Department of Physics

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SYLLABUS for FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP) in PHYSICS of DIBRUGARH UNIVERSITY and its AFFILIATED COLLEGES as per NEP-2020 Guidelines

Approved by the Board of Studies in Physics held on 9 February 2023

Preamble

The National Education Policy (NEP 2020) is a groundbreaking 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 Dibrugarh University, Dibrugarh, launched the implementation process in February 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, on 27th January 2023. In keeping with the NEP 2020, the Board of Studies (BoS) in Physics, convened on 9th February 2023, endorsed the detailed program structure and syllabus for FYUGP in Physics, designed for Dibrugarh University and its affiliated colleges. This syllabus intends to provide students with a comprehensive understanding of the discipline, enable them to hone 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 Dibrugarh University and its affiliated colleges is a comprehensive 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 develop essential skills like leadership, teamwork, and communication.

The program's 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 Dibrugarh University and its affiliated colleges 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

Aim 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 levels.

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 and innovation.

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 equip them 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 exit option are as follows:

Certificate (after completing 1 year of study):

1. Demonstrate a basic understanding of fundamental concepts and principles related to the chosen 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 the chosen 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-world problems.

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 a creative 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 from multiple 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 active learning 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 / powerpoint presentation etc.

Program Structure

Year	Semester	Course	Title of the Course	Total Credits
Year 01	1st Semester	**C - 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	Electrical circuits and Network Skills / Electrical Wiring and Maintenance	3
			Total of Semester 1	**22**
	2nd Semester	**C - 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 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				
Year 02	**3rd Semester**	**C - 3**	Mathematical Physics I	4
		C - 4	General Lab I	4
		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 Semester	**C - 5**	Electricity and Magnetism	4
		C - 6	Thermal Physics	4
		C - 7	Elements of Modern Physics	4
		C - 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 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 in skill based vocational course offered during 1st year or 2nd year summer term				
Year 03	**5th Semester**	**C - 9**	Mathematical Physics II	4
		C - 10	Quantum Mechanics I	4
		C - 11	Statistical Mechanics	4
		C - 12	Computation Lab	4
		Minor 5	Thermal Physics	4
			Internship	2
			Total of Semester 5	**22**
	6th Semester	**C - 13**	Electromagnetic Theory	4
		C - 14	Solid State Physics I	4
		C - 15	Electronics I	4
		C - 16	General Lab III	4
		Minor - 6	General Lab II	4
			Project	2

			Total of Semester 6	**22**
	Grand Total (Semester 1 to 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	**Semester 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**
	Semester 8	**C - 20**	Electronics II	4
		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 8)			**176**
Students on exit shall be awarded Bachelor of (in the field of study/ discipline) Honours (4 years) / Honours with Research (4 years) after securing the requisite 176 credits on completion of Sem 8				

Abbreviations used:

1. C = Major
2. GEC = Generic Elective Course / Multidisciplinary Course
3. AEC = Ability Enhancement Course
4. SEC = Skill Enhancement Course
5. VAC = Value Added Course

List of Major Core Courses:

1. C - 1: Mechanics and Properties of Matter
2. C - 2: Waves and Optics
3. C - 3: Mathematical Physics I
4. C - 4: General Lab I
5. C - 5: Electricity and Magnetism
6. C - 6: Thermal Physics
7. C - 7: Elements of Modern Physics
8. C - 8: General Lab II
9. C - 9: Mathematical Physics II
10. C - 10: Quantum Mechanics I
11. C - 11: Statistical Mechanics
12. C - 12: Computation Lab
13. C - 13: Electromagnetic Theory
14. C - 14: Solid State Physics I
15. C - 15: Electronics I
16. C - 16: General Lab III
17. C - 17: Mathematical Physics III
18. C - 18: Classical Mechanics
19. C - 19: Quantum Mechanics II
20. C - 20: Electronics II
21. C - 21: Solid State Physics II
22. C - 22: Atomic and Molecular Physics

List of Generic Elective Courses:

1. GEC - 1: Evolution of Science / Introduction to Communication Technology
2. GEC - 2: Materials Today / Digital and Space Technologies
3. GEC - 3: The Universe / Atmosphere of the Earth

List of Skill Enhancement Courses:

1. SEC - 1: Electrical circuits and Network Skills / Electrical Wiring and Maintenance

2. SEC - 2: Basic Instrumentation Skills
3. SEC - 3: Computational Physics Skills / Renewable Energy and Energy harvesting

List of Minor Courses:

1. Minor - 1: Mechanics
2. Minor - 2: Waves and Optics
3. Minor - 3: General Lab I
4. Minor - 4: Electricity and Magnetism
5. Minor - 5: Thermal Physics
6. Minor - 6: General Lab II
7. Minor - 7: Elements of Modern Physics
8. Minor - 8: Solid State Physics

Detailed Syllabus of 1st Semester Core Courses

Course title: Mechanics and Properties of Matter
Course code: PHYC1
Nature of the course: Core
Total credits: 4
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, Principle of Conservation of Linear Momentum.	6	-	-	8	6
	1.2: The Work-Energy Theorem, Conservative and Non-	6	-	-	8	6

	conservative Forces, Conservation of Mechanical Energy, Work done by non-conservative forces, Force as gradient of potential energy, Energy Diagram, Stable and Unstable Equilibrium					
	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. Relativistic Transformation of Velocity, Frequency and Wave-number, Relativistic addition of Velocities, Variation of Mass with Velocity, Massless Particles, 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)

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 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. Study 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. Know 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.

Additional Recommended readings:

- 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 2nd Semester Core Courses

Course title: Waves and Optics
Course code: PHYC2

Nature of the course: Core
Total credits: 4
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 equal frequencies and different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with equal phase differences and equal frequency differences.	5	-	-	6	5
	1.2: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequency and their use.	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, Intensity of Wave.	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 (No theory 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)

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. Learn 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.

Detailed Syllabus of 3rd Semester Core Courses

Course title: Mathematical Physics – I
Nature of the course: Core
Course code: PHYC3
Total credits: 4
Distribution of Marks: 80 (End sem) **+ 20** (In-sem)

Course objectives: This course will

1. Develop the requisite mathematical skills of a student to understand the fundamental topics in Physics.
2. Develop the ability of a student to critically analyze a topic.
3. Prepare a student for more advanced topics in Physics by providing a solid grip over the fundamental concepts in Physics.

Unit	Content	L	T	P	M	Hours

Unit 1: Calculus	**1.1:** Functions and their plotting, Continuity and Differentiability of functions, Approximation methods: Taylor series, Maclaurin series.	2	-	-	4	2
	1.2: First Order Differential Equations, Integrating Factor, Second Order Differential Equations, Homogeneous and Inhomogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.	10	-	-	14	10
	1.3: Calculus of functions of more than one variable: Partial Derivatives, Exact and Inexact Differentials, Integrating Factor, Constrained Maximization using Lagrange Multipliers.	6	-	-	8	6
Unit 2: Vector Calculus	**2.1:** Recapitulation of Vector algebra, Dot Product, Cross Product, Scalar Triple Product, Cartesian Components of a vector, Scalar and Vector Fields.	2	-	-	4	2
	2.2: Vector Differentiation: Directional Derivatives and Normal Derivative, Gradient of a Scalar Field and its geometrical interpretation, Divergence and Curl of a Vector Field, Del and Laplacian Operators, Vector identities.	8	-	-	10	8
	2.3 Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of Infinitesimal Line, Surface and Volume Elements, Line, Surface and Volume Integrals of Vector Fields, Flux of a Vector Field, Gauss' Divergence Theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).	14	-	-	16	14
Unit 3: Orthogonal Curvilinear Coordinates	Orthogonal Curvilinear Coordinates, Spherical Polar Coordinates, Cylindrical Coordinates; Derivation of Gradient, Divergence and Curl in Cartesian, Spherical and Cylindrical Coordinate Systems	8	-	-	12	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.	4	-	-	4	4

Unit 5: Matrices	Definition, Addition and Multiplication of matrices, Transpose of a matrix, Hermitian conjugate of a matrix, Trace and Determinant, Inverse of a matrix, Special types of square matrices- Diagonal, Symmetric and Skew-symmetric, Hermitian and Skew-hermitian.	6	-	-	8	6
	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 of this course, a student will be able 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.
3. Analyze some of the basic mathematical concepts and methods.
4. Apply the knowledge and understanding of these mathematical methods to solve problems in a number of elementary branches of Physics like mechanics, electromagnetic theory, statistical Physics, thermal Physics etc.

Recommended readings:

- Mathematical Methods for Physicists, G B Arfken, H J Weber, F E Harris, 2013, 7th Edn, Elsevier.
- Mathematical Methods for Physics and Engineering, K F Riley, M P Hobson, s J Bence, Cambridge University Press.
- An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI learning.
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book.
- Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press.
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

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Course title: General Lab I

Nature of the course: Core
Course code: PHYC4
Total credits: 4
Distribution of Marks: 80 (End sem) **+ 20** (In-sem)

Course objectives: This course will

1. Develop experimental skills of a learner in mechanics as well as in waves and optics.
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.

Unit	Content	L	T	P	M	Hours
	List of experiments					
Unit 1: Mechanics	(1) To determine the height of a building using a Sextant. (2) To study the Motion of Spring and calculate (a) Spring constant, (b) ***g*** and (c) Modulus of rigidity. (3) To determine the Moment of Inertia of a Flywheel. (4) To determine ***g*** and velocity for a freely falling body using Digital Timing Technique. (5) To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). (6) To determine the Young's Modulus of a Wire by Optical Lever Method. (7) To determine the Modulus of Rigidity of a Wire by Maxwell's needle. (8) To determine the elastic Constants of a wire by Searle's method. (9) To determine the value of ***g*** using Bar Pendulum. (10) To determine the value of***g*** using Kater's Pendulum.	-	-	30	40	60
Unit 2: Waves and	(1) To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T	-	-	30	40	60

Optics	law. (2) To determine the phase difference between two waves using Lissajous Figures. (3) To determine the refractive index of the Material of a prism using sodium source. (4) To determine the dispersive power and Cauchy constants of the material of a prism using mercury source. (5) To determine the wavelength of sodium source using Michelson's interferometer. (6) To determine wavelength of sodium light using Fresnel Biprism. (7) To determine wavelength of sodium light using Newton's Rings. (8) To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. (9) To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating. (10) To determine dispersive power and resolving power of a plane diffraction grating.					
	Total	**-**	**-**	**60**	**80**	**120**

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

At least 60% of the experiments must be performed from each unit.

Mode of In-semester assessment:

1. Viva-voce: (**Marks 10)**
2. Attendance / Laboratory performance / Notebook: **(Marks 10)**

Mode of End-semester assessment:

Examination on laboratory experiments: **(Marks 80)**

Two experiments (not more than one from a single unit) from the list to be performed.

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

1. Apply theoretical knowledge in practical applications.
2. Identify and understand different phenomena due to the interaction of light with light

and matter.

3. Analyze some of the important principles used in mechanics.

Recommended readings:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Detailed Syllabus of Generic Elective Courses

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. Attain a comprehensive comprehension of the development of science from antiquity to the 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.

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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, Need of modulation, basic idea of 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)**

Learning 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) have 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.

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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)**

Learning 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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Course title: Digital and Space Technologies
Course code: GECPHY2B
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives:

(1) To provide overview to various technologies used in societal needs
(2) To introduce features of underlying digital and space technologies
(3) To provide the context of India's technological strengths and needs

Unit	Content	L	T	P	M	Hours
Unit 1: Overview of modern technologies in society	Dependency of modern life style on technology, various example technologies like microprocessor/microcontroller, computing devices, programming language-open source and proprietary software , stand alone and connected systems, communication systems-network of systems, client-server systems, GSM/CDMA, VoLTE, internet, security, cryptography, communication medium- optical fiber leading	7	-	-	15	7

	to information age, wireless, satellite communication- radio waves in earth's atmosphere , use of satellites for remote sensing , weather prediction, disaster managements, positioning and navigation (GPS/NAVIC) and military applications, rise of automation using neural networks and AI etc. India specific technological strengths and needs like semiconductor chip manufacturing, digital literacy and A.I. Integration of societal services by digital and software platforms.					
Unit 2: Digital technology	Semiconductor, chip, solar cell, LED, IC, processor IC, Boolean algebra, mass production large scale fabrication technology leading to use of binary systems and digital revolution- computer miniaturization, portability by CMOS, microprocessor basics, low power battery operated devices, networks of systems powered by optical fibers, basic of optical and quantum technologies, limitation of electronics processing, Software and advantages. Software and communication driven growth in services and economy. Software development-programming and apps. Integration of services using software and communication platforms like online banking, online education, streaming and virtual meeting, digitization of government services like online application and forms, land dispute resolutions, India's software service/technology industry and its role in the economy and nation building.	20	-	-	35	20
Unit 3: Earth's outer environment, Satellite and Space technology	The Earth's atmosphere-composition, stratification and its connection to outer space. The role of the Sun and the Earth's magnetic field in space based technologies line GPS/IRNSS and ground systems. The SUN's cycles and short scale eruptions like flare, CME. Implication for space weather. The magnetosphere-ionosphere-thermosphere-atmosphere system. Differential response in different time and space configuration, Effect on satellites and their operation, satellite drag, Artificial satellites, types like geostationary, geo synchronous, LEO, MEO, mini/micro satellites etc. Polar, equatorial, Molniya orbits and implications, applications of space technology for society, use in communication-navigation and Earth observation, Brief idea of Indian satellites like INSAT, GSAT, IRS, IRNSS, GAGAN, Chandrayan etc.; launch vehicles like ASLV, PSLV. Application of satellite SAC (ISRO)	18	-	-	30	18
	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)**

Learning outcomes: On successful completion, students will

(3) understand the role played by technological systems in the service of society
(4) have a general idea of the working of the underlying technology
(5) be able to make decisions on the use of technology in their field of work.

References:

(1) Digital Principles and Applications, Donald P. Leach, McGraw Hill; 5th edition
(2) Human Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications, Editor: Julie A. Jacko, CRC Press Inc; 3rd edition
(3) Optical electronics, Ghatak and Thyagarajan, Combridge University Press
(4) Satellite Technology and Its Applications P.R.K. Chetty, TAB Books Inc; 2nd edition
(5) Computer Networks, Tanenbaum, Prentice-Hall, India
(6) Foundations of IT and Computers, Himadri Barman, Second Edition (ISBN - 9789384303068), Mahaveer Publications, Dibrugarh

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Course title: The Universe
Course code: GECPHY3A
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives:

1. To provide an overview of astronomy and cosmology.
2. To know about and understand the observed properties of physical systems that comprise the known universe, on various scales.

Unit	Content	L	T	P	M	Hours
Unit 1: Solar System	Planets: Formation of Solar System - planet types - planet atmospheres - extrasolar planets Sun : Solar Parameters, Solar Photosphere, Solar	10	-	-	15	10

	Atmosphere, Chromosphere. Corona, Solar Activity, solar flare					
Unit II: Stars and Galaxies	Stars: Measuring stellar characteristics (temperature, distance, luminosity, mass, size) -stellar evolution; Galaxies: Our Milky Way - Galactic structure - - Galaxy types - Galaxy formation, Hubble's Classification of Galaxies	9	-	-	15	9
Unit III: Constellation	Bright stars in night sky, constellation -Zodiacs , Orion, ursa major, ursa minor	6	-	-	10	6
Unit IV: Basic Astronomy	Astronomical Distance - light years and parsec , Mass and Time Scales, Stellar mass and temperature, Astronomical Quantities measurement and Astronomical Distances,	8	-	-	15	8
Unit V: Basic Cosmology	History of the Universe, Big Bang Model, Expansion of the Universe, fate of the Universe Other stellar objects: White dwarf, Black hole, nebula ,supernova ,comets and Kuiper belt (L-10,M)	8	-	-	15	8
Unit VI: Astronomical telescope	Hubble telescope, James webb telescope	4	-	-	10	4
	Total	**45**	**-**	**-**	**80**	**45**

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

Mode of In-Semester assessment:

1. One Internal Exam (10 Marks)
2. Presentation/ Viva-Voce/ Quiz/ Classroom-Interaction (10 Marks)

Learning outcomes:

1. Acquire knowledge of the Physical universe and its evolution.
2. Have a solid understanding in many areas of modern astronomy and their basic underlying physical principles.

Suggested Readings:

(1) Introduction to Astronomy From Darkness to Blazing Glory , Jeffrey Wright Scott, Minuteman Press,California

(2) Astronomy for beginners , Jeff Becan and Sarah Becan

(3) Astronomy For Beginners: The Introduction Guide To Space, Cosmos, Galaxies And Celestial Bodies, Sally r Ball,Han Global Trading Pte Ltd

(4) Stargazing: Beginners Guide to Astronomy, Radmila Topalovic and Tom Kerss, Collins publication,
(5) Astronomy: The Complete Beginners Guide to Discover Stars and Astronomy (A Very Short Introduction to Astronomy), Nicole Carlisle, Publisher Andrew Zen

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Course title: Atmosphere of the Earth
Course code: GECPHY3B
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives:

1. Introduce the Earth's atmosphere
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 other solar system planets

Unit	Content	L	T	P	M	Hours
Unit 1: Introduction	1.1: Evolution of the Earth Atmosphere, layers of the Atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere, ionosphere: D, E, and F layers, Hydrostatic Balance	7	-	-	13	7
	1.2: Composition of the atmosphere: Atmospheric gases, aerosols, clouds	5	-	-	12	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: Greenhouse effect- natural, enhanced, Antarctic ozone hole, global warming	7	-	-	12	7
	2.2: Climate of the earth, climate change, adaptation and mitigation	7	-	-	12	7

Unit 3: Atmosphere of other solar system planets	3.1: Terrestrial planets: Physical properties and chemical composition, difference between Terrestrial and Jovian planets,	7	-	-	11	7
	3.2: Jovian planets: Physical properties and chemical composition, difference between gas and ice giants, rings in jovian planets	7	-	-	10	7
	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)**

Learning outcomes:

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

Suggested Readings:

1. Meteorology for Scientists and Engineers, R Stull, Brooks/Cole, Thomson Learning
2. Atmospheric Chemistry and Physics, J H Seinfeld and S N Pandis, John Wiley and Sons
3. Introduction to Atmospheric Physics, D G Andrews, Cambridge University Press
4. Fundamentals of Atmospheric Modelling, M Z Jacobson, Cambridge University Press.

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Detailed Syllabus of Skill Enhancement Courses

Course title: Electrical Circuits and Network Skills
Course code: SEC113

Nature of the course: Skill Enhancement Course
Total credits: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives:

1. Design and troubleshoot the electrical circuits, networks and appliances through hands on mode.
2. Build the basic foundation for learning electrical wiring and repairing other household equipment.

Unit	Content	L	T	P	M	Hours
	1-credit theory					
Unit 1: Basic Electricity Principles	Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC, Electricity. Familiarization with multimeter, voltmeter and ammeter.	2	-	-	5	2
Unit 2: Understanding Electrical Circuits	Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.	2	-	-	5	2
Unit 3: Electrical Drawing and Symbols	Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identifying current flow and voltage drop.	2	-	-	5	2
Unit 4: Generators	DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.	1	-	-	3	1

and Transformers						
Unit 5: Electric Motors	Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heater and motors, speed and power of ac motor	2	-	-	5	2
Unit 6: Solid State Devices	Resistors, inductors and capacitors , Diode and rectifiers, Components in series or in shunt, Response of Inductors and capacitors with AC or DC sources.	1	-	-	4	1
Unit 7: Electrical Protections	Relays, fuses and disconnect switches, Circuit breakers, Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)	2	-	-	5	2
Unit 8: Electrical Wiring	Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of the extension board.	3	-	-	8	3
	2-credits practical **(Demonstration and Laboratory)**					
Lab	1. Identify different electrical components: Resistor, Capacitor, variable resistor, Rheostat, dc voltage sources: battery, battery eliminator, power supply. 2. Use ammeter and voltmeter in a circuit and measure current and voltage 3. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and Checking electrical continuity and fuses. 4. Connect resistances in series and parallel and measure the equivalent resistance using multimeter 5. Build a dc circuit using elements like battery, resistances and switch and measure current flow and voltage drop across the components. 6. Demonstration of dc motor and ac motor (like motor of a fan) and identify the differences between them.	-	-	30	40	60

	7. Identify the electronic components like rectifying diodes, Zener diodes, transistor, carbon resistance, capacitors, and test them with multimeter. 8. Read electrical diagrams and draw an electrical diagram of room with proper symbols. 9. To study & find the specifications of various types of wires and cables. 10. Demonstrate different types of Splices (knot) and joints and practice. 11. Demonstration of different types of connectors used in electrical circuits: split bolts connector, Terminal blocks etc. 12. Identify the different types of Protection Devices: that prevents from electrical damages: Fuse, Circuit Breaker, MCB, Lighting Arrester 13. Demonstrate a distribution box with connections. 14. Preparation of extension board with switches, sockets and indicator.					
	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:

1. Design and troubleshoot certain electrical circuits and domestic appliances along with the understanding of the working of those appliances.
2. Do electrical wiring and repairing. This knowledge will develop the skill of the students for various electrical repairing and servicing purposes.

Recommended readings:

- A textbook in Electrical Technology - B L Theraja - S Chand & Co.
- A textbook of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

Course title: Electrical Wiring and Maintenance
Course code: SEC114
Nature of the course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives: The aim of this course is to

1. Develop the skill of the students in domestic wiring and troubleshooting the electrical circuits specially electrical wiring and common household appliances through hands-on mode.
2. To prepare a working diagram of electrical wiring for a house/ building and install and commission electrical wiring and maintenance in domestic applications.

Unit	Content	L	T	P	M	Hours
	1-credit theory					
Unit 1: Basics of Electrical Circuits	Introductory concepts and basic circuit elements: Concept of Electric current and its unit, Conductors, Insulators, Resistance, potential and potential difference-units- different voltage sources (AC and DC)- Effects of current- - Ohm's law, heating effect of current, Joule's law of heating, electric power, electric energy, Analysis of DC circuits; Kirchhoff's laws: KCL, KVL, Current and voltage drop across the DC circuit elements. Series circuit, parallel circuit, combination circuit, . AC current and voltage, single-phase and three-phase alternating current sources, Transformers, transmission of AC Unit of power and energy, kWh, KVA. Different types of light sources like filament bulb, tube (fluorescent) light, CFL, LED and Neon light, Different types of switches, two way, three way, four way switches, fan regulators, dimmer, different types of domestic electrical appliances and their power.	4	-	-	12	4
Unit 2: Types of wiring	Various types of tools and wiring accessories, Basics of wiring: casing-capping, PVC conduit wiring, concealed wiring (PVC/MS), comparison of different wire joint (flat and straight), types of wiring systems; selection and design of wiring schemes for particular situation (domestic), selection of wire, cables, wiring accessories and use of protective devices i.e., MCB, ELCB etc.; rating and current carrying capacity of wires, cables, fuse,	2	-	-	6	2

	switches, socket, MCBs, ELCBs and other electrical accessories.					
Unit 3: Electrical Drawing and Symbols	Different types of electrical symbols used in domestic installation and power systems as per BIS code. Electrical Schematics. Power circuits and control circuits. Reading of circuit schematics. Understanding the connections of elements and identifying current flow and voltage drop. Wiring diagram of light, fan, bell and alarm circuit, staircase wiring, schematic diagram of lighting system of small room, hall and conference room, circuit breakers, inverter connections, Design and drawing of panels, distribution board using MCB, ELCB, main switches and change over switches for domestic installations, Estimation of electrical materials for domestic wiring.	6	-	-	12	6
Unit 4: Electrical Protection and Safety	Earthing: Concept and purpose of earthing, different types and procedure of earthing, drawing of plate and pipe earthing, test material and costing and estimating. Safety precautions: Effect of electric shock on human body, first aid for electric shock-rules and standards in house wiring, Introduction to Lightning Arresters – Types - Necessity and Advantages - Layout and Installation, Electrical Hazards and its effects - Basic safety introduction - Personal protection and PPE - Basic injury prevention - Basic first aid - Hazard identification and avoidance	3	-	-	10	3
	2-credits practical: **Demonstration and Laboratory**					
Lab	1. Safety use in electricity, shock treatment methods, safety precautions. 2. To study & find the specifications of various types of wires and cables. 3. To measure the gauge of a given wire with the help of a wire gauge. 4. Prepare a chart of wattage of different electrical items/ appliances like CFL bulb, LED bulb, Tube light, Ceiling Fan, Table Fan, Gyger, Mixer-grinder, Refrigerator, Water pump, Iron, Xerox Machine, Inverter, TV, Hanging/ pendant Light, Microwave oven etc. 5. Measurements of ac voltage with multimeter. 6. To connect the wires with different electrical accessories. 8. Skinning the cable and joint practice on single and multi-strand wire.	-	-	30	40	60

	9. To make a main switch board for house wiring 10. Installation of common electrical accessories such as switch, holder, plug on board 11. Installation and wiring connection of ceiling fan, exhaust fan, geyser, and water purifier. 12. Preparation of extension board with switches, sockets and indicator. 13. Demonstrate electrical circuit diagrams related to electrical household appliances. 14. Carry out the earthing of the installed electrical circuit as per standard practice 15. Practice on different types of House Wiring installation and testing 16. House wiring circuits using fuse, switches, sockets, ceiling fan etc. in P.V.C. casing-capping. 17. Prepare one estimate of materials required for CTS wiring for small domestic installation of one room and one verandah within 25 m^2 with given light, fan & plug points.					
	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 successful completion of this course students will be able to identify various electrical devices, circuits and their symbols, familiar with schematic and wiring diagrams of electrical devices, understand electrical installation plan, perform and practice any type of domestic wiring and its maintenance.

Suggested readings:

1. Elementary Electrical Engineering- M.L. Gupta (New Heights)
2. Electrical Installation and Estimating- Surjit Singh, Dhanpatrai and sons
3. A course in Electrical Installation, Estimating and costing- J B Gupta, S K Kataria and Sons
4. A textbook in Electrical Technology - B L Theraja - S Chand & Co.
5. A textbook of Electrical Technology - A K Theraja

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Course Title: Basic Instrumentation Skills
Course Code: SEC213
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
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
	1-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
	2-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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Course Title: Computational Physics Skills
Course Code: SEC313
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

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.

1. Highlights the use of computational methods to solve physical problems.
2. Use of computer language as a tool in solving physics problems.

Unit	Content	L	T	P	M	Hours
	1-credit theory					

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.	3	-	-	8	3
Unit 2: Scientific Programming	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: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/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.	3	-	-	8	3
Unit 3: Control Statements	Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic 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	3	-	-	8	3

	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 tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.	3	-	-	8	3
Unit 5: Visualization	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, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot	3	-	-	8	3
	2-credits practical					
	Programming: 1. Exercises on syntax on usage of FORTRANUsage 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 exercises:**	-	-	30	40	60

	1. To compile a frequency distribution and evaluate mean, standard deviation etc. 2. To evaluate the sum of a 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 a 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 horizontal. 8. Creating an input Gnuplot file for plotting 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 a particle in a central force field and plot the output for visualization.					
	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 successful completion of this course the student will be able 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.

References:

- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt.

Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
- Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn . , 2 007, Wiley India Edition.

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Course title: Renewable Energy and Energy Harvesting
Course code: SEC314
Nature of the course: Skill Enhancement Course
Total credits: 3
Distribution of credits: Theory – 2, Practical - 1
Distribution of marks: 80 (End sem) **+ 20** (In-sem)

Course objectives: The aim of this course is

1. To impart theoretical knowledge to the students as well as to provide them with exposure and hands-on learning wherever possible.

Unit	**Content**	**L**	**T**	**P**	**M**	**Hours**
	2-credits theory					
Unit 1: Fossil fuels and Alternative 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	-	-	6	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	-	-	6	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.	4	-	-	4	4
Unit 4: Ocean Energy	Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.	2	-	-	4	2
	Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Biomass.	2	-		4	2
Unit 5: Geothermal Energy	Geothermal Resources, Geothermal Technologies.	2	-		3	2
Unit 6: Hydro Energy	Hydropower resources, hydropower technologies, environmental impact of hydro power sources.	2	-		3	2
Unit 7: 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	3	-		4	3
Unit 8: Electromagnetic Energy Harvesting	Linear generators, physics mathematical models, recent applications	2	-		2	2
	Carbon captured technologies, cell, batteries, power consumption.	2	-		2	2
	Environmental issues and Renewable sources of energy, sustainability.	2	-		2	2

	1-credit practical: **Demonstrations and Experiments/ 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**	-	-	22	40	44
	Total	**31**	**-**	**22**	**80**	**75**

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

Mode of In-semester assessment:

Class test / Viva-voce / Assignments / Notebook/ Attendence **(Marks 20)**

Mode of End-semester assessment:

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

Project for 1 credit **(Marks 40)**

Learning outcomes:

After successful completion of this course the student will be able to

1. know about the different energy sources and their technologies
2. Know about different renewable sources of energy
3. understand the concepts Renewable energy conversion technologies,

References:

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

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Detailed Syllabus of Minor Courses

Course title: Mechanics
Course code: MINPHY1
Nature of the course: Minor
Total credits: 4
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.	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, Stable and Unstable Equilibrium	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 of Matter	**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, Lorentz contraction, Time dilation. Relativistic addition of Velocities, Variation of Mass with Velocity, Mass-energy Equivalence.	15	-	-	25	15
	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 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.
5. Realize the consequences of a non-inertial frame in our real physical world.

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
- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

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Course title: Waves and Optics
Course code: MINPHY2
Nature of the course: Minor
Total credits: 4
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	5	-	-	5	5

	Strings, Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton's Formula for Velocity of Sound, Laplace's Correction.					
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 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.	10	-	-	20	10
Unit 4: Wave optics	Electromagnetic nature of light, definition and properties of wave front, Huygens principle, Temporal and Spatial coherence	5	-	-	5	5
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 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)

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. Learn 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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Course title: General Lab 1
Course code: MINPHY3
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 80 (End sem) **+ 20** (In-sem)

Course objective: This course will

(1) Develop experimental skills of a learner in mechanics as well as in waves and optics.
(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.

Unit	Content	L	T	P	M	Hours
	List of experiments					
Unit 1: Mechanics	(1) To determine the height of a building using a Sextant. (2) To study the Motion of Spring and calculate (a) Spring constant, (b) ***g*** and (c) Modulus of rigidity. (3) To determine the Moment of Inertia of a Flywheel. (4) To determine ***g*** and velocity for a freely falling body using Digital Timing Technique.	-	-	30	40	60

	(5) To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). (6) To determine the Young's Modulus of a Wire by Optical Lever Method. (7) To determine the Modulus of Rigidity of a Wire by Maxwell's needle. (8) To determine the elastic Constants of a wire by Searle's method. (9) To determine the value of ***g*** using Bar Pendulum. (10) To determine the value of***g*** using Kater's Pendulum.					
Unit II: Waves and Optics	(1) To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law. (2) To determine the phase difference between two waves using Lissajous Figures. (3) To determine the refractive index of the Material of a prism using sodium source. (4) To determine the dispersive power and Cauchy constants of the material of a prism using mercury source. (5) To determine the wavelength of sodium source using Michelson's interferometer. (6) To determine wavelength of sodium light using Fresnel Biprism. (7) To determine wavelength of sodium light using Newton's Rings. (8) To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. (9) To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating. (10) To determine dispersive power and resolving power of a plane diffraction grating.	-	-	30	40	60

	Total	**-**	**-**	**60**	**80**	**120**

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

At least 60% of the experiments must be performed from each unit.

Mode of In-semester assessment:

1. Viva-voce: Marks 10
2. Attendance / Laboratory performance / Notebook: Marks 10

Mode of End-semester assessment:

Laboratory experiments: Marks 80

Two experiments (not more than one from a single unit) from the list to be performed.

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

1. Apply theoretical knowledge in practical applications.
2. Identify and understand different phenomena due to the interaction of light with light and matter.
3. Analyze some of the important principles used in mechanics.

Recommended readings:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

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