representation of resonance A.C. bridges: Maxwell's inductive bridge, Maxwell's L/C bridge, de Sauty's capacitance bridge, Wien's frequency bridge.

   [Vasudeva:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10, 22.13, 22.14] [Vasudeva: 22.19, 22.20, 22.21(b), 22.22] [Fewkes:6.5, 6.6, 6.7(c), 6.9, 6.14, 6.20, 6.21, 6.22, 6.24]

Practicals: (Minimum Six)

1. Susceptibility measurement of a parallel plate capacitor in a dielectric medium
2. Step Response of RC circuit with DC emf.
3. Study of LR circuit to DC using Excel worksheet
4. LCR- Transient Response
5. Response of LR circuit to A.C. - phasor diagrams
6. Response of CR circuit to A.C. - phasor diagrams
7. LCR- Series resonance –Resonant frequency, Q value and Bandwidth
8. LCR- Parallel resonance –Resonant frequency, Q value and Bandwidth
9. de Sauty's bridge - comparison of capacitance
10. Maxwell's Inductive bridge - determination of mutual inductance

List of books recommended for reference
Mandatory Reading:

1. Halliday David, Resnik Robert and Walker Jearl, 2003, *Fundamentals of Physics*, John Wiley & Sons, Inc., 6th Edition.
2. Vasudeva D. N., 1999, *Fundamentals of Magnetism and Electricity*, S. Chand & Company Ltd., 12th Revised Edition.
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, 2012, Sears and Zemansky's *University Physics with Modern Physics*, Addison-Wesley Publishers, 13th Edition(PDF).
4. FewkesJ. H. and Yarwood John,1991, *Electricity, Magnetism and Atomic Physics*, Volume I, Oxford University Press Ltd., 10th Impression.

Supplementary Reading:

1. Purcell Edward M., *Electricity and Magnetism-Berkeley Physics Course*,Volume 2, McGraw-Hill Book Company (PDF)
2. Brij Lal and Subramaniam, 1966, *Electricity and Magnetism*, Ratan Prakashan, New Delhi.
3. Thereja B.L., 1990, *Text Book of Electrical Technology*, S. Chand and Co Ltd. New Delhi.

Online resources

1. https://youtu.be/T8bjzTsZyqE
2. https://youtu.be/KNERqAu3aWU
3. https://youtu.be/7jxUT5sIbxY
4. https://youtu.be/iqzpuxVloUc
5. https://youtu.be/iqzpuxVloUc
6. https://physicscatalyst.com/elec/electric-potential-energy.php
7. https://physicscatalyst.com/elec/electric-potential.php
8. https://physicscatalyst.com/elec/relation-between-electric-field-and-potential.php
9. https://physicscatalyst.com/elec/equipotential-surfaces.php
10. https://physicscatalyst.com/elec/electric-potential-dipole.php
11. https://physicscatalyst.com/elec/potential-energy-of-dipole.php
12. https://ocw.mit.edu/courses/physics/8-02t-electricity-and-magnetism-spring-2005/lecture-notes/

Course Title : Electricity, Magnetism and Electronics

Course Code : UG-PHY-104
Credits : 3 (Theory) + 1 (Practical)

Marks :75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: The objective of this course is to introduce fundamentals of electricity, magnetism and basic electronics to the students, which are essential allied learning components for most of the subjects of Physical Sciences.

Learning Outcome: At the end of this course students will be able to:

CLO1: Comprehend basic concepts like: laws of electrostatics and magnetostatics, self and mutual inductions.

CLO2: Understand the working of d.c. and a.c. circuits in terms of the role of passive components like capacitor and inductor present in the circuits.

CLO3: Understand the working and application of various electronic circuits like rectifier, voltage regulator, CE Amplifier.

CLO4: Correlate the theoretical basis of various concepts of electricity, magnetism and electronics while performing experiments.

Course Content

Theory:

Module I: [15 h]

1. **Laws of Electrostatics [8 h]**
   Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges, Variation force with distance (F v/s r graph), Concept of electric field and Electric Field Lines, Concept of electric flux: Gauss's theorem in electrostatics (conceptual explanation), Coulomb's Law from Gauss' Law, Concept of Electric Potential: Electric Potential Energy, Equipotential Surfaces, Calculating the Potential from the Field, Calculating the Field from the Potential.
   [Halliday: 22.4, 23.2, 23.3, 24.1-24.5, 25.1-25.4, 25.9] [Vasudeva: 2.4(1)]
2. **Laws of Magnetostatics [7 h]**
   Concept of magnetic field, Definition and properties of magnetic field, Biot – Savart's law and its applications: (i) Long straight conductor and (ii) Current carrying circular loop (for a point on the axis only) Ampere's circuital law and its application: Field of solenoid. Magnetic Field lines and Magnetic flux, Gauss's law for magnetism.
   [Halliday: 29.1, 29.2, 30.1, 30.3, 32.2][Young:27.2, 27.3]

Module II: [15h]

1. **Self and Mutual Inductance [6 h]**
   Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable. Mutual inductance, Coefficient of coupling; Mutual inductance of coils in series. Energy stored in the magnetic field
   [Fewkes: 5.1, 5.2, 5.8] [Halliday:31.8, 31.10, 31.12]

2. **Transient Circuits and Alternating Current Circuits [9 h]**

Transient currents: Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time constant, Charging and Discharging of a capacitor through resistor in C-R circuit, Physical meaning of time constant. Inductive and Capacitive reactance, Variation of inductive reactance, capacitance reactance with frequency. Introduction to vector or phasor diagrams method and its application to A.C. circuits (Series L-R and Series C-R); Physical significance of Quality factor A.C. bridges: Maxwell's Inductive bridge and de Sauty's Capacitance bridge

[Fewkes:5.3, 5.4]

[Vasudeva:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10] [Fewkes: 6.20, 6.21, 6.22]

Module III. [15 h]

1. **Rectifiers and Regulators [7 h]**

Volt-ampere characteristics of Junction diode, Working of Half Wave and Full Wave Rectifiers without and with capacitive filters, Percentage regulation, Ripple factor and Rectification efficiency (only qualitative explanation with respect to HWR and FWR). Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation.

[Halliday: 4.1-4.7 and Vasudeva: 6.1-6.4, 6.13-6.17]

2. **Transistors [8 h]**

Basic configurations of transistors, Transistor's leads identification, Biasing of Transistor and working of Transistor as a switch Transistor characteristic in CE and CB mode, Current gains and their interrelation, Leakage currents in transistor Basic Amplifier Characteristics: Current gain, Voltage gain, Power gain, Input resistance, Output resistance, Classes of amplifier operations, DC load Line, Frequency response and Amplifier bandwidth of CE Amplifier.

[Young: 8.1, 8.4, 8.7-8.12, 8.17, 8.18, 8.26] [Vasudeva: 7.1-7.7, 7.10, 8.7, 8.8] [Fewkes: 7.6]

Practicals: (Minimum Six)

1. Step Response of RC circuit Charging and discharging of a capacitor
2. Response of LR and CR circuits to A.C. using phasor diagrams
3. de Sauty's capacitance bridge
4. Self inductance of a coil using Maxwell's inductive bridge
5. Mutual inductance of two coils in series
6. Half wave and Full wave rectifier using Junction Diode, Load regulation characteristics.
7. Zener Diode Regulation
8. Transistor characteristics
9. C.E. Amplifier: Gain v/s Load, Input and Output Impedance

List of books recommended for reference

Mandatory Reading:

1. Halliday David, Resnik Robert and Walker Jearl, *Fundamentals of Physics*, John Wiley & Sons, Inc., 6th Edition (2003)
2. Vasudeva D. N., *Fundamentals of Magnetism and Electricity*, S. Chand & Company Ltd., 12th Revised Edition (1999)
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, Sears and Zemansky's *University Physics with Modern Physics*, Addison-Wesley Publishers, 13th Edition (PDF) (2012)
4. Fewkes J. H. and Yarwood John, *Electricity, Magnetism and Atomic Physics*, Volume I, Oxford University Press Ltd., 10th Impression (1991)

Supplementary Reading:

1. Bhargava N. N., Kulshreshtha D. C. and Gupta S. C., *Basic Electronics and Linear Circuits*, Tata McGraw Hill Education Private Ltd., 54th Reprint (2010)
2. Mottershed Allen, *An Introduction to Electronics Devices and Circuits*, Prentice-Hall of India Private Ltd., Eastern Economy Edition (2008)
3. Metha V. K. and Mehta Rohit, *Principles of Electronics*, S. Chand & Company, Multicolour Revised Edition (2008)
4. Malvino A. P., *Electronic Principles*, Tata McGraw Hill Education Private Ltd., 5th Edition (1996)

Online resources:

1. https://youtu.be/T8bjzTsZyqE
2. https://youtu.be/KNERqAu3aWU
3. https://physicscatalyst.com/elec/electric-potential-energy.php
4. https://physicscatalyst.com/elec/electric-potential.php
5. https://ocw.mit.edu/courses/physics/8-02t-electricity-and-magnetism-spring-2005/lecture-notes/
6. https://www.elprocus.com/different-types-rectifiers-working/
7. https://www.pitt.edu/~qiw4/Academic/ME2082/Transistor%20Basics.pdf
8. https://nptel.ac.in/courses/115/102/115102014/

Course Title : General Physics: Light and atoms

Course Code : UG-PHY-MDC 2
Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)
Course Objectives : The objective of the course is to familiarize students with wave nature of light, geometrical optics and the structure of the atom.

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

CLO1: Understand the principles of wave motion and its properties.
CLO2: Understand the nature of electromagnetic waves, the principles of wave interference, including constructive and destructive interference, diffraction grating and their applications in the study of light.
CLO3: Get an insight into the properties and the applications of polarized light
CLO4: Create a foundation in the principles of light and image formation, including the properties of lenses, mirrors, and other optical devices.
CLO5: Understand the principles of atomic and subatomic particles, including the historical development of the atomic theory and the contributions of key scientists.
CLO6: Get a brief idea of the principles of radioactivity, atomic spectra, and matter waves.

Theory:

Unit I: [20 h]

Wave motion

Wave pulses and periodic waves. Waves on a rope. Interference and standing waves. Sound waves. The Physics of music.
[Griffiths: 15.1 - 15.5]

Light waves

Electromagnetic waves. Wavelength and color. Interference of light waves. Diffraction gratings. Polarized light.
[Griffiths: 16.1 - 16.5]

Light and Image formation

Reflection and image formation. Refraction of light. Lenses and image formation. Focusing light with curved mirrors. Eyeglasses. Microscopes and telescope.
[Griffiths: 17.1 - 17.5]

Unit II [10 h]

The Structure of the Atom

The existence of atoms. Cathode rays, electrons and X-rays. Radioactivity and discovery of the nucleus. Atomic spectra and Bohr model of the atom. Particle waves and Quantum Mechanics.
[Griffiths: 18.1 - 18.5]

Practicals: (Minimum Six)

1. Newton's Rings
2. Wedge shaped air film
3. Single Slit Diffraction using LASER/Sodium source.
4. Diffraction Grating using LASER/Sodium source.
5. Photoelectric effect.
6. Determination of e/m of electrons using Thomson's method.
7. Frank Hertz Experiment.
8. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.

References:

1. Griffiths Thomas and Brosing Juliet, 2009, The Physics of Everyday Phenomenon: A conceptual introduction to Physics, 6th Edition. McGraw-Hill Companies.

Additional References:

1. Halliday, Resnick , Walker, 2008, Fundamentals of Physics Extended, 8th Edition, Wiley India Pvt Ltd.
2. H.C. Verma , 2021, Concept of Physics by H.C Verma, 1st Edition, Bharati Bhawan (Publishers & Distributors).
3. Hugh Young, Roger Freedman, 2019, University Physics with Modern Physics, 15th Edition, Pearson.
4. Eugene Hecht , A. R. Ganesan , 2019. Optics, 5th Edition, Pearson Education.

Web references

1. https://www.youtube.com/watch?v=D_RIzl1uCxY
2. https://www.youtube.com/watch?v=F6dZjuw1KUo
3. https://www.youtube.com/watch?v=HH58VmUbOKM
4. https://www.youtube.com/watch?v=CJ6aB5ULqa0
5. https://www.youtube.com/watch?v=f7TK3KUBR1o
6. https://www.youtube.com/watch?v=3YcmyYgonlE

Course Title : Introduction to Mathematical Physics-II

Course Code : UG-PHY-SEC 2

Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: The brief objective of this course is to provide a foundation in mathematical concepts and techniques that are essential for further study in physics.

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

CLO1: understand vector analysis and its application in physics.

CLO2: familiarize with spherical and cylindrical coordinate systems.

CLO3: understand matrix operations and properties of matrices.

CLO4: describe the characteristics of the normal distribution, including its bell-shaped curve and the empirical rule

CLO5: calculate the standard deviation and use it to determine the acceptability of a measured answer.

CLO6: understand the properties of the binomial distribution including the use of the binomial distribution formula.

CLO7: understand the properties of the Poisson distribution and use it to solve problems and make predictions.

Course Content

Theory:

Module I **[15 h]**

1. **Vector Algebra** **[5 h]**
   Scalars and vectors. Basis vectors and components. Multiplication of Vectors. Equation of lines and planes. Using vectors to find distances.
   [Boas 3.4-3.5]

2. **Coordinate Systems** **[3 h]**
   Plane polar coordinates. Cylindrical and Spherical polar coordinates.
   [Harper 1.6.6, Riley 8.9]

3. **Matrices** **[7 h]**
   Matrix Analysis and Notation, Matrix Operations, Properties of matrices. Transpose matrix. Complex Conjugate Matrix, Hermitian Matrix, Unit matrix, Diagonal matrix, Adjoint and self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix. Solution of a system of linear equations. The eigenvalue problem.
   [Harper 2.3-2.8]

Module II: **[15 h]**

1. **The Normal Distribution** **[7 h]**

   Histograms and Distributions, Limiting distributions. The normal distribution. The standard deviation as 68% confidence limit. Justification of the mean as the best estimate. Justification of addition in quadrature. Standard deviation of the mean. Acceptability of the measured answer.

   [Taylor: 5.1-5.8]

2. **The Binomial Distribution** **[4 h]**

   Distributions. Probability in dice throwing. Definition of binomial distribution. Properties of binomial distribution. The Gauss distribution for random errors. Application: testing of hypothesis

   [Taylor: 10.1-10.6]

3. **The Poisson Distribution** **[4 h]**

   Definition of Poisson distribution. Properties of Poisson distribution. Applications. Subtracting a background.

   [Taylor: 11.1-11.4]

Practicals: (Minimum Six)

1. Exploring vector algebra using a programming language and its applications in physics.
2. Investigating Matrix Operations in Physics using a Programming Language -I
3. Statistical analysis with normal distribution using a programming language/Excel.
4. Exploring the binomial distribution through programming/Excel.
5. Exploring the Poisson distribution through programming/Excel.
6. Investigating Matrix Operations in Physics using a Programming Language -II
7. Plotting of various algebraic and trigonometric functions using Excel.
8. Non-linear curve fitting using Excel.

List of books recommended for reference

Mandatory Reading

1. Mary L. Boas, *Mathematical Methods in Physical Sciences* 3rd Edition, John Wiley and Sons, USA
2. Charlie Harper, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi
3. Taylor J, 1997, *An Introduction to Error analysis*, University Science Books.

Supplementary Reading:

1. B. D. Gupta, 2004. *Mathematical Physics*, Vikas Publishing House, New Delhi
2. Riley K. F., Hobson M. P., Bence S. J., 1998, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, UK
3. C. Hill, Learning. 2020, *Scientific Programming with Python*, 2nd Edition, Cambridge University Press.

Online resources:

1. https://www.youtube.com/playlist?list=PL1C22D4DED943EF7B
2. http://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
3. http://www.jimahoffman.com/MathB30/Matrices/Matrix1.pdf
4. http://web.pas.rochester.edu/~physlabs/manuals/L2C-StatisticsForWeb-AB5-short.pdf
5. https://library2.lincoln.ac.nz/documents/Normal-Binomial-Poisson.pdf
6. https://www.youtube.com/playlist?list=PLU6SqdYcYsfLRq3tu-g_hvkHDcorrtcBK

Semester VI

Course Title : Nuclear and Elementary Particle Physics

Course Code : PHY-E14

Marks : 75 (Theory) + 25 (Practical)

Credits : 3 (Theory) + 1 (Practical)

Contact Hours : 45 (Theory) + 30 (Practical)

Pre-requisite : Quantum Mechanics (PHY-IV.C-6)

Course Objectives : The objective of this course is to introduce students to the fundamental principles and concepts governing nuclear and particle physics.

Course Learning Outcomes: After successful completion of this course, student will be able to:
CLO1: Learn the ground state properties of a nucleus.
CLO2: Gain knowledge on basic concept of nuclear force and Meson theory of nuclear force.
CLO3: Know about the liquid drop model and shell model to understand nuclear properties.
CLO4: Learn the basic aspects of nuclear reactions
CLO5: Learn about the principles and basic constructions of nuclear reactor.
CLO6: Gain knowledge on the basic aspects of particle Physics and the fundamental interactions.

Theory:

Unit I: [20 h]

1. Basic Nuclear Properties [5 h]

Nomenclature, Nuclear Size (Electron scattering and Mirror Nuclei), Nuclear Charge, Nuclear Mass, Nuclear Density, Nuclear Spin, Nuclear Magnetic Moment, Nuclear Electric Quadrupole Moment, Parity, Binding Energy, Nuclear Stability, Packing Fraction
[Jain: 1.1, 1.2, 3.1-3.9]

2. Nuclear forces [3 h]

Main characteristics of Nuclear Forces, Meson theory of Nuclear forces, Estimation of the mass of a meson using Heisenberg's Uncertainty Principle, Yukawa potential
[Patel: 8.6] [Ilangovan: 1.9]

3. Liquid drop model of a nucleus [8 h]

Analogy between liquid drop and a nucleus, Assumptions of Liquid Drop Model, Wiezsacker Semi- Empirical Mass Formula, Equation for Mass Parabola for Isobaric Nuclei, Merit and Demerit of Semi-Empirical Mass Formula, Potential Barrier for Fission, Stability Limit against Spontaneous Fission (Bohr and Wheeler Theory for Fission Process), Energetic of Symmetric Fission
[Jain: 4.1-4.4][Patel: 5.5]

4. Nuclear Shell Model **[4 h]**

Experimental basis of Shell Model, Single-Particle Shell Model, Shell Model with Spin-Orbit Coupling, Prediction of ground state spin and parity, Prediction of Magnetic Moment, Prediction of Quadruple moment,

[Jain: 5.1-5.6][Patel: 7.3]

Unit II: **[15 h]**

1. Nuclear Reactions **[2 h]**

Nuclear Reactions, The Balance of mass and energy in Nuclear Reactions(Q-Value), The Q-Equation.

[Patel: 3.2-3.4][Jain: 11.1,11.2]

2. Radioactive decay **[10 h]**

Alpha decay: Magnetic Spectrograph-Velocity and Energy of Alpha Particles, Bragg's Experiment-Range of Alpha Particles, Geiger Law, Geiger-Nuttal Law, Disintegration energy of Spontaneous Alpha-decay, The Alpha Spectra and Fine structure: Short Range and Long-Range Alpha Particles, Alpha Decay Paradox-Barrier Penetration(Qualitative treatment)

[Ilangovan: 3.1-3.1.7] [Patel: 4.2.1- 4.2.3]

Beta Decay: Magnetic Spectrograph-Velocity and Energy of Beta Particles, Origin of Continuous Beta –ray Spectrum and difficulties in understanding it, Pauli's Neutrino Hypothesis. Types of Beta decay, Energies of Beta -decays

[Ilangovan: 3.2.1, 3.2.5][Patel: 4.3.1- 4.3.3][Jain: 8.1]

Gamma Decay: Origin of Gamma Decay, Internal Conversion, Nuclear isomerism, The Absorption of Gamma Rays with Matter, Detection of Gamma rays using G. M. Counter

[Patel: 4.4.1- 4.4.3] [Ilangovan: 3.3.2, 3.3.3, 3.3.5, 3.3.6] [Jain:13.6]

3. Nuclear Energy **[3h]**

Neutron Induced Fission, Asymmetrical Fission-Mass Yield, Energy released in the fission of U-235, Fission Chain Reaction, Principle of a Nuclear Reactor, Neutron cycle in a Thermal Nuclear Reactor (The four factor formula), Principle of a Breeder Reactor.

[Patel: 6.1-6.5, 6.7-6.9]

Unit III: **[10 h]**

4. Elementary Particle Physics **[10 h]**

Classification of Elementary Particles, Particles and Antiparticles, Fundamental Interactions, Quantum Numbers, Conservation Laws, Gell-Mann-Nishijima Formula, Concept of Quark Model, Baryons and Mesons as Bound States of Quarks

[Ilangovan: 11.1, 11.5-11.8, 12.2-12.7][Jain: 15.1-15.3]

Practicals: (Minimum Six)

1. Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc.
2. Determination of Absorption Coefficient using GM counter
3. Verification of Inverse Square Law using GM counter
4. Tutorial on Basic Properties of the Nucleus
5. Tutorial on Liquid Drop Model and Nuclear Shell Model
6. Tutorial on Q-value of Nuclear Reaction, and Radioactive Decays
7. Tutorial on Nuclear Energy
8. Tutorial on Elementary Particle Physics

[Minimum of eight numerical problems to be given to students per tutorial]

References:

1. Jain, V. K., 2015, *Nuclear and Particle Physics*, Ane Books Pvt. Ltd., New Delhi.
2. Patel, S. 2011, *Nuclear Physics: An Introduction*, 2nd Edition. New Age International Limited, New Delhi.
3. Ilangovan, K. 2012, *Nuclear Physics*, MJP Publishers, Chennai.

Additional References:

1. Krane, K. 1987, *Introductory Nuclear Physics*, 3rd Edition. Wiley, New Jersey.
2. Kaplan, I. 1956, *Nuclear Physics*, 3rd Edition, Addison-Wesley, Boston.
3. Beiser, A. 1969, *Perspectives of Modern Physics*, McGraw-Hill Book Company, Singapore.

Web References:

1. https://www.youtube.com/playlist?list=PLF15670EECA944A13
2. http://inside.mines.edu/~kleach/PHGN422/#
3. https://www.youtube.com/watch?v=josqjcH79PE&list=PLbMVogVj5nJRvq-w3zway7k3GzmUDte3a
4. https://www.youtube.com/playlist?list=PL9jo2wQj1WCNPlSEv-Yd3d13_fLiQhCyT
5. https://www.youtube.com/watch?v=2zZ1kv6vlq0
6. https://www.youtube.com/watch?v=kW6rR9H9Vu8
7. https://www.youtube.com/tTDHS64wJkk
8. https://www.youtube.com/F5fFVkYJ_Rs
9. https://www.youtube.com/eDCDrRzHGuE

Course Title : **Introduction to Materials Science**

Course Code : **PHY-E16**

Marks : **75 (Theory) + 25 (Practical)**

Credits : **3 (Theory) + 1 (Practical)**

Pre-requisite : **Quantum Mechanics (PHY-IV.C-6), Solid State Physics (PHY-E9)**

Course Objectives : To acquaint students with fundamentals of materials science and study the properties and applications of materials.

Course Learning Outcomes: At the end of this course, students will be able to:
CLO1: Describe the different types of crystal structures of solid materials.
CLO2: Identify and describe the defects and imperfections in solids and their effects on the properties of materials.
CLO3: Apply the knowledge of electrical properties of materials to solve problems related to their applications.
CLO4: Understand diffusion mechanism and apply it to solve problems related to materials processing and analysis.
CLO5: Identify and describe the different types of ceramics and their applications.
CLO6: Understand the concept of polymers and their importance in various applications.

Theory:

Unit I: **[15 h]**

1. **Structure of Crystalline Solids** **[8 h]**
   Introduction, metallic crystal structures: the face centered cubic crystal structure, the body centered cubic crystal structure, the hexagonal close-packed crystal structure, density computations, atomic arrangements, linear and planar densities, close-packed crystal structures, polymorphism and allotropy, ceramic crystal structures: radius ratio rules, AX-type crystal structures, A_MX_P-type crystal structures, $A_MB_NX_P$-type crystal structures, crystal structures from close packing of anions, ceramic density computations, silicate ceramics, carbon, polymer structures: polymer crystallinity, polymer crystals, x-ray diffraction: determination of crystal structures.
   [Callister: 4.1 – 4.20]

2. **Imperfections in Solids** **[7 h]**
   Introduction, point defects: vacancies and self-interstitials, impurities in solids, specification of composition, imperfections in ceramics, miscellaneous imperfections: dislocations-linear defects, interfacial defects, bulk or volume defects, atomic vibrations,

defects in polymers, microscopic examination: microscopic techniques, grain size determination.

[Callister: 5.1 – 5.13]

Unit II: **[15 h]**

1. **Electrical properties of materials** **[7 h]**

   Thermoelectric effects, the Hall effect, Dielectric Materials, Ferroelectricity, Pyroelectricity, Piezoelectricity, Relationship between Ferro-, Piezo- and Pyroelectricity, Applications of Ferro-, Piezo- and Pyroelectrics.

   [West: 15.1 – 15.8]

2. **Diffusion** **[8 h]**

   Introduction, diffusion mechanisms, steady-state diffusion, nonsteady-state diffusion, factors that influence diffusion, diffusion in ionic materials, diffusion in polymeric materials.

   [Callister: 6.1 – 6.8]

Unit III: **[15 h]**

3. **Applications and Properties of Ceramics** **[8 h]**

   Introduction, types and applications of ceramics: glasses, Glass-ceramics, clay products, refractories, abrasives, cements, advanced ceramics, mechanical properties: brittle fracture of ceramics, stress-strain behavior, mechanism of plastic deformations, miscellaneous mechanical considerations, glass properties, heat treatment of glasses, heat treatment of glass ceramics.

   [Callister: 12.1 – 12.8, 12.10 – 12.16]

4. **Structures of Polymers** **[7 h]**

   Introduction, hydrocarbon molecules, polymer molecules, the chemistry of polymer molecules, molecular weight, molecular shape, molecular structure, molecular configurations, thermoplastic and thermosetting polymers, copolymers.

   [Callister: 13.1 –13.10]

Practicals: (Minimum Six)

1. Grain size estimation using XRD.
2. Determination of density of materials.
3. Analysis of surface morphology using SEM/TEM
4. Determination of compressibility of liquids using crystal oscillator.
5. To study the corrosion of metals with the help of galvanic cells.
6. Thermal diffusivity of brass.
7. Thermal conductivity of a poor conductor.
8. Specific heat of graphite.
9. Measurement of ionic conductivity of solutions as a function of temperature and concentration.

References:

1. Callister W. D., 2015, *Materials Science and Engineering* 2nd Ed., John Wiley and Sons, New Jersey, USA
2. West A. R.., 2014, *Solid State Chemistry and its Applications*, John Wiley and Sons, New Jersey, USA

Additional Reference:

1. Kittel C., 2015, *Introduction to Solid State Physics*, 8th Edition, John Wiley and Sons, New Jersey, USA.

Web References:

1. https://nptel.ac.in/courses/113/102/113102080/
2. http://kaizenha.com/wp-content/uploads/2016/04/Materials-Textbook-8th-Edition.pdf
3. https://www.edx.org/learn/materials-science
4. https://www.coursera.org/courses?query=material%20science
5. https://ocw.mit.edu/courses/materials-science-and-engineering/3-012-fundamentals-of-materials-science-fall-2005/lecture-notes/
6. http://www.nptelvideos.in/2012/11/materials-science.html
7. https://www.digimat.in/nptel/courses/video/113107078/L01.html

Revised Course Learning Outcomes Semesters IV and VI

Sr. No.	Course Code	Course Title	Course Outcomes At the end of this course students will be able to:
1	**PHY-II.C-3** (To be offered from the academic year 2024-25)	**Heat and Thermodynamics**	**CLO1:** Understand different types of temperature scales and relationship between different scales of temperature. **CLO2:** Relate the effects of changes in temperature, pressure and volume on physical systems at macroscopic scale by analyzing collective motion of their particles. **CLO3:** Comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work. **CLO4:** Comprehend the second law of thermodynamics to depict the manner in which thermodynamic changes take place. **CLO5:** Use laws of thermodynamics to understand the working of engines, refrigerators and air conditioners. **CLO6:** Comprehend the concept of entropy and calculate the change in entropy when the matter is heated/cooled or when the matter undergoes change in phase.
2	**PHY-IV.C-6**	**Quantum Mechanics**	**CLO1:** understand the principles in quantum mechanics, such as the Schrödinger equation, the wave function and its statistical interpretation. **CLO2:** solve the Schrödinger equation for potentials in one and three dimension and interpretate the solutions. **CLO3:** grasp the concepts of angular momentum and spin. **CLO4:** have an insight into fundamental issues in quantum mechanics like the EPR paradox, Bells theorem and Schrödinger's cat **CLO5:** develop an understanding of why both analytic and numerical solutions are important in quantum mechanics. **CLO6:** use numerical tools and software to solve the Schrodinger equation for complex problems.

3	**PHY-E5**	**Electronics-I**	**CLO1:** Understand the fundamentals of semiconductor behaviour and the operation of basic semiconductor devices. **CLO2:** Understand basic circuit laws; semiconductor based analog circuits. **CLO3:** Use this knowledge to describe bipolar transistors and its applications. **CLO4:** Understand and apply the concept of feedback in operational amplifier and sinusoidal oscillators.
4	**PHY-E4**	**Properties of Matter and Acoustics**	**CLO1:** Gain an introductory knowledge of dynamics of rigid bodies, and its applications to basic physical problems. **CLO2:** Familiarize with of acoustics of rooms and musical scales. **CLO3:** Explain the concept of elasticity, including its various types and its applications. **CLO4**: Explain the concept of surface tension, analyse and explain the role of surface tension in various natural phenomena such as capillary action. **CLO5:** Interpret the concept of viscosity and its applications, describe the properties of fluids that determine their viscosity.
5	**PHY-E7**	**Computational Physics**	**CLO1:** Understand various numerical methods **CLO2:** Use FORTRAN language for numerical calculations. **CLO3:** Understand various concepts of Physics using numerical methods using FORTRAN as a programming language. **CLO4:** Understand least square fitting using computation.
6	**PHY-E13**	**Mechanics – II**	**CLO1:** Analyze two body problem by separating into two equivalent single body problems **CLO2:** Obtain equation of orbit for the motion under inverse square law force and study different types of orbits. **CLO3:** Relate time derivative of a vector in a fixed frame of reference to that of moving frame of reference. **CLO4:** Comprehend the occurrence of some pseudo forces such as Coriolis's force, centrifugal force due to relative motion of the

			particle in the fixed frame and rotating frames of reference. **CLO5:** Derive and solve Euler's equations of motion to understand the motion of rigid bodies. **CLO6:** Apply D'Alembert's principle to obtains LaGrange's equation of motion. **CLO7:** Comprehend the advantages of Lagrangian formulation over Newtonian formulation by solving various mechanical problems.
7	**PHY-E14**	**Nuclear and Elementary Particle Physics**	**Course Learning Outcomes**: After successful completion of this course, student will be able to: **CLO1:** Learn the ground state properties of a nucleus. **CLO2:** Gain knowledge on basic concept of nuclear force and Meson theory of nuclear force. **CLO3**: Know about the liquid drop model and shell model to understand nuclear properties. **CLO4:** Learn the basic aspects of nuclear reactions. **CLO5**: Learn about the principles and basic constructions of nuclear reactor. **CLO6:** Gain knowledge on the basic aspects of particle Physics and the fundamental interactions.
8	**PHY-E16**	**Introduction to Materials Science**	**CLO1:** Describe the different types of crystal structures of solid materials. **CLO2:** Identify and describe the defects and imperfections in solids and their effects on the properties of materials. **CLO3:** Apply the knowledge of electrical properties of materials to solve problems related to their applications. **CLO4:** Understand diffusion mechanism and apply it to solve problems related to materials processing and analysis. **CLO5:** Identify and describe the different types of ceramics and their applications. **CLO6:** Understand the concept of polymers and their importance in various applications.

Annexure C (only SY; TY and PG Part2 courses)

(Summary of changes incorporated in the syllabus)

Semester	Course Title	Existing (Indicate only the unit where the change is proposed)	Changes Proposed	Specify the reason for the change
IV	**Quantum Mechanics**	**Course Learning Outcomes:** At the end of this course students will be able to: **CLO1:** understand ~~central concepts and~~ principles in quantum mechanics, such as the Schrödinger equation, the wave function and its statistical interpretation~~, the uncertainty principle, stationary and non-stationary states, time evolution of solutions.~~ **CLO2:** solve the Schrödinger equation ~~to obtain wave functions~~ for ~~some important types of~~ potentials in one and three dimension and interpretate the solutions. ~~and give concise physical interpretations and reasoning underlying the mathematical results.~~	**Course Learning Outcomes:** At the end of this course students will be able to: **CLO1:** understand principles in quantum mechanics, such as the Schrödinger equation, the wave function and its statistical interpretation~~.~~ **CLO2:** solve the Schrödinger equation potentials in one and three dimension and interpretate the solutions. **CLO5:** develop an understanding of why both analytic and numerical solutions are important in quantum mechanics. **CLO6:** use numerical tools and software to	Reframing of sentences as per suggestions by the BoS members

		CLO5: develop an understanding of why both analytic and numerical solutions are important in quantum mechanics. ~~and have acquired experience in using both types of methods on quantum mechanical problems~~ **CLO6:** use numerical tools and software to solve the Schrodinger equation for ~~more~~ complex problems. ~~complicated cases.~~	solve the Schrodinger equation for complex problems.	
IV (To be offered from the academic year 2024-25)	**Heat and Thermodynamics**	**Course Learning Outcomes**: At the end of this course students will be able to: ~~**CLO1:** Understand different types of temperature scales and relationship between different scales of temperature.~~ ~~**CLO2:** Able to relate the effects of changes in temperature, pressure and volume on physical systems at macroscopic scale by analyzing collective motion of their particles.~~ ~~**CLO3:** Able to comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work.~~ ~~**CLO4:** Able to comprehend the second law of thermodynamics to depict the manner in which thermodynamic changes take place.~~	**Course Learning Outcomes**: At the end of this course students will be able to: **CLO1:** Understand different types of temperature scales and relationship between different scales of temperature. **CLO2:** Relate the effects of changes in temperature, pressure and volume on physical systems at macroscopic scale by analyzing collective motion of their particles. **CLO3:** Comprehend the first law of thermodynamics to represent the relationship between heat and mechanical work. **CLO4:** Comprehend the second law of thermodynamics to	Reframing of sentences

		~~**CLO5:** Explain the usefulness of these concepts for wide range of applications that include heat engines, refrigerators and air conditioners.~~ ~~**CLO6:** Calculate change in entropy in matter during change in phase.~~	depict the manner in which thermodynamic changes take place. **CLO5:** Use laws of thermodynamics to understand the working of engines, refrigerators and air conditioners. **CLO6:** Comprehend the concept of entropy and calculate the change in entropy when the matter is heated/cooled or when the matter undergoes change in phase.	
IV	**Electronics-I**	**Course Learning Outcomes**: At the end of this course students will be able to: **CLO2:** Understand basic circuit laws; semiconductor based analog circuits. ~~from a fundamental point of view.~~ **CLO4:** Understand and apply the concept of feedback ~~to study~~ in operational amplifier and sinusoidal oscillators.	**Course Learning Outcomes**: At the end of this course students will be able to: **CLO2:** Understand basic circuit laws; semiconductor based analog circuits. **CLO4:** Understand and apply the concept of feedback in operational amplifier and sinusoidal oscillators.	Reframing of sentences as per suggestions by the BoS members
IV	**Properties of Matter and Acoustics**	**Course Learning Outcomes**: At the end of this course students will be able to: ~~**CLO3:** Comprehend the phenomenon of elasticity, surface tension, viscosity and their application.~~	**Course Learning Outcomes**: At the end of this course students will be able to: **CLO3:** Explain the concept of elasticity, including its various types and its applications. **CLO4**: Explain the concept of surface tension, analyse and explain the role of surface tension in various natural	Reframing of sentences as per suggestions by the BoS members

			phenomena such as capillary action. **CLO5:** Interpret the concept of viscosity and its applications, describe the properties of fluids that determine their viscosity.	
IV	**Computational Physics**	**Course Learning Outcomes**: At the end of this course students will be able to: ~~**CLO4:** Solve problems in Physics by numerical methods using FORTRAN as a programming language.~~	**Course Learning Outcomes**: At the end of this course students will be able to: **CLO4:** Understand least square fitting using computation.	
VI	**Mechanics – II**	**Course Learning Outcomes**: At the end of this course students will be able to: ~~**CLO1:** Separate two body problem into two equivalent single body problems~~ ~~**CLO2:** Establish equation of orbit for the motion under inverse square law force and study different types of orbits.~~ ~~**CLO3:** Establish the relation between time derivative of a vector in a fixed frame of reference with respect to moving frame of reference.~~ ~~**CLO4:** Comprehend the occurrence of some pseudo forces due to relative motion between frames of references such as Coriolis's force, centrifugal force~~	**Course Learning Outcomes**: At the end of this course students will be able to: **CLO1:** Analyze two body problem by separating into two equivalent single body problems **CLO2:** Obtain equation of orbit for the motion under inverse square law force and study different types of orbits. **CLO3:** Relate time derivative of a vector in a fixed frame of reference to that of moving frame of reference. **CLO4:** Comprehend the occurrence of some pseudo forces such as Coriolis's force,	Reframing of sentences

		~~**CLO5:** Understand the motion of rigid bodies by solving Euler's equations of motion.~~ ~~**CLO6:** Understand the advantages of Lagrangian formulation over Newtonian formulation.~~ ~~**CLO7:** Solve various mechanical problems using Lagrangian equation of motion.~~	centrifugal force due to relative motion of the particle in the fixed frame and rotating frames of reference. **CLO5:** Derive and solve Euler's equations of motion to understand the motion of rigid bodies. **CLO6:** Apply D'Alembert's principle to obtains LaGrange's equation of motion. **CLO7:** Comprehend the advantages of Lagrangian formulation over Newtonian formulation by solving various mechanical problems.	
VI	**Nuclear and Elementary Particle Physics**	**Course Learning Outcomes:** After successful completion of this course, student will be able to: **CLO1**: Learn the ground state properties of a nucleus – the constituents and their properties, mass number and atomic number, relation between the mass number and the radius and the mass number, average density, range of force, saturation property, stability curve, the concepts of packing fraction and binding energy, binding energy per nucleon vs. mass number graph, explanation of fusion and fission from the nature of the binding energy graph. **CLO2**: Gain knowledge on basic concept of nuclear force	**Course Learning Outcomes**: After successful completion of this course, student will be able to: **CLO1:** Learn the ground state properties of a nucleus. **CLO2:** Gain knowledge on basic concept of nuclear force and Meson theory of nuclear force. **CLO3**: Know about the liquid drop model and shell model to understand nuclear properties. **CLO4:** Learn the basic aspects of nuclear reactions. **CLO5**: Learn about the principles and basic constructions of nuclear reactor.	Reframing of sentences as per suggestions by the BoS members

		and Meson theory of nuclear force **CLO3**: Learn the basic aspects of nuclear reactions, the Q-value of such reaction and its derivation from conservation laws. **CLO4**: Know about the liquid drop model, its justification so far as the nuclear properties are concerned, the semi-empirical mass formula. **CLO5**: Know about the shell model, evidence of shell structure, magic numbers, predictions of ground state spin and parity, theoretical deduction of the shell structure, consistency of the shell structure with the Pauli exclusion principles. **CLO6**: Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays, the properties of the constituents of these rays and the mechanisms of the emissions of these rays, outlines of Gamow's theory of alpha decay and Pauli's theory of beta decay with the neutrino hypothesis, the electron capture, the fine structure of alpha particle spectrum, the Geiger-Nuttall law, the radioactive series. **CLO7**: Learn about the principles and basic constructions of nuclear reactor and the reactor facilities available in India. **CLO8**: Gain knowledge on the basic aspects of particle Physics – the fundamental	**CLO6:** Gain knowledge on the basic aspects of particle Physics and the fundamental interactions.	

		interactions, elementary and composite particles, the classifications of particles: leptons, hadrons (baryons and mesons), quarks, gauge bosons. The students should know about the quantum numbers of particles: isospin, electric charge, strangeness, lepton numbers, baryon number and the conservation laws associated with them. **CLO9:** Solve numerical problems, relating theoretical predictions and experimental measurements, in nuclear and particle physics.		
VI	**Introduction to Materials Science**	**Course Learning Outcomes:** At the end of this course, students will be able to: ~~**CLO1:** Understand the fundamentals of materials science.~~ ~~**CLO2:** Understand the properties and applications of materials.~~ ~~**CLO3:** Investigate the relationship that exists between the structures and properties of materials.~~	**Course Learning Outcomes:** At the end of this course, students will be able to: **CLO1:** Describe the different types of crystal structures of solid materials. **CLO2:** Identify and describe the defects and imperfections in solids and their effects on the properties of materials. **CLO3:** Apply the knowledge of electrical properties of materials to solve problems related to their applications. **CLO4:** Understand diffusion mechanism and apply it to solve problems related to materials processing and analysis.	Reframing of sentences as per suggestions by the BoS members

			CLO5: Identify and describe the different types of ceramics and their applications. **CLO6:** Understand the concept of polymers and their importance in various applications.	