Department of Physics

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Syllabus for Four Year Under Graduate Programme (FYUGP) in Physics of Rabindranath Tagore University

as per NEP-2020 Guidelines

Preamble

The National Education Policy (NEP 2020) is a ground breaking initiative approved by the Union Cabinet of India on 29th July 2020. Its central aim is to overhaul the antiquated education system and achieve the ambitious aspirations of modern education in the 21st century. The NEP 2020 envisions a transformative shift towards holistic and multidisciplinary undergraduate education, which can produce versatile, reflective, and inventive individuals. With a commitment to realizing the objectives of the NEP 2020, the Rabindranath Tagore University, Hojai, launched the implementation process by the last part of 2022. The process began with the publication of a general program structure for the Four Year Undergraduate Programme (FYUGP) for all disciplines, in accordance with the UGC's FYUGP Curriculum and Credit Framework, by January 2023. This syllabus intends to provide students with a comprehensive understanding of the discipline, enable them to have critical thinking and problem-solving skills, and equip them to tackle the demands and prospects of the 21st century.

Introduction

The NEP-2020 presents a unique opportunity to revolutionize the higher education system in India by shifting the focus from teachers to students. This policy promotes Outcome-Based Education, where the desired graduate attributes serve as the foundation for designing programs, courses, and supplementary activities that enable students to achieve the desired learning outcomes. The curriculum framework for the FYUGP in Physics aims to provide a strong foundation in the subject and equip students with valuable cognitive abilities and skills necessary for success in diverse professional careers in a developing and knowledge-based society. The framework adheres to globally competitive standards of knowledge and skills in Physics while emphasizing the development of scientific orientation, an enquiring spirit, problem-solving skills, and values that promote rational and critical thinking.

The FYUGP in Physics offered by Rabindranath Tagore University is acomprehensive and challenging curriculum that aims to provide students with a strong foundation in the discipline while exposing them to cutting-edge developments in the field. The program's structure is multidisciplinary, allowing students to explore the intersections between physics and other fields of study. This approach provides students with a broader perspective and helps them understand the interconnectedness of various areas of knowledge. The program also aims to promote students' personal and professional growth by motivating them to engage in co-curricular and extracurricular activities, which will help them to develop essential skills like leadership, teamwork, and communication.

The program syllabus is designed to promote critical thinking, develop problem-solving abilities, and encourage creativity. It includes laboratory work and practical exercises that give students the opportunity to apply theoretical concepts to real-world problems and enhance their scientific skills. The program also emphasizes the importance of ethics, social responsibility, and sustainable development, instilling in students a sense of responsibility towards society and the environment.

The FYUGP program in Physics at Rabindranath Tagore University is designed to prepare students for the challenges and opportunities of the 21st century. The program's multidisciplinary and holistic approach equips students with the skills and knowledge necessary for success in a rapidly changing world. Its commitment to social responsibility and sustainable development reflects its mission to produce not only accomplished physicists but also responsible and ethical global citizens.

The NEP 2020 promotes multidisciplinary education in the undergraduate program that integrates social sciences, arts and humanities with science, technology, engineering and mathematics. For holistic development of individuals it requires to develop all capacities of human beings including intellectual, social, physical, emotional and moral behavior. Individuals should be acquainted in fields across the arts, humanities, languages, sciences and social sciences; professional, technical and vocational fields; soft skills, such as communication, discussion and debate etc.. In order to develop such holistic and multidisciplinary education, the curriculum and credit framework for the FYUGP in Physics are designed accordingly. The FYUGP in Physics consists of six different types of courses- (i) Core courses, (ii) Minor courses, (iii) Generic elective courses (GEC), (iv) Ability enhancement courses (AEC), (v) Value added courses (VAC) and (vi) Skill enhancement courses (SEC).

As per NEP's recommendations the FYUGP in Physics also features multiple exit options-

1. A certificate after completing 1 year of study
2. A diploma after completing 2 years of study
3. A Bachelor's degree after completion of a 3-year programme
4. A 4-year multidisciplinary Bachelor's degree

Aims and Objectives

The goals and objectives of FYUGP should aim to:

1. Establish an environment in all educational institutions that consolidates the knowledge obtained at the secondary level and inspires students to develop a profound interest in Physics, acquire a broad and balanced understanding of physical concepts, principles, and theories of Physics.
2. Learn, design, and conduct experiments in laboratories to demonstrate the concepts, principles, and theories learned in the classroom.
3. Develop the ability to apply the knowledge gained in the classroom and laboratories to specific problems in theoretical and experimental Physics.
4. Expose students to the vast scope of Physics as a theoretical and experimental science with applications in solving most of the problems in nature, spanning from infrared to ultraviolet regimes.
5. Emphasize Physics as the most critical branch of science to pursue interdisciplinary and multidisciplinary higher education and research in interdisciplinary and multidisciplinary areas.
6. Emphasize the importance of Physics as the most critical discipline for sustaining existing industries and establishing new ones, creating job opportunities at all employment level.

The proposed curriculum should enable students to acquire knowledge and skills necessary to solve problems progressively from novice problem solvers at entry level to expert problem solvers at graduation. Specifically, by the end of the first year, students should have the ability to solve well-defined problems, while at the end of the second year, they should be able to solve broadly defined problems. By the end of the third year, they should be able to solve complex problems that are ill-structured, requiring multidisciplinary skills to solve them. During the fourth year, students should gain experience in workplace problem solving in the form of internships, research experience to prepare for higher education, or entrepreneurship experience.

Graduate Attributes

Graduates in Physics are expected to possess a range of attributes that will enable them to succeed in their chosen careers. The NEP 2020 recognizes the importance of these attributes and aims to equip students with the necessary knowledge and skills to excel in their chosen careers. Some of such attributes connected to FYUGP are:

1. Disciplinary knowledge and skills: Graduates in Physics should possess a strong foundation in the concepts and principles of Physics, as well as the ability to apply this knowledge to solve complex problems.
2. Skilled communication: Physics graduates should be able to effectively communicate their ideas and findings through oral, written, and visual means to a diverse audience, including scientists, policymakers, and the general public.
3. Critical thinking and problem-solving capacity: Physics graduates should be able to analyze and evaluate information, identify and define problems, develop and implement solutions, and make evidence-based decisions.
4. Sense of inquiry: Physics graduates should have a curiosity-driven and self-directed approach to learning, as well as the ability to ask insightful questions and explore new areas of knowledge.
5. Team player/worker: Physics graduates should be able to collaborate effectively with others, including peers, colleagues, and interdisciplinary teams, to achieve common goals.
6. Project management skills: Physics graduates should have the ability to plan, organize, and manage projects, including research projects, from conception to completion.
7. Digital and ICT efficiency: Physics graduates should be proficient in the use of digital tools and information and communication technologies (ICT), including programming languages, simulation software, and data analysis tools.
8. Ethical awareness/reasoning: Physics graduates should have a strong ethical awareness and the ability to apply ethical reasoning in decision-making, including consideration of social, cultural, and environmental impacts.
9. National and international perspective: Physics graduates should be aware of the global and national issues related to science and technology, as well as their roles and responsibilities as global citizens.
10. Computational and problem-solving skills: Physics graduates should have strong computational skills and the ability to use computational tools and techniques for problem- solving and data analysis.

Programme Learning Outcomes

The NEP 2020 has placed significant emphasis on outcome-based education, which highlights the importance of specific learning outcomes for each course. For the FYUGP in Physics, NEP 2020 has set forth a set of programme learning outcomes, which include:

Knowledge and Comprehension: Students will be able to demonstrate a thorough understanding of fundamental principles and concepts of physics, including classical mechanics, electromagnetism, thermodynamics, quantum mechanics, and statistical mechanics.

Analytical and Problem-Solving Abilities: Students will have the ability to apply their knowledge of physics to analyze and resolve problems in various settings, using appropriate mathematical tools, experimental methods, and computational techniques.

Research and Inquiry Skills: Students will possess the ability to participate in research and inquiry- based activities, such as creating and executing experiments, collecting and evaluating data, and communicating their findings in a clear and effective manner.

Communication and Presentation Skills: Students will be able to express their ideas and discoveries effectively through both written and oral presentations, utilizing suitable scientific language and tools.

Ethics and Values: Students will possess knowledge of the ethical and social implications of their work and demonstrate a dedication to the ethical and responsible conduct of research and practice.

Interdisciplinary and Multidisciplinary Learning: Students will be capable of combining their understanding and skills with other disciplines and participating in multidisciplinary research andinnovation.

These programme learning outcomes have been formulated to ensure that students acquire a strong basis in physics while also developing a range of transferable skills and abilities that will equipthem for a diverse range of professions and further studies. By implementing an outcome-based approach and emphasizing learner-centric pedagogies, students will be able to meet these objectives and satisfy the ever-changing job market's demands.

The NEP 2020 emphasizes the importance of outcome-based education, which focuses on specific learning outcomes for each course. The NEP 2020 also provides multiple exit options for students after completion of different durations of study. The program learning outcomes for each exitoption are as follows:

Certificate (after completing 1 year of study):

1. Demonstrate a basic understanding of fundamental concepts and principles related to thechosen field of study.
2. Develop a basic set of skills and competencies related to the chosen field of study.
3. Demonstrate an ability to apply the basic knowledge and skills acquired to real-world problems.

Diploma (after completing 2 years of study):

1. Demonstrate a deeper understanding of the fundamental concepts and principles related to thechosen field of study.
2. Develop a more advanced set of skills and competencies related to the chosen field of study.
3. Demonstrate an ability to apply the advanced knowledge and skills acquired to real-worldproblems.

Bachelor's Degree (after completing a 3-year programme):

1. Demonstrate a comprehensive understanding of the fundamental concepts and principles related to the chosen field of study.
2. Develop a wide range of skills and competencies related to the chosen field of study.
3. Demonstrate an ability to apply the knowledge and skills acquired to real-world problems in acreative and innovative manner.
4. Demonstrate an ability to engage in independent research and inquiry-based activities.
5. Develop effective communication and presentation skills.
6. Demonstrate an awareness of the ethical and social implications of their work and a commitment to ethical and responsible conduct.

4-Year Multidisciplinary Bachelor's Degree (the preferred option):

1. All the learning outcomes mentioned for the Bachelor's Degree (after completing a 3-year programme).
2. Develop a multidisciplinary perspective and an ability to integrate knowledge and skills frommultiple disciplines.
3. Demonstrate an ability to engage in multidisciplinary research and innovation.
4. Develop leadership and teamwork skills.
5. Demonstrate an ability to adapt to the ever-changing demands of the job market and the society.

Teaching-Learning Process

The NEP 2020 has brought about a revolutionary change in the education system in India. One of its major focuses is on outcome-based education, which involves a shift from teacher-centric to learner-centric pedagogies and from passive to active pedagogies. This change requires a significant shift in the way teaching and learning are approached. The NEP 2020 emphasizes that each and every course has to be designed with specific objectives and outcomes in mind. To achieve these goals, appropriate teaching-learning pedagogical tools have to be adopted.

The pedagogy for FYUGP in Physics is based on the **L+T+P** model where **L**, **T**, and **P** stand for Lecture, Tutorial, and Practical respectively. This approach recognizes the importance of a well- rounded education that includes theoretical knowledge, practical experience, and personal development.

The teaching method for a theory course includes lectures that are aided with prescribed textbooks, e-learning resources, and self-study materials. The lectures are designed to provide a comprehensive understanding of the subject matter. The use of e-learning resources and self-study materials helps students to learn at their own pace and to reinforce their understanding of the material covered in the lectures.

In addition to lectures, tutorials are also an important part of the pedagogy for FYUGP in Physics. Tutorials are interactive sessions where students can ask questions, clarify their doubts, and engage in discussions with their peers and teachers. Tutorials are designed to encourage activelearning and to promote critical thinking.

To understand the link between theory and experiments, laboratory courses are designed which include practical classes. This approach recognizes that practical experience is essential for a comprehensive understanding of the subject matter. The laboratory courses are designed to provide hands-on experience to students and to help them develop the necessary skills for conducting experiments.

The pedagogy for FYUGP in Physics recognizes the importance of a holistic approach to education. It is not just about acquiring knowledge, but also about developing the necessary skills and competencies to succeed in the real world. The outcome-based approach emphasizes the importance of developing critical thinking skills, problem-solving skills, communication skills, and teamwork skills.

In conclusion, the NEP 2020 has brought about a significant shift in the education system in India. The focus on outcome-based education and learner-centric pedagogies has led to a more holistic approach to education. The pedagogy for FYUGP in Physics is based on the L+T+P model and emphasizes the importance of lectures, tutorials, and practical classes. The use of appropriate teaching-learning pedagogical tools and assessment methods is an integral part of the approach. The outcome-based approach recognizes that education is not just about acquiring knowledge, but also about developing the necessary skills and competencies to succeed in the real world.

Assessment Methods

The outcome-based education emphasizes the importance of measuring the learning outcomes of students. Assessment is an integral part of the pedagogy for FYUGP in Physics. The assessment methods used are designed to evaluate the understanding of the subject matter, the ability to apply theoretical knowledge to practical situations, and the development of critical thinking skills.

All the Core and Minor courses of the FYUGP in Physics are designed with 4 credits, while those of Generic Elective and Skill Enhancement courses (GEC and SEC) are 3-credit courses. The entire assessment of a 3-credit / 4-credit course will be performed over a total of 100 marks, out of which 80 marks is allotted to an End-semester examination and the rest of 20 marks is assigned to an In-semester assessment. The total of 80 marks in the End-semester examination for a particular course is distributed over different units as per corresponding weightage and content of the unit. The question paper should contain short answer type questions, problem solving questions and descriptive type questions. The In-semester evaluation should be done in a continuous mode throughout the semester. It could be done through class tests, internal examinations, homework assignment, regularity and attendance, classroom interaction, quiz, powerpoint presentation etc.. Half of the total 20 marks of the In-semester assessment is assigned to an internal examination and the remaining 10 marks are to be evaluated on the basis of homework assignment / attendance / classroom interaction /quiz / power-point presentation etc.

Course Structure

Year	Semester	Course	Title of the Course	Total Credits
Year 01	1st Sem	**Core - 1**	Mechanics and Properties of Matter	4
		Minor 1	Mechanics (for disciplines other than Physics)	4
		GEC - 1	Evolution of Science / Introduction to Communication Technology	3
		AEC - 1	Modern Indian Language	4
		VAC - 1	Understanding India	2
		VAC - 2	Health and Wellness	2
		SEC - 1	Solar Energy	3
			Total of Semester 1	**22**
	2nd Sem	**Core - 2**	Waves and Optics	4
		Minor 2	Waves and Optics (for disciplines other than Physics)	4
		GEC - 2	Materials Today / Digital and Space Technologies	3
		AEC - 2	English Language and Communication Skills	4
		VAC - 3	Environmental Science	2
		VAC - 4	Yoga Education	2
		SEC - 2	Basic Instrumentation Skills	3
			Total of Semester 2	**22**
		Grand Total (Semester 1 and Semester 2)		**44**

Students on exit shall be awarded Undergraduate Certificate (in the field of study/ discipline) after securing the requisite 44 credits in Sem 1 and 2 provided they secure 4 credits in work based vocational courses offered during summer term or internship/ apprenticeship in addition to 6 credits from skill based courses earned during 1st and 2nd Semester				
		Core - 3	Mathematical Physics I	4
		Core- 4	General Lab I	4

Year 02	**3rd Sem**	**Minor 3**	General Lab I (for disciplines other than Physics)	4
		GEC - 3	The Universe / Atmosphere of the Earth	3
		AEC - 3	Communicative English / Mathematical Ability	2
		VAC - 5	Digital and Technological Solutions / Digital Fluency	2
		SEC - 3	Computational Physics Skills / Renewable Energy and Energy harvesting	3
			Total of Semester 3	**22**
	4th Sem	**Core - 5**	Electricity and Magnetism	4
		Core - 6	Thermal Physics	4
		Core - 7	Elements of Modern Physics	4
		Core - 8	General Lab II	4
		Minor 4	Electricity and Magnetism (for disciplines other than Physics)	4
			Community engagement (NCC / NSS / Adult Education / Student mentoring / NGO / Govt. institutions, etc.)	2
			Total of Semester 4	**22**
	Grand Total (Semester 1 to Semester 4)			**88**

Students on exit shall be awarded Undergraduate Diploma (in the field of study/ discipline) after securing the requisite 88 credits on completion of Sem 4 provided they secure additional 4 credit inskill based

vocational course offered during 1st year or 2nd year summer term.

	5th Sem	**Core - 9**	Mathematical Physics II	4
		Core - 10	Quantum Mechanics I	4
		Core - 11	Statistical Mechanics	4
		Core - 12	Computation Lab	4

Year 03		**Minor 5**	Thermal Physics	4
			Internship	2
			Total of Semester 5	**22**
	6th Sem	**Core - 13**	Electromagnetic Theory	4
		Core - 14	Solid State Physics I	4
		Core - 15	Electronics I	4
		Core - 16	General Lab III	4
		Minor - 6	General Lab II	4
			Project	2
			Total of Semester 6	**22**
	Grand Total (Semester 1 to Semester 6)			**132**

Students on exit shall be awarded Bachelor of (in the field of study/ discipline) Honours (3 years)after securing the requisite 132 credits on completion of Semester 6.

Year 4	**Sem 7**	**C - 17**	Mathematical Physics III	4
		C - 18	Classical Mechanics	4
		C - 19	Quantum Mechanics II	4
		Minor - 7	Elements of Modern Physics	4
			Research Ethics and Methodology	4
			Research Project (Development of Project / Research proposal, Review of related literature) / **DSE Course in lieu of Research Project**	2
			Total of Semester 7	**22**
		C - 20	Electronics II	4

	Sem 8	**C - 21**	Solid State Physics II	4
		C - 22	Atomic and Molecular Physics	4
		Minor 8	Solid State Physics	4
			Dissertation (Collection of Data, Analysis and Preparation of Report) / **DSE Courses in lieu of Dissertation**	6
			Total of Semester 8	**22**
	Grand Total (Semester 1 to Semester 8)			**176**

Detailed Syllabus of 1st Semester Core/Major Courses

Course title: Mechanics and Properties of Matter
Course code: PHYC1
Nature of the course: Core
Total credits: 4 (Th 3,Pr 1)
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives:

(1) To impart the knowledge of Newtonian mechanics and its role in relevant areas.
(2) To impart the knowledge of properties of matter.
(3) To develop the concepts of special theory of relativity.

Unit	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: Newtonian Mechanics	**1.1:** Frames of Reference, Inertial Frames, Galilean Transformations, Galilean Invariance; Dynamics of a System of Particles, Centre of Mass, centre of mass of a half-ring, half-disc and hemisphere. Principle of Conservation of Linear Momentum. Momentum of variable mass: motion of rocket.	7	-	-	10	7
	1.2: The Work-Energy Theorem, Conservative and Non-conservative Forces, Conservation of Mechanical Energy, Work done by non-conservative forces, Force as gradient of potential energy, Energy Diagram.	5	-	-	6	5
	1.3: Principle of Conservation of Angular Momentum, Rotation about a fixed axis, Moment of Inertia, Calculation of Moment of Inertia for rectangular, cylindrical and spherical bodies, Kinetic Energy of Rotation, Motion involving both translation and rotation.	**8**	-	-	12	8
Unit 2: Properties of Matter	2.1: Relation between Elastic constants, Twisting torque on a Cylinder or Wire.	**4**	-	-	5	4
	2.2: Kinematics of Moving Fluids, Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.	**4**	-	-	5	4

Unit 3: Oscillations	Simple Harmonic Motion (SHM) and Oscillations, Differential Equation of SHM and its solution, Kinetic Energy, Potential Energy, Total energy and their time-average values, Damped oscillation, Forced oscillations, Resonance, Power Dissipation and Quality Factor.	8	-	-	12	8
Unit 4: Non-Inertial Systems	Non-inertial Frames and Fictitious Forces, Uniformly Rotating Frame, Laws of Physics in rotating coordinate systems, Centrifugal Force, Coriolis Force and its applications, Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.	8	-	-	10	8
Unit 5: Special Theory of Relativity	Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations, Simultaneity and order of events, Lorentz contraction, Time dilation. Twin paradox. Relativistic Transformation of Velocity, Frequency and Wave- number, Relativistic addition of Velocities, Variation of Mass with Velocity, Mass-energy Equivalence. Relativistic Kinematics, Transformation of Energy and Momentum, Relativistic Doppler effect.	16	-	-	20	16
	Total	**60**	**-**	**-**	**80**	**60**

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Lab Practical (1.1): (Minimum four experiments are to be performed)

1. To determine the Young's modulus of a given material by Searle's apparatus.
2. To determine the Modulus of rigidity of a given wire by static method.
3. To determine the value of 'g' using Bar Pendulum.
4. To determine the value of 'g' using Kater's Pendulum.
5. To determine the Moment of inertia of cylinder about two different axes of symmetry by torsional oscillation method.
6. To determine the height of a building using Sextant device.
7. To measure the length of an object using vernier caliper, screw gauge and spherometer.

Mode of In-semester assessment:

1. One internal examination **(10 Marks)**

2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Course outcomes: At the completion of this course, a student will be able to

1. Understand the basic concepts of mechanics by parallel studies of linear dynamics and rotational dynamics.
2. Understand the basic conservation laws by studying them in various mechanical systems including collisions, oscillations, gravitational systems etc.

3. Analyze simple harmonic oscillators in detail.
4. Understand planetary motions as a central force problem.
5. Understand the concept of frame of reference, importance of relative transformations and invariance of laws of Physics.
6. Realize the consequences of a non-inertial frame in our real physical world.
7. Underatand about the peculiar phenomena of special relativity which are not seen in Newtonian relativity.

Recommended readings:

- An introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning.
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Detailed Syllabus of 1st semester Minor Courses

Course Title: Mechanics
Course Code: MINPHY1
Nature of the course: Minor
Total credits: 4 (Theory 3, Practical 1)
Distribution of Marks : 80 (End sem**) + 20 (**In sem**)**

Course objective:

1.To impart the knowledge of Newtonian mechanics and properties of matter.
2.To impart the concepts of special theory of relativity.

Unit	Content	L	T	P	M	Hours
Unit 1: Newtonian Mechanics	1.1:Frames of Reference, Inertial Frames, Galilean Transformations, Galilean Invariance; Dynamics of a System of Particles, Centre of Mass, Principle of Conservation of Linear Momentum. Momentum of variable mass: motion of rocket	6	-	-	6	6
	1.2: The Work-Energy Theorem, Conservative and Non-conservative Forces, Conservation of Mechanical Energy, Work done by non-conservative forces, Force as gradient of potential energy, Energy Diagram.	8	-	-	10	8
	1.3: Principle of Conservation of Angular Momentum, Rotation about a fixed axis, Moment of Inertia, Calculation of Moment of Inertia for rectangular, cylindrical and spherical bodies, Kinetic Energy of Rotation, Motion involving both translation and rotation.	10	-	-	15	10
Unit 2: Properties ofMatter	**2.1:** Relation between Elastic constants, Twisting torque on a Cylinder or Wire.	6	-	-	6	6
	2.2: Kinematics of Moving Fluids, Poiseuille's Equation for Flow of a Liquid through a Capillary Tube	5	-	-	3	5
Unit 3: Oscillations	Simple Harmonic Motion (SHM) and Oscillations, Differential Equation of SHM and its solution, Kinetic	10	-	-	15	10
	Energy, Potential Energy, Total energy and their time-average values, Damped oscillation, Forced oscillations, Resonance, Power Dissipation and Quality Factor.					
Unit 4: Special Theory of Relativity	Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations, Simultaneity and order of events,	15	-	-	25	15

	Lorentz contraction, Time dilation. Relativistic addition of Velocities, Variation of Mass with Velocity, Mass-energy Equivalence.					
	Total	60	-	-	80	60

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Lab Practical (1.1): (Minimum four experiments are to be performed)

1. To determine the Young's modulus of a given material by Searle's apparatus.
2. To determine the Modulus of rigidity of a given wire by static method.
3. To determine the value of 'g' using Bar Pendulum.
4. To determine the value of 'g' using Kater's Pendulum.
5. To determine the Moment of inertia of cylinder about two different axes of symmetry by torsional oscillation method.
6. To determine the height of a building using Sextant device.
7. To measure the length of an object using vernier caliper, screw gauge and spherometer

Mode of In-semester assessment:

1.One internal examination **(10 Marks)**
2.Assignment/Presentation /Attendance /Classroom interaction /Quiz etc. **(10 Marks)**

Course outcomes: At the completion of this course, a student will be able to

1.Understand the basic concepts and ideas in mechanics- e.g. motion, force and torque, mass and moment of inertia, linear and angular momentum, kinetic energy and potential energy etc. by parallel studies of linear dynamics and rotational dynamics.

2.Understand the basic conservation laws by studying them in various mechanical systems including collisions, oscillations, gravitational systems etc.

3.Analyze simple harmonic oscillator in detail.

4.Understand the concept of frame of reference, importance of relative transformations and invariance of laws of Physics.

4.Realize the consequences of a non-inertial frame in our real physical world.

Recommended readings:

1.An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2.Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3.Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4.Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5.Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, PearsonEducation
6.Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
7.Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
8. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Detailed Syllabus of 1st Sem Generic Elective Courses

Option 1

Course title: Evolution of Science
Course code: GECPHY1A
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives:

1. To provide students with an understanding of the historical development of scientific knowledge, including key figures and their contributions.
2. To examine the interdisciplinary nature of science and its impact on various fields and industries.
3. To explore the ethical and social implications of scientific advancements, and to promote critical thinking about their consequences.
4. To foster an appreciation for the scientific method and the role of experimentation and observation in advancing scientific knowledge.

Overall, the course aims to provide students with a comprehensive understanding of the evolution of science, its impact on society, and the role that science will play in shaping the future.

Unit	Content	L	T	P	M	Hours
Unit 1:	Invention of wheel and beginning of science, Science for progress. Science in ancient world Medieval science Renaissance and industrial revolution: Rise of western science Contributions of Aristotle, Galileo Galilei, Robert Hooke, Darwin, Kepler etc. Contributions of Sir Isaac Newton: Laws of motion, Universal law of Gravitation	14	0	0	25	14
Unit 2:	Nineteenth century and beginning of modern science: Developments of electricity and magnetism, Maxwell's contributions, Contributions of Thomas A. Addison.	13	0	0	20	13
Unit 3:	Einstein and Special Theory of Relativity: The paradigm shift. Quantum Theory, Quantum generation, The Second creation: development of concept of field quantisation, ups and downs. Nuclear era: space science and technology. Electronic age and birth of computers. Laser and optical evolution. Contemporary science and India's contribution.	18	0	0	35	18
	Total				**80**	**45**

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Mode of In-semester assessment:

1. One internal examination **(10 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Learning outcomes: At the completion of this course, a student will be able to

1. Understand the development of science from antiquity tothe present era.
2. Comprehend the noteworthy scientific breakthroughs, inventions, and contributions that have paved the way for modern science.
3. Assess the influence of science on human civilization and how scientific progress has positively impacted societal progress.

4. Cultivate a critical mindset to evaluate the significance of scientific contributions and their effect on society.
5. Develop an admiration for the interdisciplinary character of science and its interconnection with other academic disciplines.

Suggested Readings:

a) The Scientific Revolution by Steven Shapin.
b) A history of physics in its elementary branches, including the evolution of physical laboratories by F. Cajori.
c) A brief history of Physics by P. F. Kisak.

Option 2

Course title: Introduction to Communication Technology
Course code: GECPHY1B
Nature of the course: **Generic Elective Course**
Total credits: 3 **Distribution of marks: 80** (End sem) **+ 20** (In-sem)

Course objectives:

(1) To introduce the students with the technologies used in modern communication systems
(2) To make the students familiar with antenna
(3) To discuss the basic idea behind cellular communication, satellite communication etc.

Unit	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1:	What is a communication system, Block diagram of a communication system, Electromagnetic spectrum,Need of modulation, basic ideaof Amplitude Modulation its advantage, disadvantages and application, Frequency modulation, advantages, disadvantages and its application, electromagnetic Spectrum	15	-	-	25	15

Unit 2:	Digital communication, Block diagram of Pulse code modulation and its applications, What is digital modulation, advantages and disadvantages of digital modulation.	5	-	-	12	5
Unit 3:	What is an antenna, Dipole antenna, Yagi antenna, different parameters used in antenna	5	-	-	13	5
Unit 4:	Introduction to microwave, Microwave communication system, advantages and disadvantages. Cellular communication, basic idea of spectrum and technologies used in cellular communication, generations of cellular communications. Introduction to satellite communication, antenna look angles, satellite communication block diagrams and frequency ranges used, Basic principle of GPS. Historical development of optical communication, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, cylindrical fiber, single mode fiber, cutoff wavelength. Optical Fiber materials	20	- -	- -	30	20
	Total	45	-	-	80	45

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Mode of In-semester assessment:

1. One internal examination **(10 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Course outcomes: At the completion of this course, a student will be able to

(1) Understand the role played by communication technologies in the service of society.
(2) Understand a general idea of the working of the underlying technology.

Suggested readings:

- Electronic Communications System: Fundamentals Through Advanced by Wayne Tomasi Pearson Education; 5th edition
- Kennedy's Electronic Communication Systems (SIE) byGeorge Kennedy McGraw Hill Education; Sixth edition
- Principles of Electronic Communication Systems by Louis E. Frenzel McGraw-Hill; Fourth edition
- Optical Fiber Communications by Gerd Keiser, McGraw Hill Education; Fifth edition.

Detailed Syllabus of 1st Sem Skill Enhancement Courses

Course Title: Solar Energy
Course code: SEC1.1
Nature of course: Skill Enhancement Course
Total credits: 3
Distribution of credits: Theory- 2, Practical- 1
Distribution of marks: 60 (End sem) **+ 20** (In sem) **+ 20** (Project)

Unit	Content	L	T	P	M	Hours
UNIT I **Solar Energy**	Solar energy definition, its importance, storage of solar energy,solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	13			12	10
UNIT 2 **Solar Radiation**	Sun as a source of energy, Solar radiation, Solar radiation at the Earth's surface, Measurement of Solar radiation-Pyroheliometer, Pyranometer, Sunshine recorder, Prediction of available solar radiation, Solar energy-Importance, Storage of solar energy, Solar pond.	12			12	10
UNIT 3 **Solar Thermal Systems**	Principle of conversion of solar radiation into heat, Collectors used for solar thermal conversion: Flat plate collectors and Concentrating collectors, Solar Thermal Power Plant, Solar cookers, Solar hot water systems, Solar dryers, Solar Distillation, Solar greenhouses.	12			12	10
UNIT 4 **Solar Photovoltaic Systems**	Conversion of Solar energy into Electricity - Photovoltaic Effect, Solar photovoltaic cell and its working principle, Different types of Solar cells, Series and parallel connections, Photovoltaic applications: Battery chargers, domestic lighting, street lighting and water pumping.	13			14	10
	Total	50			80	50

(L= Lecture, T= Tutorial, P= Practical, M= Marks)
Mode of In-semester assessment:

1. One internal examination **(10 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Activities /Demonstration/Practical /Project:
(Any four of the following are to be performed)
1. Plot sun chart and locate the sun at your location for a given time of the day.
2. Analyse shadow effect on incident solar radiation and find out contributors.
3. Connect solar panels in series & parallel and measure voltage and current.
4. Measure intensity of solar radiation using Pyranometer and radiometers.
5. Construct a solar lantern using Solar PV panel (15W)
6. Assemble solar cooker
7. Desigining and constructing photovoltaic system for a domestic house requiring 5kVA power.
8. To study the V-I characteristics & power curves of solar cells, and find maximum power point & efficiency.

Course Outcomes:
After successful completion of the course, students will be able to:
1. Acquire knowledge on solar radiation principles with respect to solar energy estimation.
2. Get familiarized with various collecting techniques of solar energy and its storage.
3. Learn the solar photovoltaic technology principles and different types of solar cells for energy conversion and different photovoltaic applications.
4. Understand the working principles of several solar appliances like Solar cookers, Solar hot water systems, Solar dryers, Solar Distillation, Solar greenhouses.

Reference Books:
1. Solar Energy Utilization, G. D. Rai, Khanna Publishers
2. Solar Energy- Fundamentals, design, modeling & applications, G.N. Tiwari, Narosa Pub., 2005.
3. Solar Energy-Principles of thermal energy collection & storage, S.P. Sukhatme, Tata McGraw Hill Publishers, 1999.
4. Solar Photovoltaics- Fundamentals, technologies and applications, Chetan Singh Solanki, PHI Learning Pvt. Ltd.
5. Science and Technology of Photovoltaics, P. Jayarama Reddy, BS Publications, 2004.
6. Solar energy, MP Agarwal, S Chand and Co. Ltd.
7. Solar energy,Suhas P Sukhative Tata McGraw Hill Publishing Co Ltd.
8. Non-conventional energy sources, GD Rai- Khanna Publishers, NewDelhi.

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Detailed Syllabus of 2nd Semester Core/Major Courses

Course title: Waves and Optics

Course code: PHYC2

Nature of the course: Core

Total credits: 4 (Theory 3, Practical 1)

Distribution of marks: **80** (End sem) + **20** (In-sem)

Course objectives:

(1) To develop the theoretical knowledge of waves and oscillations and superposition principle.
(2) To acquaint the learner with the interesting phenomena of light.
(3) To build the theoretical knowledge of various optical instruments.

Unit	Content	L	T	P	M	Hours
Unit 1: Superposition of Harmonic Oscillations	**1.1:** Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats).Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.	5	-	-	6	5
	1.2: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequency and their uses.	3	-	-	4	3
Unit 2: Wave Motion	**2.1:** Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of a Wave, Pressure of a Longitudinal Wave, Energy Transport. Water waves: Ripple and gravity waves.	6	-	-	8	6
	2.2: Velocity of Transverse Vibrations of Stretched Strings, Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton’s Formula for Velocity of Sound, Laplace’s Correction.	5	-	-	8	5

Unit 3: Harmonic Waves	Standing (Stationary) Waves in a String: Fixed and Free Ends, Analytical Treatment, Phase and Group Velocities, Changes with respect to Position and Time, Energy of Vibrating String, Transfer of Energy, Normal Modes of Stretched Strings, Plucked and Struck Strings, Melde's Experiment, Longitudinal Standing Waves and Normal Modes, Open and Closed Pipes, Superposition of N Harmonic Waves.	7		-	10	7
Unit 4: Wave optics	Electromagnetic nature of light, definition and properties of wave front, Huygens principle, Temporal and Spatial coherence.	3	-	-	4	3
Unit 5: Interference	**5.1:** Division of amplitude and wavefront, Young's double slit experiment, Lloyd's Mirror and Fresnel's Biprism, Phase change on reflection: Stokes' treatment, Interference in Thin Films: parallel and wedge-shaped films. Newton's Rings: Measurement of wavelength and refractive index.	8	-	-	10	8
	5.2: Michelson Interferometer- (i) Idea of form of fringes (theory not required), (ii) Determination of Wavelength, (iii) Wavelength Difference, (iv) Refractive Index and (v) Visibility of Fringes. Fabry-Perot interferometer.	4	-	-	6	4
Unit 6: Diffraction	**6.1:** Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula (Qualitative discussion only)	2	-	-	4	2
	6.2: Fraunhofer Diffraction: Single slit, Circular aperture. Resolving Power of a telescope, Double slit, Multiple slits. Diffraction grating, Resolving power of grating.	6	-	-	6	7
	6.3: Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.	7	-	-	8	6

Unit 7: Holography	Principle of Holography, Recording and Reconstruction Method, Theory of Holography as Interference between two Plane Waves, Point Source Holograms.	4	-	-	6	4
	Total	**60**	**-**	**-**	**80**	**60**

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Lab Practical (2.1): (Minimum four experiments are to be performed)

1. To determine the Frequency of an electrically maintained tuning fork by Melde's 3experiment and to verify Z^2 – T law.
2. To study of Lissajous Figure of two different waves using CRO and find out the unknown frequency of an electric signal.
3. To familiarize with Schuster's focusing, and determine angle of prism.
4. To determine the dispersive power and Cauchy constants of 6the material of a prism using mercury source.
5. To determine the Refractive index of the material of a prism using sodium light.
6. To determine the wavelength of sodium light using Newton's ring.
7. To determine wavelength of light using Fresnel Biprism.

Mode of In-semester assessment:

1.One internal examination **(10 Marks)**

2.Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Course outcomes: At the completion of this course, a student will be able to

1. Understand the basics of wave motion.
2. Know about the behavior of light due to its wave nature.
3. Identify and understand different phenomena due to the interaction of light with matter.
4. Analyze some of the fundamental laws and principles of light which are used in many important optical instruments.

Recommended readings:

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
- Principles of Optics, Max Born and Emil Wolf, 7thEdn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- Modern Optics, A.B. Gupta, 2013, Books & Allied (P) Ltd.
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

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Details of 2nd Sem Minor course

Course title: Waves and Optics
Course code: MINPHY2
Nature of the course: Minor
Total credits: 4 (Theory 3, Practical 1)
Distribution of marks: 80(End sem) **+20**(In sem)

Course objective: This course will

1. Enable the students to analyze different phenomena due to the interaction of light with light and matter.
2. Train the students to use different optical instruments.
3. Help the students to understand various natural phenomena using different apparatus in the laboratory.

Unit	Content	L	T	P	M	Hours
Unit 1: Superposition of Harmonic Oscillations	**1.1:** Linearity and Superposition Principle, Superposition of two collinear oscillations having (i) equal frequencies and (ii) different frequencies (Beats), Superposition of N collinear Harmonic Oscillations with (i) equal phase differences and (2) equal frequency differences.	8	-	-	8	8
	1.2: Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures with equal and unequal frequency and their use.	5	-	-	5	5
Unit 2: Wave Motion	**2.1:** Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of a Wave, Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave.	4	-	-	4	4
	2.2: Velocity of Transverse Vibrations of Stretched strings. Velocity of longitudinal waves in a fluid in pipe. Newton's formula for velocity of sound, Laplace's correction.	5	-	-	5	5
Unit 3: Superposition of Harmonic Waves	Standing (Stationary) Waves in a String: Fixed and Free Ends, Analytical Treatment, Phase and Group Velocities, Changes with respect to Position and Time, Energy of Vibrating String, Transfer of	**10**	-	-	20	10

	Energy, Normal Modes of Stretched Strings, Plucked and Struck Strings, Melde's Experiment, Longitudinal Standing Waves and Normal Modes, Open and Closed Pipes, Superposition of N Harmonic Waves.					
	Electromagnetic nature of light, definition and properties of wave front, Huygens principle, Temporal and Spatial coherence	**5**	-	-	5	5
	5.1: Division of amplitude and wavefront, Young's double slit experiment, Lloyd's Mirror and Fresnel's Biprism, Phase change on reflection: Stokes' treatment, Interference in Thin Films: parallel and wedge-shaped films. Newton's Rings: Measurement of wavelength and refractive inde	**14**	-	-	24	14
	5.2: Michelson Interferometer- (i) Idea of form of fringes (No theory required), (ii) Determination of Wavelength, (iii) Wavelength Difference, (iv) Refractive Index and (v) Visibility of Fringes. Fabry- Perot interferometer.	**9**	-	-	9	9
	Total	**60**	-	-	80	60

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Lab Practical (2.1): (Minimum four experiments are to be performed)

1. To determine the Frequency of an electrically maintained tuning fork by Melde's 3experiment and to verify Z^2 – T law.
2. To determine the focal length of a convex mirror with the help of convex lens.
3. To determine the refractive index of a liquid by using plane mirror and convex lens.
4. To determine the focal length of two lenses and their combination by displacement method.
5. To determine the Refractive index of the material of a prism using sodium light.
6. To determine the wavelength of sodium light using Newton's ring.
7. To familiarize with Schuster's focusing; determination of angle of prism.

Mode of In-semester assessment:

1. One internal examination **(10 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Course outcomes: At the completion of this course, a student will be able to

1. Understand the basics of wave motion.
2. Know about the behavior of light due to its wave nature.
3. Identify and understand different phenomena due to the interaction of light with light and matter.
4. Analyze some of the fundamental laws and principles of light which are used in many important optical instruments.

Recommended readings:

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
- Principles of Optics, Max Born and Emil Wolf, 7thEdn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

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Details of 2nd Sem Generic Electrive course

Course title: Materials Today

Course Code: GECPHY2A

Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives: This course is intended to provide an introduction to

(1) The various states of matter along with a distinction between matter and materials
(2) The development of materials over the ages
(3) The classification of materials and their properties
(4) Advanced class of materials and their applications

Unit	Content	L	T	P	M	Hours
Unit 1: States of Matter	Overview of the different states of matter: Solid, Liquid, Gas, Plasma	7	-	-	12	7
Unit II: History and Evolution of Materials	Materials: Drivers of human civilization Development of materials: Stone age, Copper age, Bronze age, Iron age Explanation with examples to mark this development	10	-	-	18	10

Unit III: Classification of Engineering Materials	Metals & Alloys, Non-Metals, Ceramics, Polymers, Composites etc. with examples and applications Uses, Performance, Composition & Structure; Physical and Chemical properties; Processing & Synthesis of various classes of materials	13	-	-	25	13
Unit IV: Trends in Advanced Materials	Breakthroughs in Materials Development Overview of Advanced Materials: Semiconductors, Biomaterials, Smart Materials (Materials of the Future), Nano-structured Materials	15	-	-	25	15
	Total	**45**	**-**	**-**	**80**	**45**

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Mode of In-semester assessment:

1. One internal examination **(10 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Course outcomes: This course will enable the students to

(1) Define the possible states of matter as well as to distinguish matter from material
(2) Explain the chronological development that materials have gone through for achieving their present stage
(3) Compare and classify materials and their properties
(4) Define advanced materials and their fascinating behavior

Suggested readings:

(1) Materials Science and Engineering: An introduction, William D. Callister, Jr. and David G. Rethwisch, John Wiley & Sons, Inc.
(2) Understanding Materials Science: History, Properties, Applications, Rolf E. Hummel, Springer-Verlag, New York
(3) Essentials of Materials Science and Engineering, Donald R. Askeland and Pradeep P. Fulay, Cengage learning, Canada

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Details of 2nd Sem Skill Enhancement Course

Course Title: Basic Instrumentation Skills
Course Code: SEC2.1
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 2, Practical -1
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives: This course aims to

1. Provide exposure to various aspects of instruments
2. Provide hands-on experience of handling instruments.
3. Teach various debugging techniques for the instruments.

Unit	Content	L	T	P	M	Hours
	2-credit theory					
Unit 1: Basic of Measurement	Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance	2	-	-	6	2
Unit 2: Electronic Voltmeter	Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. **AC millivoltmeter:** Type of AC milli voltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.	2	-	-	8	2
Unit 3:	Block diagram of basic CRO. Construction of CRT,	2	-	-	6	2

Cathode Ray Oscilloscope	Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.					
	Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	1	-	-	4	1
Unit 4: Signal Generators and Analysis Instruments	Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.	2	-	-	4	2
Unit 5: Impedance Bridges & Q-Meters	Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q-Meter. Digital LCR bridges.	2	-	-	4	2
Unit 6: Digital Instruments	Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.	2	-	-	4	2
Unit 7: Digital Multimeter	Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.	2	-	-	4	2
	1-credits practical: **Demonstration and Laboratory**					
	The test of lab skills will be of the following test items: 1. Use of an oscilloscope. 2. CRO as a versatile measuring device. 3. Circuit tracing of Laboratory electronic equipment,	**-**	**-**	30	40	60

	4. Use of Digital multimeter / VTVM for measuring voltages 5. Circuit tracing of Laboratory electronic equipment, 6. Winding a coil / transformer. 7. Study the layout of a receiver circuit. 8. Troubleshooting a circuit 9. Balancing of bridges **Laboratory Exercises:** 1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance. 2. To observe the limitations of a multimeter for measuring high frequency voltage and currents. 3. To measure Q of a coil and its dependence on frequency, using a Q- meter. 4. Measurement of voltage, frequency, time period and phase angle using CRO. 5. Measurement of time period, frequency, average period using universal counter/ frequency counter. 6. Measurement of rise, fall and delay times using a CRO. 7. Measurement of distortion of a RF signal generator using distortion factor meter. 8. Measurement of R, L and C using a LCR bridge / universal bridge. **Open Ended Experiments:** 1. Using a Dual Trace Oscilloscope 2. Converting the range of a given measuring instrument (voltmeter, ammeter)					
	Total	**15**	**-**	**30**	**80**	**75**

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Mode of In-semester assessment:

Viva-voce / Assignments / Notebook/ Attendance **(Marks 20)**

Mode of End-semester assessment:

Examination for 1 credit theory **(Marks 40)**

Examination for 2 credit practical **(Marks 40)**

Learning outcomes: After completing this course the students will be able to

1. Handle various measuring laboratory instruments properly
2. Assess the possible sources of error in the measurements
3. Analyze issues and debug problems in the instrument functioning

References:

- A textbook in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

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Detailed Syllabus of 3rd Semester Core/Major Courses

Course Title: Mathematical Physics I
Course Code: PHY MAJ 3.1
Nature of course: Major/Core
Total Credits: 4(Th 3, Pr1)
Distribution of Marks: 60 (End Sem) **+ 15** (In Sem) + **25(**Practical)

Course objectives: This course will develop the requisite mathematical skills of a student to understand the fundamental topics in vector algebra, applications of vectors in different fields, differential equation & its applications, different coordinate systems and idea of probability etc.

Theory: (Marks: 60)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: Vector algebra	Recapitulation of vector algebra. Scalar products, Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Cartesean components of a vector, Scalar and vector fields. Directional derivatives and normal derivatives. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. Ordinary integrals of vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line integral, surface integral and volume integral of vector fields. Flux of a vector field. Gauss' divergence theorem, Green's theorem, Stokes theorem and their applications (proofs not necessary).	25			22	25
Unit 2: Differential Equations	First Order Differential Equations, Integrating Factor. Second order Differential equations. Homogeneous and Inhomogeneous Equations with constant coefficients. Wronskian and	17			16	17

	general solution. Calculus of functions of more than one variable: Partial derivatives, Exact differentials, Inexact differentials. Constrained maximization using Lagrange Multipliers.					
Unit 3: Orthogonal Curvilinear Coordinates	Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.	8			10	8
Unit 4: Dirac Delta function	Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function	5			6	5
Unit V: Introduction to Probability	Independent random variables: Probability distribution functions; binomial, Gaussian and Poisson, with examples. Mean and variance.	5			6	5
Total		**60**			**60**	**60**

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

Computer Lab Practical: 3.1 (Marks: 25)

The aim of this Lab is to teach computer programming, numerical analysis and to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- The course will consist of lectures (both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- Students can use any one operating system Linux or Microsoft Windows.

Introduction and Overview Computer architecture and organization, memory and Input/output devices.

Basics of scientific computing Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

Review of C & C++/Python/ Matlab/ Mathematica Programming fundamentals Introduction to Programming, constants, variables and data types, operators and Expressions I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (if statement. if-else Statement. Nested if Structure. else-if Statement. Ternary Operator. goto Statement. switch Statement. Unconditional and Conditional Looping. while Loop. do-while Loop. for Loop. break and continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.

Programs Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search

Random number generation Area of circle, area of square, volume of sphere, value of pi (π)

Introduction to Numerical computation softwares Introduction to Scilab/Mathematica/Matlab/Python, Advantages and disadvantages, Scilab / Mathematica / Matlab/ Python environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab / Mathematica / Matlab/ Python, Multidimensional ar- rays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab / Mathematica / Matlab/Python functions, Introduction to plotting, 2D and 3D plotting. **Curve fttting, Least square fit, Goodness of fit, standard deviation** Ohms law to calculate R, Hooke's law to calculate spring constant.

Mode of In-semester assessment:

1. Internal examination **(15 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.

Learning outcomes: This course will enable the students to

1. Write a problem in physics in the language of mathematics.
2. Identify a range of diverse mathematical techniques to formulate and solve a problem in basic physics.

Recommended readings:

1. Mathematical Methods for Physicists, G B Arfken, H F Weber, F E Harris, 2013, 7th Edition, Elsivier.
2. Mathematical Methods for Physics and Engineering, K F Riley, M P Hobson, S J Bence, Cambridge University Press.
3. An Introduction to ordinary Differential equations, E A Coddington, 2009, PHI learning.
4. Differential equations, George F Simmons, 2007, McGraw Hill.
5. Mathematical Physics, D S Rajput.
6. Advanced Engineering Mathematics, Erwin Kreyszing, 2008, Wiley India.
7. Essential Mathematical Method, K F Riley & M P Hobson, 2011, Cambridge University Press.

Course Title: Thermal Physics
Course Code: PHY MAJ 3.2
Nature of course: Major/Core
Total Credits: 4 (Th 3, Pr 1)
Distribution of Marks: 60 (End Sem) **+ 15** (In Sem) + **25**(Practical)

Objectives of the course:

(1) Develop the ability of a student to critically analyze a topic.
(2) Have the knowledge and skills to identify and describe the statistical nature of concepts and laws of thermodynamics.
(3) Have the knowledge of various thermodynamic properties, such as, entropy, temperature etc and thermodynamic potentials.
(4) Develop the ability of a student to critically analyze a topic.
(5) Have the knowledge and skills to identify and describe the statistical nature of concepts and laws of thermodynamics.
(6) Have the knowledge of various thermodynamic properties, such as, entropy, temperature etc and thermodynamic potentials.

Theory: (Marks: 60)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: First & Zeroth Law of Thermodynamics (Thermodynamics)	Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions. First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient.	8			8	8
Unit 2: Second law of thermodynamics (Thermodynamics)	Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine and effciency. Refrigerator & coeffcient of performance, Second Law of Thermodynamics: Kelvin-Planck	10			9	10

	and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale					
Unit 3: Entropy (Thermodynamics)	Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Change of Entropy in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.	7			8	7
Unit 4: Thermodynamic potentials (Thermodynamics)	Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.	7			7	7
Unit 5: Maxwell's Thermodynamic Relations (Thermodynamics)	Derivations of Maxwell's Relations. Applications of Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of Cp-Cv , (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.	7			7	7
Unit 6: Distribution of Velocities (Kinetic theory of gases)	Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (*No proof required*). Specific heats of Gases.	7			7	7
Unit 7: Molecular collisions (Kinetic theory of gases)	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.	4			4	4
Unit 8: Real Gases (Kinetic theory of gases)	Behaviour of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical	10			10	10

	Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. JouleThomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.					
Total		**60**			**60**	**60**

(L= Lecture, T= Tutorial, P= Practical, M= Marks)

General Lab Practical: 3.2 (25 Marks)

- A minimum of five experiments to be performed in classes
- One experiment is to be performed in Examination.

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its two Junctions.
7. To record and analyze the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system.
8. To determine Stefan's Constant by electric bulb method.
9. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Mode of In-semester assessment:

1. Internal examination **(15 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.

Learning Outcome:

1. Understand the basic laws of thermodynamics and different thermodynamic properties and potentials.
2. Understand the knowledge of various thermodynamic properties, such as, entropy, temperature etc and thermodynamic potentials.
3. Understand the ability of a student to critically analyze a topic.
4. Understand the knowledge and skills to identify and describe the statistical nature of concepts and laws of thermodynamics.

Recommended Readings:

a) Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

b) A Treatise on Heat, Meghnad Saha, and B. N.Srivastava, 1958, Indian Press
c) Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
d) Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
e) Advanced Practical Physics for students, B L Flint and H T Worsnop, 1971, Asia publishing House.
f) Advanced level Physics Practicals, Michal Nelson and Jon M Ogborn, 4th edition, reprinted 1985, Heinemann Educational Publishers.
g) A Textbook of Practical Physics, I Prakash & Ramkrishna, 11th Edition, 2011, Kitab Mahal.
h) Engineering Practical Physics, S Panigrahi & B Mallik, 2015, Cenage Learning India Pvt. Ltd.
i) Practical Physics, G L Squires, 2015, 4th Edition, Cambridge University Press.
j) A Laboratory Manual of Physics for undergraduate classes, D P Khandelwal, 1985, Vani Publications.

3rd Semester GEC/MD – 3

Course Title: Atmosphere of the Earth
Course code: MD-PHY 3.1
Nature of the Course: Generic Elective Course(Multidisciplinary)
Total Credits: 3
Distribution of Marks: 60 (End sem) + **15** (In sem)

Course Objectives:

1. Introduce the atmosphere of the earth.
2. Give an idea on different layers of the atmosphere.
3. Introduce atmospheric composition and their impact on climate.
4. Introduce the concept of present day climate change.
5. Introduce the atmospheres of other solar system planets.

Theory (Marks: 60)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: Introduction	1.1: Evolution of the earth's atmosphere. Layers of the atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere, Ionosphere: D, E and F layers. Hydrostatic Balance.	7	-	-	10	7
	1.2: Composition of the atmosphere: Atmospheric gases, aerosols, clouds.	5	-	-	9	5
	1.3: atmospheric thermodynamics: First law of thermodynamics for atmosphere and its application, Clausius-Clapeyron equation.	5	-	-	10	5
Unit 2: Atmospheric processes	2.1:Ggreenhouse effect- natural, enhanced, Antarctic ozone hole, global warming.	7	-	-	8	7
	2.2: Climate of the earth, climate change, adaptation and mitigation.	7	-	-	7	7
Unit 3: Atmosphere of the other	3.1:Terrestrial planets: Physical properties and chemical composition, difference between Terrestrial and Jovian planets.	7	-	-	8	7

solar system planets	3.2: Jovian planets: physical properties and chemical composition. Difference between gas and ice giants, rings in Jovian planets.	7	-	-	8	7
Total		**45**			**60**	**45**

(L- Lecture, T- Tutorial, P- Practical, M- Marks)

Mode of In-semester assessment:

1. Internal examination **(15 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.

Learning outcomes: This course will enable the students to

1. Understand the different layers of atmosphere and the related physical phenomena.
2. Understand chemical composition of the atmosphere of the earth and other planets.
3. Understand the phenomenon of climate change and other processes.

Recommended readings:

1. Metrology for Scientists and Engineers, R Stull, Brooks/Cole. Thomson Learning.
2. Atmospheric Chemistry and Physics, J H Seinfeild and S N Pandis, Jhon Wiley and Sons.
3. Introduction of Atmospheric Modelling, M Z Jacobson, Cambridge University Press.

3rd Semester (Minor)
Course Title: Thermal Physics
Nature of Course: Minor
Course Code: PHY MIN 3.1
Total credits: 4(Th 3, Pr 1)
Distribution of Marks: **60** (End sem) + **15** (In sem) + 25 (Practical)

Objectives of the course:

1. Develop the ability of a student to critically analyze a topic.
2. Have the knowledge and skills to identify and describe the statistical nature of concepts and laws of thermodynamics.
3. Have the knowledge of various thermodynamic properties, such as, entropy, temperature etc and thermodynamic potentials.

Theory (Marks: 60)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: First & Zeroth Law of Thermodynamics (Thermodynamics)	Thermodynamic Equilibrium, Zeroth Law of Thermodynamics and Concept of Temperature, Concept of Work & Heat, State Functions. First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes.	8			8	8
Unit 2: Second law of thermodynamics (Thermodynamics)	Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine and effciency. Refrigerator & coeffcient of performance, Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale	10			10	10
Unit 3:	Concept of Entropy, Clausius Theorem.	7			7	7

Entropy (Thermodynamics)	Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Change of Entropy in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.					
Unit 4: Thermodynamic potentials (Thermodynamics)	Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples,	7			7	7
Unit 5: Maxwell's Thermodynamic Relations (Thermodynamics)	Derivations of Maxwell's Relations. Applications of Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of Cp-Cv , (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations.	7			7	7
Unit 6: Distribution of Velocities (Kinetic theory of gases)	Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (*No proof required*). Specific heats of Gases.	9			9	9
Unit 7: Real Gases (Kinetic theory of gases)	Behaviour of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. JouleThomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases.	12			12	12
Total		**60**			**60**	**60**

(L- Lecture, T- Tutorial, P- Practical, M- Marks)

General Lab Practical: 3.1 (Marks: 25)

- Minimum five experiments are to be performed in classes.
- One experiment is to be performed in the Examination.

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine Stefan's Constant by electric bulb method.
6. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its two Junctions.
7. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Mode of In-semester assessment:

1. Internal examination **(15 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.

Learning outcomes: After completing this course the students will be able to

1. Apply theoretical knowledge in practical applications.
2. Identify and understand different phenomena of thermal physics, electricity and mechanics.

Recommended readings:

1. Advanced Practical Physics for students, B L Flint and H T Worsnop, 1971, Asia publishing House.
2. Advanced level Physics Practicals, Michal Nelson and Jon M Ogborn, 4th edition, reprinted 1985, Heinemann Educational Publishers.
3. A Textbook of Practical Physics, I Prakash & Ramkrishna, 11th Edition, 2011, Kitab Mahal.
4. Engineering Practical Physics, S Panigrahi & B Mallik, 2015, Cenage Learning India Pvt. Ltd.
5. Practical Physics, G L Squires, 2015, 4th Edition, Cambridge University Press.
6. A Laboratory Manual of Physics for undergraduate classes, D P Khandelwal, 1985, Vani Publications.

3rd Semester Skill Enhancement Course
Option -A

Course Title: Renewable Energy and Energy Harvesting
Course Code: PHY SEC 3.1-A
Nature of Course: Skill Enhancement
Credits: 3 (Th 2, Pr 1)
Distribution of Marks: 50 (End Sem) + **25** (Practical)

Course objectives: The aim of this course is not just to impart theoretical knowledge to the students about the various energy sources in nature, but to provide them with exposure and hands-on learning wherever possible.

Theory (Marks: 50)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: Fossil fuels & Alternate Sources of energy	Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	5	-	-	9	5
Unit 2: Solar energy	Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	5	-	-	8	5
Unit 3: Wind Energy harvesting	Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.	5	-	-	7	5
Unit 4: Ocean Energy	Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Biomass.	5			7	5

Unit 5: Geothermal Energy & Hydro Energy	Geothermal Resources, Geothermal Technologies. Hydropower resources, hydropower technologies, environmental impact of hydro power sources.	5	-	-	7	5
Unit 6: Piezoelectric Energy harvesting	Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.	6	-	-	6	6
Unit 7 Electromagnetic Energy Harvesting	Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability	5			6	5
	1- Credits practical: **Demonstration and Experiment/Project**					
	1. Demonstration of Training modules on Solar energy, wind energy, etc. 2. Conversion of vibration to voltage using piezoelectric materials. 3. Conversion of thermal energy into voltage using thermoelectric modules. **Project Preparation**	-	-	12	25	24
Total		36	--	12	75	60

(L- Lecture, T- Tutorial, P- Practical, M- Marks)

Learning outcomes: After completion of this course the students can have an idea regarding various non-conventional energy sources available in nature.

Recommended Readings:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009 • J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
6. http://en.wikipedia.org/wiki/Renewable_energy

3rd Semester Skill Enhancement Course
Option -B

Course Title: Computational Physics Skills
Course Code: PHY SEC 3.1-B
Nature of Course: Skill Enhancement
Credits: 3(Theory 2, Practical 1)
Distribution of Marks: 50 (End Sem) + 25 (Practical)

Course objectives: The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics. • Highlights the use of computational methods to solve physical problems • Use of computer language as a tool in solving physics problems (applications) • Course will consist of hands on training on the Problem solving.

Theory (Marks: 50)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: Introduction	Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of Linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.	6	-	-	10	6
Unit 2: Scientific Programmin g	Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN. Basic elements of FORTRAN: Character set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmatic, Relational, Logical, Character and Assigment Expressions. Fortran statements: I/O Statements (uniformatted/formatted), Executable and Non-executable statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.	6	-	-	10	6
Unit 3:	Types of Logic (Sequential, Selection, Repetition),	6	-	-	10	6

Control Statements	Branching Statements (Logical IF, Arithmatic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF, Ladder Statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.					
Unit 4: Scientific word processing: Introduction to LaTex	Tex/LaTex word processor, preparing a basic LaTex file, Document classes, Preparing an input file for LaTex, Compiling LaTex file, LaTex commands and environments. Changing the type style, symbols from other languages. **Equation representation**: Formulae and equations, Figures and other floating bodied, Lining in columns-Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index glossary, List making environments, Picture environment and colors, errors.	6			10	6
Unit 5: Visualizatio n	Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, curve fitting – straight line, polynomials, user defined function. Physics with Gnu plot (equations, building functions, user defined variables and functions), Understanding data with Gnu plot.	6	-	-	10	6
	1- Credit practical: **Programming:**					
	1. Excercises on syntax on usage of FORTRAN, usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write source codes in FORTRAN. 2. To print out all natural even/ odd numbers between given limits. 3. To find maximum, minimum and range of a given set of numbers. 4. Calculating Euler number using exp(x) series evaluated at x=1 **Hands on Excercises:** 1. To compile a frequency distribution and evaluate	-	-	15	25	30

	mean, standard deviation etc. 2. To evaluate sum of finite series and the area under a curve. 3. To find the product of two matrices. 4. To find a set of prime numbers and Fibonacci series. 5. To write program to open a file and generate data for plotting using Gnuplot. 6. Plotting trajectory of a projectile projected horizontally. 7. Plotting trajectory of a projectile projected making an angle with the horizontally. 8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file. 9. To find the roots of a quadratic equation. 10. Motion of a projectile using simulation and plot the output for visualization. 11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization. 12. Motion of particle in a central force field and plot the output for visualization.					
Total		30	-	15	75	60

(L- Lecture, T- Tutorial, P- Practical, M- Marks)

Learning outcomes: The completion of the course will enable the students to

1. Work smoothly in a Linux environment.
2. Use FORTRAN programming in numerical analysis.
3. Prepare documents (including scientific documents) using LaTex.
4. Do graph plotting and analysis through programming languages like GNU plot.

Recommended readings:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
3. LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
4. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
5. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
6. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
7. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
8. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

Detailed Syllabus of 4th Semester Major Courses

Course Title: Electricity and Magnetism
Course Code: PHY MAJ 4.1
Nature of Course: Major/Core
Credits: 4
Distribution of Marks: 80 (End Sem) + **20** (In sem)

Course objectives: This course will

1. Able to understand electric and magnetic field in matter.
2. Able to understand the dielectric properties and magnetic properties of matter. \
3. Able to understand the electromagnetic induction due to current carrying coils.
4. Able to understand the Kirchhoff's law in different circuits.
5. Able to understand the Network theorem in various circuits.

Theory (Marks: 80)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: Electric field and Potential	Electric field: Electric field lines, Electric flux, Gauss' law and its applications to charge distribution with spherical, cylindrical and planer symmetry. Conservative nature of Electrostatic field. Electrostatic potential. Laplace's equation, Poisson's equation. The Uniqueness theorem. Potential and Electric field of a dipole. Force and torque on dipole. Electrostatic energy of a system of charges. Electrostatic energy of charged sphere. Conductors in an electrostatic field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to (i) Plane infinite sheet and (ii) Sphere	20			24	20
Unit 2: Dielectric properties of matter	Electric field in matter. Polarization, Polarization charges. Electrical Susceptibility and Dielectric constant. Capacitors (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. relation between electric field **E**, polarization vector **P** and displacement vector **D**.	8			12	8
Unit 3:	Magnetic force on a point charge. Definition and	14			18	14

Magnetic field and Ballistic galvenometer	properties of a magnetic field B. curl and divergence. vector potential. Magnetic force on (i) a current carrying wire (ii) between current elements. Torque on a current loop in a uniform magnetic field. Biot-Savert law and its applications to (i) straight wire and (ii) circular loop. Current loop as magnetic dipole and its dipole moment (analogy with electric dipole). Ampere's circuital law and its application to (i) Solenoid and (ii) Torus. Torque on a current loop. Ballistic galvanometer: current and charge sensitivity. Electromagnetic damping. Logarithmic damping. CDR.					
Unit 4: Magnetic properties of matter	Magnetization vector (**M**). Magnetic Intensity (**H**). Magnetic Susceptibility and permeability. Magnetic flux density (**B**). Relation among **B**, **H** and **M**. Ferromagnetism. B-H curve and hysteresis.	4			6	4
Unit 5: Electromagnetic induction.	Faraday's law. Lenz's law. Self inductance and Mutual inductance. Reciprocity theorem. Energy stored in a magnetic field. Introduction to Maxwell's equations. Charge conservation and displacement current.	6			10	6
Unit 6: Electrical circuits and Network Theorems	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. Ideal constant voltage and constant current sources. Netwok theorems: Thevenin theorem, Norton theorem, Superposition theorem, reciprocity theorem. Maximum power transfer theorem. Application to dc circuits.	8			10	8
Total		**60**			**80**	**60**

(L- Lecture, T- Tutorial, P- Practical, M- Marks)

Mode of In-semester assessment:

1. One internal examination **(10 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Learning outcomes: At the completion this course the students will able to

1. Understand the electric and magnetic fields in matter.
2. Understand the dielectric properties and magnetic properties of matter.
3. Understand the electromagnetic induction and related laws.
4. Understand the application of Kirchhoff's law in different circuits.
5. Understand the Network theorem and its application in circuits.

Recommended readings:

1. Electricity, Magnetism and electromagnetic Theory, S Mahajan and Choudhury, 2012, Tata Mc Graw hill.

2. Electricity and Magnetism, Edward M Purcell, 1986, Tata Mc Graw hill Education.
3. Introduction to Electrodynamics, D J Griffiths, 3rd Edition, 1998, Benjamin Cummings.
4. Feynman lectures Vol 2. R P Feynman, M Sands, 2008, Pearson Education.
5. Elements of Electromagnetics, M N O Sadiku, 2010, Oxford University Press.
6. Electricity and Magnetism, J H Fewkes & J Yarwood, Vol 1, 1991, Oxford University Press.

4th Semester Major/Core
Course Title: Elements of Modern physics
Course Code: PHY MAJ 4.2
Nature of Course: Core/Major
Credits: 4
Distribution of Marks: 80 (End Sem) + **20** (In sem)

Course objectives: The objectives of the course are:
1. To offer the idea to understand the modern development in Physics, starting from Planck's law.
2. To develop the idea of Heisenberg uncertainity principle.
3. To give the preliminary idea of structure of nucleus, radioactivity Fission and Fusion and Laser.

Theory (Marks: 80)

Unit :	Content	L	T	P	M	Hours
Unit 1: Quantum Theory	Quantum theory of light; photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. group and phase velocities and relation between them. Two-slit experiment with electrons. Probability. wave amplitude and wave functions.	12			16	12
Unit 2: Uncertainty and Wave-Particle Duality	Position measurement : gamma ray microscope thought experiment; wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from wave packets, impossibility of a particle following a trajectory; estimating minimum energy of a confined particle using uncertainty principle; energy-time uncertainty principle-application to virtual particles and range of an interaction.	7			10	7
Unit 3: Structure of the Atomic Nucleus	Size and structure of atomic nucleus and its relation with atomic weight; impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Atomic Mass Unit. Mass defect and binding energy Nuclear forces, Nature of nuclear forces, N–Z graph, liquid drop model: semi-empirical mass formula and binding energy, nuclear shell model (qualitative discussions) and magic numbers.	8			11	8

Unit 4: Radioactivity	Stability curve and stability of nuclei, Law of radioactive decay, disintegration constant, half life and mean life. Activity unit. Law of successive disintegration, Secular equilibrium, Transient equilibrium. Alpha decay, Range of alpha particles, Range energy relation, Fine structure of alpha energy spectrum. Beta decay energy released, continuous beta spectrum and Pauli's prediction of neutrino. Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.	10			13	10
Unit 5: Detection of nuclear radiation	Method of energy loss by charged particles and gamma photons. Photoelectric, Compton and Pair-production processes Gas filled detectors – principle and construction of a gas filled detector, Ionization, proportional, GM and spark region.	5			7	5
Unit 6: Nuclear Reactions	Nuclear Reactions, Energy consideration in Nuclear Reaction, Q-value of nuclear reaction, Mass deficit in Nuclear reaction, Einstein's mass-energy equivalence principle and generation of nuclear energy. Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235. Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).	8			11	8
Unit 7: Lasers	Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Characteristics of LASER. Three-Level and Four-Level Lasers. Basic lasing. Ruby Laser and He-Ne Laser.	10			12	10
Total		**60**			**80**	**60**

(L- Lecture, T- Tutorial, P- Practical, M- Marks)

Mode of In-semester assessment:

1. One internal examination **(10 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc. **(10 Marks)**

Learning outcomes:

On completion of the course students will be able to understand modern development in Physics, Starting from Planck's law, it development of the idea of probability interpretation and the formulation of Schrodinger equation. Students will also get preliminary idea of structure of nucleus, radioactivity Fission and Fusion and Laser.

4th Semester Core/Major

Course Title: General Lab Practical
Course Code: PHY MAJ 4.3
Nature of Course: Core
Credits: 4
Distribution of Marks: 50 (Gr A) +50 (Gr B)

Minimum six experiments are to be performed in classes from each Group.
One experiment is to be performed from each Group in Practical Examination.

Course objective: This course will

1. develop experimental skills of a learner in Electricity & magnetism as well as in Modern Physics.
2. develop the ability of a student to expertise oneself in the field of basic physics enabling him/her to get a better knowledge of the theory.

Group: A

1. To use a multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. To measure the field strength **B** and its variation in a solenoid (determine dB/dx).
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.

Group: B

1. To measurement of Planck's constant using black body radiation and photo-detector.

2. To draw the characteristic curve of a photo cell and find the maximum velocity of emitted electron.

3. To determine work function of material of filament of directly heated vacuum diode.

4. To determine the Planck's constant using LEDs of at least 4 different colours.

5. To determine the ionization potential of mercury.

6. To determine the value of e/m by (a) magnetic focusing or (b) bar magnet.

7. To determine the wavelength of laser source using diffraction of single slit.

8. To determine the wavelength of laser source using diffraction grating.

9. To show the tunneling effect in tunnel diode using I--V characteristics.

4^{th} Semester Minor

Course Title: Electricity and Magnetism
Course Code: PHY- MINOR 4.1
Nature of Course: Minor
Credits: 4 (Th 3 + Pr 1)
Distribution of Marks: 60 (End Sem) + **15** (In sem) + **25** (Practical)

Course objectives: The objective of this course are:

1. To offer the idea of Gauss's law of electrostatics and application of it to solve different problems..
2. To develop the idea of magnetic forces on moving charges, and magnetic fields due to current.
3. To give the preliminary idea of various magnetic materials.
4. To understand the concept of induction.

Theory (Marks: 60)

Unit :	**Content**	**L**	**T**	**P**	**M**	**Hours**
Unit 1: Vector Analysis	Vector algebra, Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).	12			12	12
Unit 2: Electrostatics	Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem – Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.	22			24	22

Unit 3: Magnetism	Magnetostatics: Biot-Savart's law, and its applications to – (i) straight conductor, (ii) circular coil and (iii) solenoid carrying current. Divergence and curl of a magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia, para, and ferro-magnetic materials.	10			14	10
Unit 4: Electromagnetic Induction	Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.	6			2	6
Unit 5: Maxwell's Equations and EM Wave	Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.	10			8	10
Total		60			60	60

(L- Lecture, T- Tutorial, P- Practical, M- Marks)

General Lab Practical : 4.1(Marks: 25)

(Minimum five experiments are to be performed in classes)

(One experiments is to be performed in examination)

1. To use a multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. To measure the field strength **B** and its variation in a solenoid (determine dB/dx).
7. To determine self inductance of a coil by Anderson's bridge.
8. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

Mode of In-semester assessment:

1. Internal examination **(15 Marks)**
2. Assignment / Presentation / Attendance / Classroom interaction / Quiz etc.

Learning outcomes: Upon completion of this course, students are expected to

1. Know Gauss's law of electrostatics and how to solve a variety of problems by applying it.,
2. Know the idea to calculate the magnetic forces that act on moving charges and the magnetic fields due to currents,
3. Know the brief idea of different types of magnetic materials
4. Understand the concepts of induction, and their application to solve variety of problems.

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