SYLLABI FOR FOUR-YEAR UNDERGRADUATE PROGRAMME

IN

PHYSICS

AS PER NATIONAL EDUCATION POLICY (NEP) 2020

Recommended by the 1st meeting of the Board of Studies (BoS), Department of Physics, and approved by the 1st meeting of the Academic Council of Lakhimpur Girls' College (A), held on 28 June 2026, vide Resolution No. AC/1/2026/05.

LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

NORTH LAKHIMPUR, LAKHIMPUR -787031, ASSAM

Endorsed syllabi of Dibrugarh University as model syllabi for the development of syllabi of the Department of Physics, Lakhimpur Girls' College (A), with necessary modifications and additions, keeping in view the context and academic requirements.

FYUGP SYLLABI
DEPARTMENT OF PHYSICS
LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

Aim and Objectives

The goals and objectives of FYUGP should aim to:

1. Making aware of Indian knowledge system relating to physical science.
2. 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.
3. Learn, design, and conduct experiments in laboratories to demonstrate the concepts, principles,
4. 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, 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

PO1: Indian knowledge system: Making aware of Indian knowledge system relating to physical science.

PO2: Disciplinary knowledge: Students will **develop** an adequate foundation of theoretical concepts and experimental techniques in physics.

PO3: Problem solving capacity: Students will be able to **apply** the knowledge of physics to **solve** problems using mathematical tools, experimental methods and computational techniques in relevant areas.

PO4: Communication and presentation skills: Students will be able to communicate effectively about their understanding, ideas and findings to **explain** natural phenomena.

PO5: Analytical and critical thinking: Students will be able to **evaluate** the validity of information and evidence as well as to **assess** different methodologies & tools. They will be able to critically **analyze** the existing knowledge and diverse situations.

PO6: Digital and ICT efficiency: Students will be able to **use** modern ICT tools in a variety of learning environments for knowledge gain, and work situations to broaden the capability and improve efficiency.

PO7: Teamwork and leadership: Students will be able to **develop** teamwork and leadership abilities to work effectively in a co-operative and coordinated manner within diverse teams and peer groups.

PO8: Research and inquiry: The students will **develop** the skills of observation and inquiries, and the ability to identify and articulate problems/issues.

PO9: Multidisciplinary learning: Students will be able to **analyze** a problem through a multidisciplinary approach.

PO10: Ethics and Values: Students will **comply with** ethical conduct and adhere to professional standards in learning.

PO11: Employability and entrepreneurial skills: Students will **acquire** adequate skills and knowledge to become employable and/or entrepreneur.

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

A. Assessment Method for a Theory-based Major Course: The assessment of a 4-credit theory-based Major course will be performed over a total of 100 marks which is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for an end semester examination.

▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme:

Activity	**Marks**
1st In-Semester Examination	10
2nd In-Semester Examination	10
Student's activities- Seminar/presentation, assignment, regularity, classroom activity etc. (at least two activities)	20

▪ **End Semester Examination:**
Total Marks: **60**
Duration of examination: As per the Autonomous college guidelines.
The question paper shall be set as per the Autonomous college guidelines.

B. Assessment Method for a Practical/ Laboratory-based Major Course: The entire assessment of a 4-credit practical-based Core course will be performed over a total of 100 marks which is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for an end semester examination.
▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme:

Activity	**Marks**
Attendance	10
Maintenance of Laboratory Notebook	10
Viva-voce on performed experiments	20

▪ **End Semester Examination:**
Total Marks: **60**
Duration of examination: As per the Autonomous college guidelines.
One experiment to be performed.
Evaluation of 60 marks on the performed experiment shall be done as per the Autonomous college guidelines.

C. Assessment Method for a Theory-based Discipline Specific Elective (DSE) Course: The assessment of a 4-credit theory-based DSE course will be performed over a total of 100 marks which

is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for an end semester examination.

▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme:

Activity	**Marks**
1st In-Semester Examination	10
2nd In-Semester Examination	10
Student's activities- Seminar/presentation, assignment, regularity, classroom activity etc. (at least two activities)	20

▪ **End Semester Examination:**

Total Marks: **60**

Duration of examination: As per the Autonomous college guidelines.

The question paper shall be set as per the Autonomous college guidelines.

D. Assessment Method for a Practical/ Laboratory-based Discipline Specific Elective (DSE) Course: The entire assessment of a 4-credit practical-based DSE course will be performed over a total of 100 marks which is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for an end semester examination.

▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme:

Activity	**Marks**
Attendance	10
Maintenance of Laboratory Notebook	10
Viva-voce on performed experiments	20

▪ **End Semester Examination:**

Total Marks: **60**

Duration of examination: As per the Autonomous college guidelines.

One experiment to be performed.

Evaluation of 60 marks on the performed experiment shall be done as per the Autonomous college guidelines.

E. Assessment Method for a Theory-based Minor Course: The assessment of a 4-credit theory based Minor course will be performed over a total of 100 marks which is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for an end semester examination.

▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme

Activity	**Marks**
1st In-Semester Examination	10
2nd In-Semester Examination	10
Student's activities- Seminar/presentation, assignment, regularity, classroom activity etc. (at least two activities)	20

▪ **End Semester Examination:**
Total Marks: **60**
Duration of examination: As per the Autonomous college guidelines.
The question paper shall be set as per the Autonomous college guidelines.

F. Assessment Method for a Practical/ Laboratory-based Minor Course:
The entire assessment of a 4-credit practical-based Minor course will be performed over a total of 100 marks which is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for a end semester examination.
▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme:

Activity	**Marks**
Attendance	10
Maintenance of Laboratory Notebook	10
Viva-voce on performed experiments	20

▪ **End Semester Examination:**
Total Marks: **60**
Duration of examination: As per the Autonomous college guidelines.
One experiment to be performed.
Evaluation of 60 marks on the performed experiment shall be done as per the Autonomous college guidelines.

G. Assessment Method for a Skill Enhancement Course (SEC): The assessment of a 3-credit [1 (T) + 2 (P)] SE Course will be performed over a total of 100 marks which is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for an end semester examination.

▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme:

Activity	Marks
One In-semester Theory Examination	10
Attendance/Classroom and Laboratory activity/ Performance/Maintenance of Laboratory Notebook	10
Viva-voce	20

▪ **End Semester Examination:**
Total Marks: **60**
Duration of examination: As per the Autonomous college guidelines.
One experiment to be performed.
Evaluation of 60 marks on the performed experiment shall be done as per the Autonomous college guidelines

Type of examination	Marks
One In-semester Theory Examination	30
Practical/Hands-on examination for 2-credit practical	30

The question paper for 1-credit theory examination shall be set as per the Autonomous college guidelines.
The evaluation of 30 marks in the 2-credit laboratory/ practical/ hand-on exercise examination be done as per the Autonomous college guidelines.

H. Assessment Method for a Generic Elective Course (GEC): The assessment of a 3-credit GE course will be performed over a total of 100 marks which is distributed as: (i) 40 marks for internal assessment and (ii) 60 marks for an end semester examination.

▪ **Mode of Internal Assessment:** The internal assessment shall be based on a continuous formative evaluation process over the entire semester. Evaluation of 40 marks shall be done as per the following scheme

Activity	Marks
1st In-Semester Examination	10
2nd In-Semester Examination	10
Student's activities- Seminar/presentation, assignment, regularity, classroom activity etc. (at least two activities)	20

▪ **End Semester Examination:**
Total Marks: **60**
Duration of examination: As per the Autonomous college guidelines.
The question paper shall be set as per the Autonomous college guidelines.

General structure and distribution of number of Courses in the FYUGP in Physics

Semester	Major (4)	Minor (4)	AEC (4)	GEC (3)	SEC (3)	VAC (2)	Intern./ CE/ Project (4)	Research	DSE (4)	Total Credit
I	1	1	1	1	1	1	x	x	x	20
II	1	1	1	1	1	1	x	x	x	20
III	2	1	x	1	1	1	x	x	x	20
IV	4	1	x	x	x	x	x	x	x	20
V	3	1	x	x	x	x	1	x	x	20
VI	3	1	x	x	x	x	x	x	x	20
VII	3	1	x	x	x	x	x	RM (4)	x	20
VIII	3	1	x	x	x	x	x	Diss. (8)	2 (In lieu of Diss.)	20

PROGRAMME STRUCTURE

Year	Semester	Course	Title of the Course	Total Credits
Year 01	1st semester	PHY-MAJ-4-101	Mechanics and Properties of Matter ***(With IKS-1)***	**4**
		PHY-MIN-4-101	Mechanics (for disciplines other than Physics) ***(With IKS-1)***	**4**
		ASM- AEC-4-101 /HIN-AEC-4-101	Modern Indian Languages – Assamese/ Hindi	**4**
		PHY-GEC-3-101	Evolution of Science / Introduction to Communication Technology ***(With IKS-1)***	**3**
		PHY-SEC-3-101	Electrical circuits and Network Skills / Electrical Wiring and Maintenance / **Basic Electronic Skills and LED Technology**	**3**
		UGP-VAC-2-101/ UGP-VAC-2-101	Understanding India/ Health and Wellness	**2**
			Total of Semester 1	**20**
	2nd Semester	PHY-MAJ-4-201	Waves and Optics ***(With IKS-2)***	**4**
		PHY-MIN-4-201	Waves and Optics (for disciplines other than Physics) ***(With IKS-2)***	**4**
		ENG-AEC-4-201	English Language and Communication Skills	**4**
		PHY-GEC-3-201	Materials Today / Digital and Space Technologies ***(With IKS-2)***	**3**
		PHY-SEC-3-201	Basic Instrumentation Skills/ Mastering Productivity with Google Workspace/**Advanced LED Applications, Repairing & Entrepreneurship**	**3**
		UGP-VAC-2-201	Value Added Course	**2**
			Total of Semester 2	**20**

	Grand Total (Semester 1 and 2)			**40**
Students who wish to exit after the 2nd semesters will undergo a 4-credit internship/apprenticeship during the summer term in order to get a UG Certificate.				
Year 02	3rd Semester	PHY-MAJ-4-301	Mathematical Physics I ***(With IKS-3)***	**4**
		PHY-MAJ-4-302	Physics Lab (Major)	**4**
		PHY-MIN-4-301	Physics Lab I (Minor) (for disciplines other than Physics)	**4**
		PHY-GEC-3-301	The Universe /Atmosphere of the Earth and Climate Change ***(With IKS-3)***	**3**
		PHY-SEC-3-301	Computational Physics Skills / Renewable Energy and Energy Harvesting/**Mobile Phone Repairing Technology**	**3**
		UGP-VAC-2-301	Value Added Course	**2**
			Total of Semester 3	**20**
	4th Semester	PHY-MAJ-4-401	Electricity and Magnetism ***(With IKS-4)***	**4**
		PHY-MAJ-4-402	Thermal Physics	**4**
		PHY-MAJ-4-403	Elements of Modern Physics	**4**
		PHY-MAJ-4-404	Physics Lab II (Major)	**4**
		PHY-MIN-4-401	Electricity and Magnetism (for disciplines other than Physics) ***(With IKS-3)***	**4**
			Total of Semester 4	**20**
	Grand Total (Semester 1 to 4)			**80**
Students who wish to exit after the 4th semester will undergo a 4-credit internship/apprenticeship during the summer term in order to get a UG Certificate.				
Year 03	5th Semester	PHY-MAJ-4-501	Mathematical Physics II	**4**
		PHY-MAJ-4-502	Quantum Mechanics I	**4**

		PHY-MAJ-4-503	Statistical Mechanics-I	**4**
		PHY-MIN-4-401	Thermal Physics (for disciplines other than Physics)	**4**
		Internship/ Community Engagement	Internship (2) + Comm. Engmnt (2) **OR** Internship (4) / Comm. Engmnt. (4)	**4**
			Total of Semester 5	**20**
	6th Semester	PHY-MAJ-4-601	Electromagnetic Theory	**4**
		PHY-MAJ-4-602	Condensed Matter Physics-I	**4**
		PHY-MAJ-4-603	Electronics-I	**4**
		PHY-MAJ-4-604	Physics Lab II (Major)	**4**
		PHY-MIN-4-601	Physics Lab II (Minor)	**4**
			Total of Semester 6	**20**
Grand Total (Semester 1 to 6)				**120**
Students on exit shall be awarded Bachelor of (in the field of study/ (discipline) Honours (3 years) after securing the requisite 120 credits on completion of Semester 6.				
Year 04	7th Semester	PHY-MAJ-4-701	Mathematical Physics III	**4**
		PHY-MAJ-4-702	Classical Mechanics	**4**
		PHY-MAJ-4-703	Quantum Mechanics II	**4**
		PHY-MIN-4-701	Elements of Modern Physics	**4**
		Research	Research Methodology	**4**
			Total of Semester 7	**20**
	8th Semester	PHY-MAJ-4-801	Condensed Matter Physics II	**4**
		PHY-MAJ-4-802	Electronics II	**4**

		PHY-MIN-4-801	Condensed Matter Physics	**4**
		Research / DSE	Research Project / Dissertation(8) **OR** DSE - I (4) + DSE - II (4)	**8**
			Total of Semester 8	**20**
	Grand Total (Semester 1 to 8)			**160**
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 160 credits on completion of Semester 8.				

NB: ***IKS Courses will be included for 3rd & 4th years during the period of adaption of the syllabus for these years.***

2nd Major Papers for Integrated Teachers' Education Programme (ITEP)

Year	Semester	Course	Title of the Course	Total Credits
Year 01	1st semester	PHY-MAJ-4-101	Mechanics and Properties of Matter ***(With IKS-1)***	**4**
		PHY-MAJ-4-301	Mathematical Physics I ***(With IKS-3)***	**4**
	2nd Semester	PHY-MAJ-4-201	Waves and Optics ***(With IKS-2)***	**4**
		PHY-MAJ-4-501	Electricity and Magnetism ***(With IKS-4)***	**4**
Year 02	3rd Semester	PHY-MAJ-4-301	Physics Lab (Major)	**4**
		PHY-MAJ-4-501	Mathematical Physics II	**4**
		PHY-MAJ-4-502	Quantum Mechanics I	**4**
	4th Semester	PHY-MAJ-4-401	Thermal Physics	**4**
		PHY-MAJ-4-402	Elements of Modern Physics	**4**
		PHY-MAJ-4-403	Physics Lab II (Major)	**4**
		PHY-MAJ-4-601	Electromagnetic Theory	**4**
Year 03	5th Semester	PHY-MAJ-4-501	Statistical Mechanics-I	**4**
		PHY-MAJ-4-502	Mathematical Physics III	**4**
		PHY-MAJ-4-702	Classical Mechanics	**4**
	6th Semester	PHY-MAJ-4-601	Condensed Matter Physics-I	**4**
		PHY-MAJ-4-602	Electronics-I	**4**

NB: ***IKS Courses will be included for 2nd & 3rd years during the period of adaption of the syllabus for these years.***

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Abbreviations used:

1. MAJ = Major
2. GEC = Generic Elective Course / Multidisciplinary Course
3. AEC = Ability Enhancement Course
4. SEC = Skill Enhancement Course
5. VAC = Value Added Course
6. DSE = Discipline Specific Elective
7. PO = Programme Outcome
8. LO = Learning Outcome
9. L = Lectures
10. T = Theory Class
11. P = Practical Class
12. M = Marks
13. H = Hours

DETAILED SYLLABUS OF CORE COURSES

SEMESTER I

Course title: Mechanics and Properties of Matter *(With IKS-1)*
Course code: PHY-MAJ-4-101
Nature of the course: Core
Total credits: 4
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Description: This course comprises Indian origin of the basic ideas of physical sciences, Newtonian mechanics and the fundamental laws of motion. It focuses on important topics in mechanics such as reference frames, work-energy theorems, conservation laws, matter and its properties, types of oscillations, and fundamental ideas about the special theory of relativity for undergraduate students. It aims to provide students with a deep understanding of the laws governing the motion of objects and the nature of space and time.

Course Objectives: The course aims to impart knowledge of Newtonian mechanics, the properties of matter, oscillations, and rotating frames, as well as their role in relevant areas of physics. It will help the students develop the concepts of the special theory of relativity and help them understand space and time more.

Course Outcomes (COs): After the completion of the course, a student will be able to

CO1: Describe the Indian origin of the basic ideas of physical sciences.
- **LO1.1:** Describe the Indian origin of the basic ideas of physical sciences.

CO2: Understand the basic concepts of mechanics, reference frames, and conservation laws.
- **LO2.1:** Define key terms related to mechanics.
- **LO2.2:** Explain linear dynamics and rotational dynamics.
- **LO2.3**: Interpret relative transformations and the invariance of laws of physics

CO3: Correlate the consequences of non-inertial frame to our real world.
- **LO3.1:** Identify the nature of fictitious forces and their effect on the real world.
- **LO3.2:** Classify these forces arising due to non-inertial frames.
- **LO3.3:** Solve problems related to non-inertial frames and fictitious forces.

CO4: Define elastic properties of matter
- **LO4.1**: Define elastic constants of solid materials
- **LO4.2**: Establish relations among elastic constants of solid materials
- **LO4.3**: Describe motion of fluids through a pipe

CO5: Compare special relativity with Newtonian relativity.
- **LO5.1:** Define key terms related to special theory of relativity.
- **LO5.2:** Contrast the changes in motion occurred due to relativistic speed and non-relativistic speed.
- **LO5.3:** Interpret equivalence of mass and energy, relativistic transformation of momentum and energy and relativistic effects such as relativistic.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO2.1 LO3.1 LO5.1 CO1	LO2.2 LO2.3 LO4.2 LO3.2 LO3.3 LO5.2 LO5.3 CO2	LO4.1 LO4.3	CO4		
Procedural		CO5		CO3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**W**									
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S			M	M		S
CO5	S	S	S	S			M	M		S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit 1: IKS-1

Vaiseṣika Philosophy/Sutra, Idea of anu or paramanu, Kanad's laws of motion, Comparision of Kanada's laws and Newton's laws of motion, Theory of Gravitation according to Bhaskaracharya. Five-layered Universe **(L 4, H 4, M 4)**

Unit 2:

2.1: Newtonian Mechanics

Frames of Reference, Inertial Frames, Galilean Transformations, Galilean Invariance; Dynamics of a System of Particles, Center of Mass, Principle of Conservation of Linear Momentum

(L 7, H 7, M 7)

2.2: 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. **(L7, H 7, M 7)**

2.3: 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 **(L 9, H 9, M 9)**

Unit 3:

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. **(L 8, H 8, M 8)**

Unit 4:

Properties of Matter

4.1: Elasticity and Elastic Constants, Relation between Elastic constants, Twisting torque on a Cylinder or Wire. **(L 6, H 6, M 6)**

4.2: Kinematics of Moving Fluids, Poiseuille's Equation for Flow of a Liquid through a capillary Tube. **(L 5, H 5, M 5)**

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

(L 14, H 14, M 14)

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Indian Contribution to Science, *Vijnana Bharati*
2. A Concise History of Science in India, Indian National Science Academy
3. An introduction to Mechanics, *D. Kleppner, R. J. Kolenkow*, Cambridge University Press.
4. Mechanics: Berkeley Physics Course Vol. 1, *C. Kittel, W. Knight, et.al.*, Tata McGraw- Hill.
5. Fundamentals of Physics, *Halliday, Resnick, Walker,* John Wiley & Sons.
6. University Physics, *R. L. Reese*, Brooks/Cole Publishing Company.
7. Introduction to Special Relativity, *R. Resnick*, John Wiley & Sons.
8. Mechanics, *D. S. Mathur*, S. Chand and Company Ltd.
9. Theoretical Mechanics (Schaum's Outline series), *M. R. Spiegel*, Tata McGraw Hill.
10. Analytical Mechanics, *G. R. Fowles and G. L. Cassiday*, Thomson Brooks/Cole.

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SEMESTER II

Course title: Waves and Optics *(With IKS-2)*
Course code: PHY-MAJ-4-201
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides Indian origin to the field of sound and light and an introduction to the basic concepts of waves, oscillation, and optics. It aims to provide knowledge about superposition principles, give comprehensive ideas about simple harmonic oscillations, and introduce wave concepts, including group velocities and phase velocities. It depicts the electromagnetic nature of light and enters the domain of optics by providing in depth knowledge of optical phenomena and optical instruments based on these phenomena to undergraduate students.

Course Objectives: This course aims to develop theoretical knowledge of waves, oscillations, and the superposition principle. The course provides fundamental concepts in the study of wave phenomena and the behavior of light, especially in thin films. To acquaint the learner with the principles behind various optical instruments and to build a theoretical knowledge of them

Course Outcomes (COs): At the completion of the course, a student will be able to

CO1: Acquire the knowledge of Indian origin to the field of sound and light.
- **LO1.1:** Describe the basic origin of Indian concept sound and light

CO2: Analyze the principle of linearity and superposition, concepts of wave motion and standing waves.
- **LO2.1:** Define superposition, plane and spherical waves, and stationary waves.
- **LO2.2:** Explain the superposition of waves, the velocity of longitudinal and transverse waves in different media, and the role of standing waves in different physical systems.
- **LO2.3:** Construct Lissajous figures and develop the differential equation of a wave.

CO3: Connect the knowledge obtained from the wave with the behavior of light.
- **LO3.1:** Explain the phenomenon of interference in thin films.
- **LO3.2:** Develop theoretical knowledge of various optical instruments.
- **LO3.3:** Illustrate key concepts of diffraction.

CO4: Analyze simple harmonic oscillators in detail.
- **LO4.1:** Explain simple harmonic motion in an oscillatory system.
- **LO4.2:** Solve the differential equation of simple harmonic motion.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual	LO1.1 LO2.1 CO1	LO2.2 LO3.1 LO3.3	LO2.3 LO3.2 LO4.1 LO4.2	CO2 CO3 CO4		
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	W	S	S	S			M	M		S
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S			M	M		S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit 1: IKS-2: Vedic philosophy of light and sound (*Vāk*) -four stages—Para, Pashyanti, Madhyama, and Vaikhari, (Tejas Theory) - Early philosophical inquiry into the speed and particle nature of light. Mirrors and Lenses in Ancient Indian Architecture **(L 4, H 4, M 4)**

Unit 2: Superposition of Harmonic Oscillations

2.1: Linearity and Superposition Principle. Superposition of two collinear harmonic oscillations having equal frequencies and different frequencies (Beats). Superposition of N collinear harmonic oscillations with equal phase differences and equal frequency differences **(L 5, H 5, M 5)**

2.2: Graphical and Analytical Methods: Lissajous Figures with equal and unequal frequency and their use. **(L 3, H 3, M 3)**

Unit 3: Wave Motion

3.1: Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling), Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of a Wave **(L 3, H 3, M 3)**

3.2: Velocity of transverse vibrations of stretched strings, Velocity of longitudinal waves in a fluid in a pipe, Pressure of a longitudinal wave, Newton's formula for velocity of sound, Laplace's correction, Energy, power transport and intensity of wave **(L 6, H 6, M 6)**

Unit 4: Standing Waves

Standing (Stationary) Waves, Standing Waves in a String: Fixed and Free ends, Normal Modes of Stretched Strings, Comparison of Standing Wave with Travelling Waves, Plucked and Struck Strings, Melde's Experiment, Longitudinal Standing Waves in Open and Closed Pipes, Normal Modes of Longitudinal Waves, Phase and Group Velocities. **(L 6, H 6, M 6)**

Unit 5: 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. **(L 5, H 5, M 5)**

Unit 6: Wave optics

Electromagnetic nature of light, definition and properties of wave front, Huygens' principle, Temporal and Spatial coherence. (**L 3, H 3, M 3)**

Unit 7: Interference

7.1: Division of amplitude and wavefront, Young's double slit experiment, Phase change on reflection: Stokes' treatment, Fresnel's Biprism, Interference in Thin Films: parallel and wedge-shaped films. Newton's Rings: Measurement of wavelength and refractive index **(L 7, H 7, M 7)**

7.2: 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. Introduction to Fabry-Perot interferometer **(L 4, H 4, M 4)**

Unit 8: Diffraction

8.1: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula (Qualitative discussion only). **(L 2, H 2, M 2)**

8.2: Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit. **(L 6, H 6, M 6)**

8.3: Fraunhofer Diffraction: Single slit, Circular aperture. Resolving Power of a telescope, Double slit, Multiple slits. Diffraction grating, Resolving power of grating. **(L 6, H 6, M 6)**

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Indian Contribution to Science, *Vijnana Bharati*
2. A Concise History of Science in India, Indian National Science Academy
3. Waves: Berkeley Physics Course, *F. Crawford*, Tata McGraw-Hill.
4. Fundamentals of Optics, *F. A. Jenkins and H. E. White*, McGraw-Hill.
5. Principles of Optics, *M. Born and E. Wolf*, Pergamon Press.
6. Optics, *A. Ghatak*, Tata McGraw Hill.
7. Modern Optics, *A. B. Gupta*,Books & Allied (P) Ltd.
8. The Physics of Vibrations and Waves, *H. J. Pain*, John Wiley and Sons.
9. The Physics of Waves and Oscillations, *N. K. Bajaj*,Tata McGraw Hill.
10. Fundamental of Optics, *A. Kumar, H. R. Gulati and D. R. Khanna*,R. Chand Publications.

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SEMESTER III

Course title: Mathematical Physics – I *(With IKS-3)*
Nature of the course: Core
Course code: PHY-MAJ-4-301
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course contains Indian contribution to the field of Mathematics from ancient time and is an ensemble of mathematical tools and methods which are necessary to study different branches in physics. As a first course of mathematical physics at the undergraduate level, it covers a number of elementary topics such as calculus, vector calculus, orthogonal curvilinear co-ordinates, Dirac delta function and matrices. Apart from rigorous and detailed discussions on these topics, the course directs the students about their applications in physics.

Course Objectives: The aim of this course is to
1. Introduce a learner to a number of mathematical tools and methods.
2. Develop a basic understanding of these mathematical tools and methods.
3. Acquaint a learner with application of these mathematical tools and methods in physics.
4. Develop an adequate amount of mathematical skill among the learners to navigate through different areas in physics.

Course Outcomes (COs): At the completion of this course, a learner will be able to

CO1: Acquire the knowledge of Indian contribution to the field of Mathematics from ancient time.
- **LO1.1:** State the key developments of Mathematical knowledge in India.
- **LO1.2:** Describe the contributions of great Indian scientists in the field of Astronomy and Mathematics in ancient India.

CO2: Understand a few mathematical concepts and their importance in physics.
- **LO2.1:** Define key terms and operations in calculus, vector calculus, curvilinear coordinates, Dirac delta function and matrices.
- **LO2.2:** Explain the properties and rules of calculus, vector calculus, curvilinear coordinates, Dirac delta function and matrices.
- **LO2.3:** Describe a problem in physics in terms of calculus, vector calculus, curvilinear coordinates, Dirac delta function and matrices.

CO3: Apply the above mathematical concepts to solve problems.
- **LO3.1:** Solve advanced level mathematical problems based on the key concepts in calculus, vector calculus, curvilinear coordinates, Dirac delta function and matrices.
- **LO3.2:** Use calculus, vector calculus, curvilinear coordinates, Dirac delta function and matrices to solve problems in elementary branches of physics like mechanics, electromagnetic theory, thermal physics etc.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO1.2 CO1 LO2.1	LO2.2 LO2.3 CO2	LO2.1 LO2.2 CO2			
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	W									
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit-1: IKS-3

Early Historical Period, Concept of Zero, Number System, Arithmetic, Pythagoras theorem; Vedic Mathematics; Kerala School of Mathematics, Concept of Pi; Mathematician and Physicists in Ancient India. **(L 4, H 4, M 4)**

Unit 2: Calculus

2.1: Functions and their plotting, Continuity and Differentiability of functions, Approximation methods: Taylor series, Maclaurin series. **(L 2, H 2, M 2)**

2.2: 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. **(L 10, H 10, M 10)**

2.3: Calculus of functions of more than one variable: Partial Derivatives, Exact and Inexact Differentials, Integrating Factor, Constrained Maximization using Lagrange Multipliers.

(L 6, H 6, M 6)

Unit 3: Vector Calculus

3.1: Recapitulation of Vector algebra, Dot Product, Cross Product, Scalar Triple Product, Cartesian Components of a vector, Scalar and Vector Fields. **(L 2, H 2, M 2)**

3.2: 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. **(L 7, H 7, M 7)**

3.3: 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). **(L 12, H 12, M 12)**

Unit 4: Orthogonal Curvilinear Coordinates

Orthogonal Curvilinear Coordinates, Spherical Polar Coordinates, Cylindrical Coordinates; Derivation of Gradient, Divergence and Curl in Cartesian, Spherical and Cylindrical Coordinate Systems. **(L 8, H 8, M 8)**

Unit 5: Dirac Delta Function

Definition of Dirac Delta Function, Representation as limit of a Gaussian function and rectangular function, Properties of Dirac Delta Function **(L 3, H 3, M 3)**

Unit 6: 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. **(L 6, H 6, M 6)**

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended readings:

1. Indian Contribution to Science, *Vijnana Bharati*
2. A Concise History of Science in India, Indian National Science Academy
3. Mathematical Methods for Physicists, *G. B. Arfken, H. J. Weber, F. E. Harris*, Elsevier.
4. Mathematical Methods for Physics and Engineering, *K. F. Riley, M. P. Hobson, S. J. Bence*, Cambridge University Press.
5. An introduction to ordinary differential equations, *E. A. Coddington*, PHI learning.
6. Differential Equations, *G. F. Simmons*, McGraw Hill.
7. Mathematical Tools for Physics, *J. Nearing*, Dover Publications.
8. Mathematical methods for Scientists and Engineers, *D. A. McQuarrie*, University Science Books (USA).
9. Engineering Mathematics, *S. Pal and S. C. Bhunia*, Oxford University Press.
10. Advanced Engineering Mathematics, *Erwin Kreyszig*, Wiley India.

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Course title: Physics Lab I (Major)
Course code: PHY-MAJ-4-302
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The course on Physics Lab I (Major) comprises 10 experiments covering mechanics and properties of matter and 10 experiments from wave and optics. Experiments related to moment of inertia, coefficient of viscosity, Young's modulus, modulus of rigidity, bar pendulum and kater's pendulum are included to gain hands-on knowledge. Moreover, application of optical tools like prism, Michelson Interferometer, Fresnel biprism and Newton ring are included.

Course Objectives: The aims of the course are to

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.
3. To learn error propagation and its role in making conclusions.

Course Outcomes (COs): At the completion of the course, the students will be able to

CO1: Understand the idea of different phenomena in mechanics and wave optic.

- **LO1.1**: Explain the working of bar and Kater's pendulum and formation of Lissajous figures.
- **LO1.2**: Classify between spring constant and elastic constant like Young's Modulus and modulus of rigidity.
- **LO1.3:** Interpret the working of Michelson Interferometer, Fresnel biprism and Newton rings.

CO2: Apply theoretical knowledge of mechanics and wave optics in practical applications.

- **LO2.1**: Develop principles of elasticity to analyze mechanical systems.
- **LO2.2** Experiment with methods and techniques to conduct measurements, analyze data related to wavelength, diffraction and interference, dispersive and resolving power.
- **LO2.3**: Relate the experimental findings with the corresponding theory.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Appl y	Analyze	Evaluate	Create
Factual						
Conceptual		LO1.1 LO1.2 LO1.3	LO2.1			
Procedural			LO2.2 LO2.3			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	S	M	M	M
CO2	S	S	M	S	M	M	M	M	M	M

(S: Strong, M: Medium, W: Weak)

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.

Unit 2: Waves and Optics

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda 2 - T$ 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.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

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

Recommended Readings:

1. Advanced Practical Physics for students, *B. L. Flint and H. T. Worsnop,* Asia Publishing House.
2. Advanced level Physics Practicals, *M. Nelson and J. M. Ogborn*, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, *I. Prakash & Ramakrishna,* Kitab Mahal.
4. Engineering Practical Physics, *S. Panigrahi & B. Mallick*, Cengage Learning India Pvt. Ltd.
5. Practical Physics, *G.L. Squires,* Cambridge University Press.
6. A Laboratory Manual of Physics for undergraduate classes, *D. P. Khandelwal,* Vani Pub.

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SEMESTER IV

Course title: Electricity and Magnetism *(With IKS-4)*
Nature of the course: Core
Course code: PHY-MAJ-4-401
Total credit assigned: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course contains Indian origin of the basic ideas of physical sciences and provides a comprehensive introduction to the fundamental principles of electromagnetism, focusing on electrostatics and magnetostatics, as well as their potential applications in various contexts. The curriculum covers the behavior of electric fields, electric potential, and energy, exploring key concepts such as Gauss' law, Laplace's and Poisson's equations, and the method of images. It also delves into the dielectric properties of matter, the principles of magnetostatics, and the magnetic properties of materials. The course also examines electromagnetic induction, including Faraday's and Lenz's laws, and introduces Maxwell's equations. In addition, students will study electrical circuits, network theorems, and their applications to both AC and DC circuits. Through a combination of theoretical discussions and practical examples, this course aims to build a strong foundation in electromagnetism and its relevance to real-world phenomena and technological applications.

Course Objectives: The basic objective of this course is to

1. Introduce learners to the fundamental principles of electromagnetism.
2. Develop a basic understanding of electrostatics, magnetostatics, and electromagnetic induction.
3. Introduce learners to the dielectric properties of matter and the magnetic properties of materials.
4. Acquaint learners with key topics including network theorems, AC and DC circuits, and their

potential applications in real-world problems.

Course Outcomes (COs): After completion of the course the students will be able to

CO1: Acquire the knowledge of Indian origin of the basic ideas of physical sciences.
- **LO1.1:** Describe the key developments of Astronomy and Nano technology in India.
- **LO1.2:** Analyze how Vedic astronomical wisdom and architectural genius combined to create a sophisticated system for timekeeping and planetary observation.

CO2: Understand the fundamental laws of electromagnetism and their importance in Physics.
- **LO2.1**: Define the key concepts of electric and magnetic fields.
- **LO2.2**: Explain the basic laws of electrostatics, magnetostatics and electromagnetic induction.
- **LO2.3:** Describe the behavior of electric fields in matter and explain polarization phenomena.
- **LO2.4:** Discuss magnetic properties of materials, including hysteresis, using B-H curves and magnetization concepts.

CO3: Apply fundamental laws to solve practical problems.
- **LO3.1:** Use Gauss's law to solve problems involving symmetrical charge distributions.
- **LO3.2:** Solve different problems based on Laplace's, Poisson's equations and method of images.

CO4: Evaluate the behavior of electrical circuits and networks using different approaches
- **LO4.1:** Apply Thevenin's and Norton's Theorems to simplify complex circuits.
- **LO4.2:** Analyze AC circuits using Kirchhoff's laws and solve for complex impedances and reactance.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Appl y	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO1.2 CO1 LO2.1	LO2.2 LO2.3 LO2.4 CO2				
Procedural			LO3.1 LO3.2 LO4.1 CO3	LO4.2	CO4	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**

CO1	W									
CO2	S	M	S	S	M		M	M		M
CO3	S	S	S	S			S	S		M
CO4	S	S	S	S	S		S	S		S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit 1: IKS-4:

Ancient Indian Culture and Nanotechnology, Beginnings of Indian Astronomy. Traditional Wisdom of Astronomy in India: Jantar Mantar - Ancient Astronomical Observatories of India and some instruments, Laghu Samrat Yantra in Jaipur, Samrat Yantra, Rashivalaya (Star Sign), Ram Yantra, Misra Yantra

(L 4, H 4, M 4)

Unit 1: Electrostatics

1.1: Electric Field, Electric Lines of Force, Electric Flux, Gauss' Law with applications to charge distributions with Spherical, Cylindrical and Planar symmetry. **(L 5, H 5, M 5)**

1.2: Conservative nature of Electrostatic Field, Electrostatic Potential, Laplace's and Poisson equations, The Uniqueness Theorem, Potential and Electric Field of a dipole, Force and Torque on a Dipole.

(L 5, H 5, M 5)

1.3: Electrostatic Energy of System of Charges, Electrostatic Energy of a Charged Sphere, Conductors in an electrostatic field, Surface charge and force on a conductor, Capacitance of a system of charged conductors, Parallel-plate Capacitor, Capacitance of an isolated conductor, Method of Images and its application to (i) Plane Infinite Sheet and (ii) Sphere. **(L 9, H 9, M 9)**

Unit 2: Dielectric Properties of Matter

Electric Field in matter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant; Capacitor (parallel plate, spherical, cylindrical) filled with dielectric; Displacement vector **D**, Relations between Electric field vector **E**, Polarization vector **P** and **D**, Gauss' Law in dielectrics.

(L7, H 7, M 7)

Unit 3: Magnetostatics

3.1: Magnetic force between current elements and definition of Magnetic Field **B**, Biot-Savart's Law and its simple applications (straight wire and circular loop), Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole), Ampere's Circuital Law and its application to (i) Solenoid, Properties of **B**: curl and divergence, Vector Potential, Lorentz Force Law, Magnetic Force on (i) point charge (ii) current carrying wire (iii) between current elements, Torque on a current loop in a uniform Magnetic Field. **(L 9, H 9, M 9)**

3.2: Torque on a current loop, Ballistic Galvanometer, Current and Charge Sensitivity, Electromagnetic Damping, Logarithmic Damping, CDR. **(L 3, M 3, H 3)**

Unit 4: Magnetic Properties of Matter

Magnetization vector (**M),** Magnetic Intensity (**H),** Magnetic Susceptibility and permeability. Relation between **B, H** and **M**, Ferromagnetism. B-H curve and hysteresis **(L 4, H 4, M 4)**

Unit 5: Electromagnetic Induction

Faraday's Law, Lenz's Law, Self-Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations, Charge Conservation and Displacement current. **(L 6, H 6, M 6)**

Unit 6: Electrical Circuits

AC Circuits, Kirchhoff's Laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (i) Resonance, (ii) Power Dissipation (iii) Quality Factor and (iv) Band Width. Parallel LCR Circuit. **(L 4, H 4, M 4)**

Unit 7: Network Theorems

Ideal voltage and current Sources, Network Theorems: Thevenin Theorem, Norton Theorem, Superposition Theorem, Reciprocity Theorem, Maximum Power Transfer theorem, Applications to DC circuits **(L 4, H 4, M 4)**

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Journey of Science and Technology in India: A Historical Perspective, *Ajay Ghatak*, National Academy of Sciences
2, Indian Contribution to Science, *Vijnana Bharati*
3. Electricity, Magnetism & Electromagnetic Theory, *S. Mahajan and Choudhury*, Tata McGraw.
4. Electricity and Magnetism, *E. M. Purcell*, McGraw-Hill Education.
5. Introduction to Electrodynamics, *D. J. Griffiths*, Pearson Education.
6. Feynman Lectures Vol.2, *R. P. Feynman, R. B. Leighton, M. Sands*, Pearson Education.
7. Elements of Electromagnetics, *M. N. O. Sadiku*, Oxford University Press.
8. Electricity and Magnetism, *J. H. Fewkes & J. Yarwood*. Vol. I, Oxford University Press.

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Course title: Thermal Physics
Nature of the course: Core
Course code: PHY-MAJ-4-402
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course covers fundamental thermodynamic principles and kinetic theory of gasses. The course starts with the main laws of Thermodynamics, energy conservation, isothermal and adiabatic processes, and the relationship between specific heats. Heat engines, Carnot cycles, and entropy concepts are also explored thereafter. Thermodynamic potentials like internal energy, enthalpy, and Gibbs free energy are studied, alongside Maxwell's relations and their applications. The kinetic theory section addresses the Maxwell-Boltzmann distribution, molecular collisions, and real gas behavior. By course end, students will understand and will be able to apply thermodynamic principles to various physical systems.

Course Objectives: Thermal physics is essential as it provides foundational knowledge of energy transformation and conservation principles crucial for various scientific and engineering disciplines. Understanding thermodynamics is crucial for designing and optimizing engineering systems like engines, refrigerators, and power plants. The course is equipped to provide students with analytical and problem-solving skills, enabling them to apply thermodynamic laws to real-world situations. Additionally, thermodynamics intersects with fields like chemistry, biology, and materials science, making it highly relevant for interdisciplinary applications. This course prepares students for advanced studies and careers in science and engineering by equipping them with essential theoretical and practical skills.

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the fundamental principles of thermodynamics.
- **LO1.1:** Define extensive and intensive thermodynamic variables and their significance.
- **LO1.2:** Explain the Zeroth Law of Thermodynamics and its role in defining temperature.
- **LO1.3:** Interpret the First Law of Thermodynamics to analyze processes and calculate energy changes.

CO2: Experiment with apparatus for practical thermodynamic applications.
- **LO2.1:** Develop explanations for entropy changes in reversible and irreversible processes.
- **LO2.2:** Illustrate the implications of entropy in the context of the Second Law of Thermodynamics.

CO3: Apply thermodynamic potentials and their applications.
- **LO3.1:** Apply thermodynamic potentials such as internal energy, enthalpy, and Gibbs free energy to solve problems.
- **LO3.2:** Construct equations and relations using Clausius-Clapeyron and Ehrenfest equations.
- **LO3.3:** Summarize the performance of various thermodynamic cycles.

CO4: Analyze the behavior of gases and related phenomena.
- **LO4.1:** Describe the Maxwell-Boltzmann distribution and its significance.
- **LO4.2:** Analyze the behavior of real gases using the Van der Waals equation.
- **LO4.3:** Apply the Joule-Thomson effect to analyze gas cooling processes.
- **LO4.4:** Distinguish between reversible and irreversible processes and their implications.
- **LO4.5:** Identify the efficiency of heat engines and refrigerators using the Second Law of Thermodynamics.
- **LO4.6:** Explain the concept of entropy and its role in energy transformations.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	CO1, LO1.2	LO3.1, LO4.5	LO4.2		
Conceptual		LO1.3, LO2.2, LO3.3, LO4.1	LO2.1, CO3, LO4.3	CO4, LO4.4		
Procedural		LO4.6	CO2, LO3.2			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	W	W	W	W	M	W
CO2	S	S	M	S	M	W	W	W	M	M
CO3	S	S	M	S	M	W	S	M	M	S
CO4	S	S	M	S	M	M	S	M	W	S
CO5	S	S	M	S	M	W	M	M	W	M

(S: Strong, M: Medium, W: Weak)

Course Contents:

Thermodynamics

Unit 1: Zeroth and First Law of Thermodynamics

Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Temperature Coefficient of Resistance, Concept of Work & Heat, Mechanical Equivalent of Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient. **(L 8, H 8, M 8)**

Unit 2: Second Law of Thermodynamics

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Theorem, Carnot's Cycle, Carnot engine & efficiency. refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **(L 10, H 10, M 10)**

Unit 3: Entropy

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in termsof Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

(L 7, H 7, M 7)

Unit 4: Thermodynamic Potentials

4.1: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

(L 7, H 7, M 7)

4.2: Derivations and applications of Maxwell's Relations, Maxwell's Relations: (i) Clausius Clapeyron equation, (ii) Values of Cp-Cv, (iii) TdS Equations, (iv) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (v) Energy equations, (vi) Change of Temperature during Adiabatic Process.

(L 7, H 7, M 7)

Kinetic Theory of Gases

Unit 6: Distribution of Velocities

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific Heats of Gases.

(L 7, H 7, M 7)

Unit 7: Molecular Collisions

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (i) Viscosity, (ii) Thermal Conductivity and (iii) Diffusion. Brownian Motion and its Significance.

(L 4, H 4, M 4)

Unit 8: Real Gasses

Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waals Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.

(L 10, H 10, M 10)

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Heat and Thermodynamics, *M.W. Zemansky and R. Dittman,*McGraw-Hill.
2. A Treatise on Heat, *M. Saha, and B. N. Srivastava*, Indian Press.
3. Thermal Physics, *S. Garg, R. Bansal and Ghosh*, Tata McGraw-Hill.
4. Modern Thermodynamics with Statistical Mechanics, *C. S. Helrich*, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, *Sears & Salinger*, Narosa.
6. Concepts in Thermal Physics, *S. J. Blundell and K. M. Blundell*, 2012, Oxford University Press.
7. Thermal Physics, *A. Kumar and S. P. Taneja*, R. Chand Publications.

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Course title: Elements of Modern Physics
Course code: PHY-MAJ-4-403
Nature of the course: Core
Total credits: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course offers the fundamental principles of Physics from classical to quantum realms beginning by the nature of blackbody radiation, applying Kirchhoff's law, Stefan-Boltzmann law, and understanding the implications of Wien's displacement and distribution laws. It will explore deeper into quantum theory with investigations into the photoelectric effect, Compton scattering, and the wave-particle duality, including the De Broglie wavelength and matter waves. Moreover, to analyze nuclear reactions, energy release mechanisms in fission and fusion, and their applications in nuclear reactors and stellar energy processes will provide a comprehensive overview. Overall, this course integrates theoretical knowledge with practical applications, preparing students for advanced studies in physics and related disciplines.

Course Objectives:

1. To acquaint the learner with the theoretical developments of modern physics.
2. To deliver the key concepts of modern physics.
3. To impart the knowledge of nuclear physics.
4. To introduce the basics of laser physics.

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Analyze and apply concepts of both thermal radiation and quantum mechanics.

LO1.1: Explain and apply fundamental laws and principles such as blackbody

Radiation, Kirchhoff's law, Stefan-Boltzmann law, and Planck's Quantum Hypothesis.

LO1.2: Analyze the wave properties such as probability, amplitude, and functions.

CO2: Apply quantum mechanics principles.

LO2.1: Explain and apply the concept of wave-particle duality.

LO2.2: Use the uncertainty principle to estimate the minimum energy of confined particles.

CO3: Analyze of the fundamental properties of atomic nuclei.

LO3:1: Examine the theoretical nuclear models like the Liquid Drop Model and the Nuclear Shell Model.

LO3.2: Explain the nuclear stability, isotopic trends (N-Z graph), and the role of nuclear forces in atomic nuclei.

LO3.3: State advanced concepts such as mass defect, binding energy, nuclear spin, and magnetic moment.

CO4: Assess the principles of laser physics.

LO4.1: State basic lasing elements and concepts such as population inversion, optical pumping, and their role in achieving and maintaining laser operation.

LO4.2: Describe the operational principles of three-level and four-level lasers.

LO4.3: Distinguish the design considerations for different types of lasers and evaluate their suitability for various applications in technology.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO4.1 LO3.3					
Conceptual		LO1.1 LO2.1 LO3.2 LO4.2	LO2.2 CO2	LO1.2 LO2.3 LO3.1 LO4.3 CO1 CO3	CO4	
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	S	M	M	M	M	M	M
CO2	S	M	S	S	S	M	S	M	M	S

CO3	S	S	M	M	M	M	M	S	M	S
CO4	S	S	M	S	M	M	S	S	S	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit 1: Radiation Laws and Quantum Behaviours of Radiation

1.1: Blackbody Radiation, Kirchhoff's law, Stefan-Boltzmann law, Wien's Displacement law, Wien's Distribution Law, Rayleigh-Jeans Law, Ultraviolet Catastrophe, Planck's Quantum Hypothesis, Planck's Constant. **(L 7, H 7, M 7)**

1.2: Quantum theory of Light- Photo-electric Effect and Compton Scattering. De Broglie Wavelength and Matter Waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase Velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave Amplitude and Wave Functions **(L 9, H 9, M 9)**

Unit 2: Quantum Mechanical Principles

Position measurement-gamma ray microscope thought experiment, Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables), Estimating minimum energy of a confined particle using uncertainty principle, Energy-time uncertainty principle. **(L 6, H 6, M 6)**

Unit 3: Basic Properties and Models of Nucleus

Basic properties of Atomic Nucleus: Structure, Size, Mass, Density, Charge, Mass Defect, Binding Energy, Spin, Magnetic moment, Nonexistence of electrons in the nucleus as a consequence of the Uncertainty Principle, Properties of Nuclear Force, N-Z Graph, Liquid Drop Model: Semi-empirical Mass Formula, Nuclear Shell Model and Magic Numbers **(L 10, H 10, M 10)**

Unit 4: Radioactivity and Nuclear Reactions

4.1: Radioactivity: Stability of the Nucleus; Law of Radioactive Decay; Mean-life and Half-life; Alpha decay, Beta decay and Energy Spectrum, Pauli's Neutrino Hypothesis; Gamma Ray Emission, Electron-Positron Pair Creation by Gamma Photons in the vicinity of a nucleus. **(L 6, H 6, M 6)**

4.2: Nuclear reaction, Q-value, conservation laws; Fission and Fusion; Fission- nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium-235; Fusion and Thermonuclear Reactions driving stellar energy (brief qualitative discussions). **(L 14, H 14, M 14)**

Unit 5: Basics of Lasers

Metastable States, Spontaneous and Stimulated Emissions, Einstein's Relations, Optical and Electrical pumping, population inversion and light amplification, Ruby Laser and He-Ne Laser, Basic Lasing Action. **(L 8, H 8, M 8)**

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Concepts of Modern Physics, *A. Beiser*, Tata McGraw-Hill.

2. Introduction to Modern Physics, *F. K. Richtmyer, K. H. Kennard, J. N. Cooper*, Tata McGraw Hill.
3. Introduction to Quantum Mechanics, *D. J. Griffith*, Pearson Education.
4. Physics for Scientists and Engineers with Modern Physics, *Jewett and Serway*, Cengage Learning.
5. Modern Physics, *G. Kaur, G. R. Pickrell*, McGraw Hill.
6. Quantum Mechanics: Theory & Applications, *A. K. Ghatak, S. Lokanathan*, Macmillan.
7. Modern Physics, *J. R. Taylor, C. D. Zafiratos, M. A. Dubson*, PHI Learning.
8. Theory and Problems of Modern Physics, Schaum's outline, *R. Gautreau, W. Savin*, Tata McGraw-Hill.
9. Quantum Physics, Berkeley Physics, *E. H. Wichman*, Tata McGraw-Hill.

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Course title: Physics Lab II (Major)
Course code: PHY-MAJ-4-404
Nature of the course: Core
Total credit assigned: 4
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The course on Physics Lab II (Major) comprises experiments covering Electricity and magnetism, thermal physics and modern physics.

Course Objectives: This course will enable the students to
1. Understand and appreciate the theory of modern physics as well as thermal physics and optics.
2. Develop the ability to relate the theories into everyday applications.

Course Outcomes (COs): At the completion of the course, the students will be able to
CO1: Understand the basic concepts in hands-on mode through the basic electricity and Thermal physics and modern physics experiments
- **LO1.1:** Recall the concepts of series and Parallel LCR circuits
- **LO1.2:** Explain the characteristics of RC circuit, Thevenin and Norton theorem
- **LO1.3**: Recall the basics of thermal conductivity and thermos emf.
- **LO1.4**: Explain the basics of lasers.

CO2: Experiment with various electrical circuits and electronic instruments.
- **LO2.1:** Execute the experiment to measure the wavelength of He-Ne laser light.
- **LO2.2:** Conduct the experiment to study photoelectric effect
- **LO2.3** Perform the experiment to determine Plank's constant

CO3: Analyze different electronic components and circuits to understand its functioning and apply
- **LO3.1:** Analyze Q factor and bandwidth
- **LO3.2:** Analyze the frequency response curve to determine impedance and resonance

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1	LO1.1 LO1.2 LO1.3 LO1.4		LO3.1 LO3.2		
Procedural			LO2.1 LO2.2 LO2.3			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	S	M	M	M
CO2	S	S	M	S	M	M	M	M	M	M
CO3	M	S	M	S	M	M	S	M	M	M

(S: Strong, M: Medium, W: Weak)

Lists of Experiments:

Unit 1: Electricity and Magnetism

1. To study the characteristics of a series RC circuit.
2. To determine an unknown Low Resistance using Potentiometer/Carey Foster's Bridge.
3. To verify the Thevenin and Norton theorems.
4. To verify the Superposition, and Maximum power transfer theorems.
5. To determine self-inductance of a coil by Anderson's bridge.
6. To study the response curve of a series and parallel LCR circuit and determine its (a) Resonant frequency (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
7. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
8. Determine a high resistance by leakage method using Ballistic Galvanometer.

Unit 2: Thermal Physics

1. To determine Mechanical Equivalent of Heat, J by Callender and Barne's constant flow

method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus/Angstrom's Method.
3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
4. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
5. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

Unit 3: Modern Physics

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine the work function of the material of filament of directly heated vacuum diodes.
4. To determine the Planck's constant using LEDs of at least 4 different colors.
5. To determine the ionization potential of mercury.
6. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
7. To set up the Millikan oil drop apparatus and determine the charge of an electron.
8. To determine the wavelength of a laser source using diffraction of a single slit and double slit.
9. To determine (i) wavelength and (ii) angular spread of He-Ne laser using plane diffraction grating.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks 60)

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

Recommended Readings:

1. Advanced Practical Physics for students, *B. L. Flint and H. T. Worsnop,* Asia Publishing House.
2. A Text Book of Practical Physics, *I. Prakash & Ramakrishna,* Kitab Mahal.
3. Advanced Level Physics Practicals, *M. Nelson and Jon M. Ogborn,* Heinemann Educational Publishers.
4. A Laboratory Manual of Physics for undergraduate classes, *D. P. Khandelwal,* Vani

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DETAILED SYLLABUS OF SKILL ENHANCEMENT COURSES

SEMESTER I

Course title: Electrical Circuits and Network Skills
Course code: PHY-SEC-3-101A
Nature of the course: Skill Enhancement Course
Total credits: 3
Distribution of credits: Theory -1, Practical -2
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: Electrical Circuits and Network Skills is a skill-oriented course which focuses on fundamental concepts of electrical components, symbols, devices etc. It also provides fundamental skills necessary for designing, analyzing, troubleshooting electrical circuits and appliances through hands-on mode. It also enables the students to apply theoretical concepts in real-world scenarios.

Course Objectives:

1. Enable the students to 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.
3. Study of various devices.

Course Outcomes (COs): The students will be able to

CO1: Demonstrate proficiency in circuit analysis and apply fundamental concepts of electrical circuits.

- **LO1.1:** Identify basic circuit elements.
- **LO1.2:** Explain the effects of electric current.
- **LO1.3:** Solve DC circuits using Ohm's law and Kirchhoff's laws.
- **LO1.4:** Explain the working and principles of generators and motors.

CO2: Develop and Implement Electrical circuits.

- **LO2.1:** Build dc circuits using elements.
- **LO2.2:** Utilize breadboarding techniques to construct and troubleshoot simple electrical circuits.
- **CO3:** Develop Proficiency in Electrical Safety and Protection.
- **LO3.1** Explain the concept and purpose of earthing, along with different types of earthing methods and their procedures.
- **LO3.2** Draw earthing system and build safety protocols and precautions for electrical installations.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1 LO1.2					
Conceptual	LO3.1	LO 1.4 LO 3.1	CO1 LO1.3			
Procedural		CO3 LO3.2	CO2 LO2.1 LO2.2			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	M	M	M	M
CO2	S	S	M	M	S	S	M	M	M	S
CO3	S	S	M	M	S	S	M	M	M	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

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.

(L 2, H 2, M 3)

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. **(L 2, H 2, M 4)**

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. **(L 2, H 2, M 4)**

Unit 4: Generators and Motors
DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers, Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heater and motors, speed and power of ac motor. **(L 3, H 3, M 6)**

Unit 5: 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. **(L 1, H 1, M 3)**

Unit 6: 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). **(L 2, H 2, M 5)**

Unit 7: Electrical Wiring
Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drops 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. **(L 3, H 3, M 5)**

(Total Lectures 15, Total Contact Hours 15, Total Marks 30)

2-credits Practical

Demonstration and Laboratory:

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 a 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.
7. Identify the electronic components like rectifying diodes, Zener diodes, transistor, carbon resistance, capacitors, and test them with a multimeter.
8. Read electrical diagrams and draw an electrical diagram of the 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 prevent 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 Practical Classes 30, Total Contact Hours 60, Total Marks 30)

Recommended Readings:

1. A textbook in Electrical Technology, *B. L. Theraja,* S Chand & Co.
2. A textbook of Electrical Technology, *A. K. Theraja,* S Chand & Co.108
3. Performance and design of AC machines, *M. G. Say,* ELBS Edition.

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Course title: Electrical Wiring and Maintenance
Course code: PHY-SEC-3-101B
Nature of the course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a comprehensive understanding of the fundamentals of electrical circuits, wiring, and safety. It covers essential concepts such as electric current, conductors, insulators, resistance, potential difference, and various voltage sources (AC and DC). Students will learn about Ohm's law, the heating effect of current, Joule's law, electric power, and energy, as well as the analysis of DC circuits using Kirchhoff's laws. The course delves into series, parallel, and combination circuits, and introduces AC currents, single-phase and three-phase sources, transformers, and power transmission. It also explores different types of lighting sources, switches, and domestic electrical appliances. Students will learn about different types of wiring techniques including casing capping, PVC conduit, and concealed along with the selection and design of wiring schemes, wire joints, and protective devices such as MCBs and ELCBs. Students will become proficient in reading and creating electrical schematics and symbols, designing wiring diagrams, and estimating materials for domestic installations.

Course Objectives: The basic objectives of this course are to

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

Course Outcomes (COs): After completion of the course the students will be able to:

CO1: Understand and Apply Fundamental Concepts of Electrical Circuits.
- **LO1.1:** Identify basic circuit elements.
- **LO1.2:** Explain the effects of electric current.
- **LO1.3:** Solve DC circuits using Ohm's law and Kirchhoff's laws.

CO2: Design and Implement Wiring Systems.
- **LO2.1:** Distinguish between types of wiring and accessories.
- **LO2.2:** Design a wiring scheme for a domestic installation.

CO3: Develop Proficiency in Electrical Safety and Protection.

LO3.1: Describe the concept and purpose of earthing, along with different types of earthing methods and their procedures.
LO3.2: Draw earthing system and build safety protocols and precautions for electrical installations.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1					
Conceptual	LO3.1	LO1.2	LO1.3 CO1	LO2.1		
Procedural						CO2 LO3.2 CO3
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	S	M	M	S
CO2	S	S	S	S	M	S	S	S	M	S
CO3	S	S	S	S	M	S	S	S	M	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

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. **(L 4, H 4, M 7)**

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, switches, socket, MCBs, ELCBs and other electrical accessories.

(L 2, H 2, M 7)

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. **(L 4, H 4, M 8)**

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. **(L 5, H 5, M 8)**

(Total Lectures 15, Total Contact Hours 15, Total Marks 30)

2-credits Practical

Demonstration and Laboratory:

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.
7. Skinning the cable and joint practice on single and multi-strand wire.
8. To make a main switch board for house wiring
9. Installation of common electrical accessories such as switch, holder, plug on board
10. Installation and wiring connection of ceiling fan, exhaust fan, geyser, and water purifier
11. Preparation of extension board with switches, sockets and indicator.
12. Demonstrate electrical circuit diagrams related to electrical household appliances.
13. Carry out the earthing of the installed electrical circuit as per standard practice
14. Practice on different types of House Wiring installation and testing
15. House wiring circuits using fuse, switches, sockets, ceiling fan etc. in P.V.C. casing-

capping.

16. Prepare one estimate of materials required for CTS wiring for small domestic installation of one room and one verandah within 25 m with given light, fan & plug points.

(Total Practical Classes 30, Total Contact Hours 60, Total Marks 30)

Recommended Readings:

1. Elementary Electrical Engineering, *M. L. Gupta*, New Heights.
2. Electrical Installation and Estimating, *S. 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*, S Chand & Co.

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Title of the Course: Basic Electronic Skills and LED Technology
Course code: PHY-SEC-3-101C
Nature of the Course: Skill Enhancement Course (SEC)
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 60 (End-sem) + 40 (In-sem)

Course Objectives:

1 credit Theory

1. Understand basic electronics, measuring instruments and LED principles.
2. Develop component testing, circuit assembly and basic LED assembly skills.

Learning Outcomes

LO1: Explain basic electronic components and circuits.
LO2: Use measuring instruments safely and effectively.
LO3: Assemble and test LED circuits and basic LED products.
LO4: Demonstrate workshop safety and troubleshooting skills.

Course Contents

Unit I: Basics of Electronics

• Electronic and electrical components and applications
• Resistors, capacitors, coils and transformers
• Ohm's Law and circuit calculations
• AC and DC fundamentals
• Diodes, transistors and biasing
• Amplification and filter circuits (M 20, L 4, H 4)

Unit II: Measuring Instruments & Safety
• Multimeter and testing methods
• Regulated power supply
• Safe handling of AC/DC supply
• Workshop safety precautions (M 15, L 3, H3)

Unit III: Fundamentals of LED
• LED illumination principle
• LED properties and classifications
• Advantages of LED lighting
• Working principle and life expectancy (M 20, L 4, H 4)

Unit IV: LED Circuit Connections and Basic Assembly
• Series and parallel LED connections
• Constant current and voltage drivers
• Thermal management
• Introduction to LED bulb and tube assembly (M 25, L 4, H4)

Practicals
• Testing electronic components
• Soldering and desoldering
• Multimeter use
• LED circuit assembly
• Basic LED bulb assembly

Assessment Pattern

Theory (30 Marks)

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- Internal Assessment: 10 Marks
- One Test - =10 Marks
- Students have to choose any one of the following suggested activities in a semester for their in semester assessment =10 marks

- Seminar presentation of any concept
- Peer Teaching and Discussion
- Writing report on study visits arranged by the institutes to organization practicing these skills.

- End Semester Examination: 20 Marks

Practical (70 Marks)

- Practical Performance: 30 Marks
- Practical Record Book: 10 Marks
- Viva-Voce: 10 Marks
- End Practical Examination: 20 Marks

Total: 100 Marks

SEMESTER II

Course Title: Basic Instrumentation Skills
Course Code: PHY-SEC-3-201A
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Description: The course on Basic Instrumentation Skills is an introductory course on basic tools and equipment used in laboratories. It describes the different types of analog and digital voltmeter and ammeters used in measurements. The course also covers the concept of CRO, Function generator and bridges and the techniques to use them in laboratory measurements. The course also includes laboratory sessions so that the students learn the basic experimental techniques.

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.

Course Outcomes (COs): The students will able to

CO1: Understand the basic principle and techniques required to carry out laboratory measurements
LO1.1: Define terms related to measurement such as accuracy, precision, sensitivity, and

resolution.

LO1.2: Explain the construction and operation principles of CRT, including electron gun and electrostatic focusing.

LO1.3: Explain the block diagram and working principle of digital voltmeters.

CO2: Explain the working of multimeter, CRO, etc.

LO2.1: Explain the block diagram and working principle of digital voltmeters.

LO2.2: Explain the time base operation and synchronization in CROs.

CO3: Apply CRO, Multimeters, Bridges for different measurements.

LO3.1: Make use of CRO to measure voltage (DC and AC), frequency, and time period.

LO3.2: Utilize signal generators and frequency counters in practical measurement scenarios.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		LO1.1 LO1.2 LO1.3 LO2.1				
Conceptual		LO2.2	LO3.1 LO3.2			
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	S	M	M	S
CO2	S	S	M	S	M	M	M	M	M	M
CO3	M	S	M	S	M	M	S	M	M	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

1 credit Theory

Unit 1: Basic of Measurement

Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Ideal Voltage and Current source. **(L 2, H 2, M 5)**

Unit 2: Voltmeter and Multimeter

Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Principles of voltage measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. Digital Voltmeter, Block diagram and working of a digital Voltmeter. **(L 4, H 4, M 7)**

Unit 3: Cathode Ray Oscilloscope

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), 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. Digital storage Oscilloscope. **(L 4, H 4, M 7)**

Unit 4: Signal Generators and Analysis Instruments

Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. **(L 3, H 3, M 6)**

Unit 5: Impedance Bridges & Q-Meters

Working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Kelvins Bridge **(L 2, H 2, M 5)**

(Total Lectures 15, Total Contact Hours 15, Total Marks 30)

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.
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. Measurement of voltage, frequency, time period and phase angle using CRO.
4. Measurement of time period, frequency, average period using universal counter/ frequency counter.
5. Measurement of rise, fall and delay times using a CRO.
6. 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 Practical Classes 30, Total Contact Hours 60, Total Marks 30)

Recommended Readings:

1. Modern Electronic Instrumentation & Measurement Techniques, *A. D. Helfrick, W.D. Cooper*, Pearson India.
2. A textbook in Electrical Technology, *B. L. Theraja, A.K. Theraja*, S Chand and Co.
3. Electronic Measurements and Instrumentation, *R.S. Sedha*, S Chand and Co.

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Title of the Course: Mastering Productivity with Google Workspace
Course Code: PHY-SEC-3-201B
Nature of the Course: Skill Enhancement Course (SEC)
End Semester: 80 Marks (40T+40P)
In Semester: 20 Marks
Total Credits: 03

COURSE OBJECTIVES

1. To introduce students to the essence of Google Workspace and its suite of productivity tools, allowing them to better understand and shape their digital productivity.
2. To guide students in uncovering the potential of collaborative document creation.
3. Develop students' data organization and analysis skills.
4. To empower students to master cloud-based file management, ensuring seamless organization and accessibility of their digital resources.
5. To guide students in creating engaging presentations (Slides) that effectively communicate their ideas.
6. To enable students to utilize real-time collaboration and communication tools effectively.
7. To provide students with the skills to design and create websites efficiently.
8. To inspire students to explore the realm of automation and workflow optimization within the Google Workspace environment.

Course Outcomes (COs): After the completion of the course the learners will be able to

CO1: Efficiently Navigate Google Workspace Apps
CO2: Effective Communication and Collaboration with productivity
CO3: Real-world Application and Problem-Solving skill development
CO4: navigate and utilize core Google Workspace applications, including Gmail, Google Drive, Google Docs, Sheets, Slides, and Calendar.
CO5: integrate various Google Workspace apps for seamless collaboration, including efficient use of tools like Google Meet, Tasks, and Keep.

Reading List:

1. "Google Workspace for Dummies" by Ryan Teeter and Karl Barksdale
2. "Google Drive & Docs In 30 Minutes" by Ian Lamont

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1 CO2	CO3			
Procedural						CO4 CO5
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			S	M	S	S	M			S
CO2	M	M	S	W	S	S	M			S
CO3	M	M	S	W	S	S	M			S
CO4	M	M	S	W	S	S	M			S
CO5	M	M	S	W	S	S	M			S

1 credit Theory

Unit I
Introduction to Google Workspace

1.1 Overview of Google Workspace Applications and Tools
1.2 Navigate through Google Workspace interface
1.3 Benefits of using Google Workspace
1.4 Understanding cloud computing and how it applies to Google Workspace

(L 2, M 5)

Unit II
Efficient Email Management with Gmail

2.1 Setting up a Google account
2.2 Gmail account setup and customization
2.3 Creating, formatting, and attaching files to emails
2.4 Inbox organization, archiving, and marking emails
2.5 Labels, filters, and folder management

2.6 Managing contacts and tasks in Gmail
2.7 Scheduling Emails

(L 3, P 3, M 10)

Unit III
Cloud-based file management: Google Drive

3.1 Overview of the Google Drive interface
3.2 Uploading and downloading files and folders
3.3 Sharing files with individuals or groups, setting different permission levels, collaboration
3.4 Managing file versions and revisions

(L 3, P 3, M 10)

Unit IV
Cloud-based document processing: Google Docs

4.1 Creating new Google Docs documents and formatting text with fonts, styles, and colors
4.2 Adding images, tables, and other elements to documents, page layout, margins, and orientation
4.3 Sharing, real time collaboration, tracking & revisions, Comments, Suggestions
4.4 Extensions and add-ons

(L 8, T 1, P 6, M 15)

Unit V
Data collection, organize and analyzing: Google Sheet and Google Form

5.1 Organizing and Formatting Data in Google Sheet, mathematical operations, analyzing data using sorting, filtering, and pivot tables, charts and graphs
5.2 Designing and creating surveys with Google Forms, question formats, Quizzes, sections, reviewing analyzing form responses
5.3 Linking Google Forms to Google Sheets
5.4 Extensions and Add-ons Presentation using Google Slides

(L 8, T 1, P 6, M 15)

Unit VI
Presentation using Google Slides

6.1 Google slide layouts
6.2 Insert images, videos, and audio into slides
6.3 Slide transitions
6.4 Embedding Google Docs, Sheets, and Forms into presentations

(L 3, T 1, P 5, M 5)

Unit VII
Creating websites with Google Sites

7 Creating websites with Google Sites
7.1 Setting up and configuring Google Sites**)**
7.2 Site layouts, creating pages, and organizing content.
7.3 Inserting text, images, videos, and other multimedia elements.

7.4 Site theme, logo, favicon
7.5 Site Publishing, access permissions

(L 5, T 1, P 7, M 10)

Unit: 8
Google Classroom

8.1: Creating and managing classes in Google Classroom,
8.2: Assignments, Grading, Feedback, conducting exams, quizzes, sharing materials. Overview of other Google workspace productivity tools:
Google Calendar, Google Keep, Google Meet etc. **(L 5, P 7, M 10)**

MODES OF IN-SEMESTER ASSESSMENT

One Test = 10 Marks

Students have to choose any one of the following suggested activities in a semester for their in-semester assessment = 10 Marks

- Seminar presentation of any concept
- Peer Teaching and Discussion
- Practical : Home assignment/Viva Learning Outcomes:

Reading List:

1. "Google Workspace for Dummies" by Ryan Teeter and Karl Barksdale
2. "Google Drive & Docs In 30 Minutes" by Ian Lamont

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Course Title: **Advanced LED Applications, Repairing & Entrepreneurship**
Course Code: PHY-SEC-3-201C
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Objectives:

1 credit Theory

1. Develop LED assembly, repairing and troubleshooting skills.
2. Understand advanced LED systems, quality standards and entrepreneurship opportunities.

Learning Outcomes
LO1: Assemble and repair LED lighting products.

LO2: Diagnose and rectify faults in LED systems.
LO3: Understand smart, solar and sustainable LED applications.
LO4: Prepare business and project plans related to LED enterprises.

Course Contents

Unit I: LED Drivers and Assembly

- AC-DC regulated supply
- AC-AC systems
- Driver selection and characteristics
- LED light engine, heat sink and luminaire assembly (M 20, L 4, H 4)

Unit II: Fault Diagnosis and Repair

- Failure modes in LED systems
- Driver and thermal failure analysis
- Replacement of damaged components
- Repair and testing procedures (M 20, L 4, H 4)

Unit III: Smart, Renewable and Sustainable LED Systems

- Smart lighting and sensor-based control
- IoT applications and programmable LED displays
- Solar LED lighting and energy-efficient systems
- Rural electrification and environmental benefits (M 20, L 4, H 4)

Unit IV: Quality Standards, Entrepreneurship and Project Work

- IP ratings and quality assurance
- Safety standards and maintenance
- Business setup and market opportunities
- Project documentation, mini project and presentation (M 20, L 3, H 3)

Practicals

- LED bulb and tube light assembly
- Driver testing and repair
- Repair of faulty LED strips
- Solar LED lamp assembly
- Sensor-based LED project
- Final project and viva

Assessment Pattern

Theory (30 Marks)

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- Internal Assessment: 10 Marks

- Internal Assessment: 10 Marks
- One Test - =10 Marks
- Students have to choose any one of the following suggested activities in a semester for their in semester assessment =10 marks

  - Seminar presentation of any concept
  - Peer Teaching and Discussion
  - Writing report on study visits arranged by the institutes to organization practicing these skills.

- End Semester Examination: 20 Marks

Practical (70 Marks)

- Practical Performance: 30 Marks
- Practical Record Book: 10 Marks
- Viva-Voce: 10 Marks
- End Practical Examination: 20 Marks

Total: 100 Marks

SEMESTER III

Course Title: Computational Physics Skills
Course Code: PHY-SEC-3-301A
Nature of the Course: Skill Enhancement Course
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The Computational Physics Skills course includes the basics of computer programming and scientific writing to emphasize their role in dealing with problems in Physics.
Course Objectives:
1. To introduce the use of computer language and computer programming in solving physics problems.
2. To familiarize the learners about scientific writing and analysis tools useful for interpretation and presentation of results obtained.

Course Outcomes (COs): After successful completion of the course, the student will be able to

CO1: Apply computer programming language to solve physics problems.

LO1.1: List the syntax of computer programming.

LO1.2: Solve physics problems using computer programming.

CO2: Utilize scientific writing and analysis tools.

LO2.1: Construct standard scientific documentation using scientific writing tool.

LO2.2: Show the outcomes of graphical analysis using visualization tool.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	LO2.2	LO2.1 CO2			
Conceptual			LO1.2 CO1			
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	S	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

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 with example **(L 3, H 3 M 6)**

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, Relational, Logical, Character and Assignment Expressions. Fortran Statement. **(L 3, H 3 M 6)**

Unit 3: Control Statements

Types of Logic, Branching Statements, Looping Statements, Jumping Statements, Subscripted Variables, Functions and Subroutines, open a file, writing in a file, reading from a file.

(L 3, H 3 M 6)

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.

(L 3, H 3 M 6)

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. **(L 3, H 3 M 6)**

(Total Lectures 15, Total Contact Hours 15, Total Marks 30)

2-credits Practical

Programming:

1. Exercises on syntax on usage of FORTRAN Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write source codes in FORTRAN.
2. To print out all natural even/ odd numbers between given limits.
3. To find maximum, minimum and range of a given set of numbers.
4. Calculating Euler number using exp(x) series evaluated at x = 1.

Hands on Exercises:

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.
    11. Motion of a particle in a central force field and plot the output for visualization.
    12.

(Total Practical Classes 30, Total Contact Hours 60, Total Marks 30)

Recommended Readings:

1. Introduction to Numerical Analysis, *S. S. Sastry*, PHI Learning Pvt. Ltd.

2. Computer Programming in Fortran 77, *V. Rajaraman*, PHI Learning Pvt. Ltd.
3. LaTeX–A Document Preparation System, *L. Lamport*, Addison-Wesley.
4. Gnuplot in action: understanding data with graphs, *P. K. Janert*, Manning.
5. Schaum's Outline of Theory and Problems of Programming with Fortran,
S. Lipsdutz and A. Poe, Mc-Graw Hill.
6. Computational Physics: An Introduction, *R. C. Verma et al.* New Age
International Publishers.
7. A first course in Numerical Methods, *U. M. Ascher and C. Greif*, PHI Learning Pvt. Ltd.
8. Elementary Numerical Analysis, *K. E. Atkinson*, Wiley India Edition.

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Course title: Renewable Energy and Energy Harvesting
Course code: PHY-SEC-3-301 B
Nature of the course: Skill Enhancement Course
Total credits: 3
Distribution of credits: Theory – 2, Practical - 1
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Description: This course explores a wide range of energy sources, beginning with fossil fuels and nuclear energy, highlighting their limitations and the necessity for renewable energy alternatives. It provides an in-depth examination of various renewable energy technologies, including solar, wind, ocean, geothermal, and hydro energy, along with their applications and environmental impacts. The course also covers advanced topics in energy harvesting, such as piezoelectric and electromagnetic energy, focusing on their principles, technologies, and sustainable applications. Through this comprehensive study, students will gain a thorough understanding of both conventional and innovative energy sources, preparing them to contribute to the development of sustainable energy solutions.

Course Objectives: The aim of this course is
1. Examine the limitations and environmental impacts of fossil fuels and nuclear energy as well as the necessity of renewable energy and their practical applications.
2. Gain knowledge of solar, wind, ocean, geothermal, and hydro energy sources, including their applications and environmental benefits.
3. Study advanced energy harvesting methods, such as piezoelectric and electromagnetic energy, and their sustainable applications
4. Understand the integration of both conventional and innovative energy sources for a comprehensive approach to energy sustainability.

Course Outcomes (COs):
CO1: Core knowledge of Renewable Energy Technologies.
- **LO1.1:** Describe the characteristics, advantages, and limitations of fossil fuels and nuclear energy.
- **LO1.2:** State the need for and benefits of transitioning to renewable energy sources.

LO1.3: Explain the fundamental principles and applications of various renewable energy technologies, including solar, wind, ocean, geothermal, and hydro energy.

CO2: Understanding practical Skills in Designing and Implementing Renewable Energy Systems.

LO2.1: Design and implement solar energy systems, such as solar water heaters, photovoltaic systems, and solar greenhouses.

LO2.2: Assess and evaluate wind energy systems, including wind turbines and their power electronic interfaces.

LO2.3: Analyze the efficiency and practical applications of solar and wind energy technologies in real-world scenarios.

CO3: Discuss Advanced Energy Harvesting and Sustainability Practices.

LO3.1: Explain the principles and applications of piezoelectric and electromagnetic energy harvesting technologies.

LO3.2: State the environmental impact and sustainability of various energy sources and harvesting techniques.

LO3.3: Assess knowledge of renewable energy systems to propose sustainable solutions for reducing carbon footprint and enhancing energy efficiency.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.2 LO3.2 CO1					
Conceptual		LO1.1 LO1.3 LO3.1 CO2 CO3		LO2.3 LO1.4 LO3.3	LO2.2	
Procedural						LO2.1
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	S	M	S	S	M	M
CO2	S	S	M	S	S	M	S	S	M	S
CO3	S	M	M	S	S	M	S	S	M	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

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. **(L 5, H 5, M 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.
(L 5, H 4, M 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. **(L 4, H 4, M 4)**

Unit 4: Ocean Energy
Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Biomass. **(L 4, H 4, M 4)**

Unit 5: Geothermal Energy
Geothermal Resources, Geothermal Technologies. **(L 2, H 2, M 2)**

Unit 6: Hydro Energy
Hydropower resources, hydropower technologies, environmental impact of hydro power sources.
(L 2, H 2, M 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. **(L 3, H 3, M 3)**

Unit 8: Electromagnetic Energy Harvesting
Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability. **(L 5, H 5, M 5)**

(Total Lectures 30, Total Contact Hours 30, Total Marks 30)
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.

OR

Project Preparation
(Total Practical Classes 15, Total Contact Hours 30, Total Marks 30)
Recommended Readings:

1. Non-conventional energy sources, *G. D. Rai*, Khanna Publishers, New Delhi.
2. Solar energy, *M. P. Agarwal*, S Chand and Co. Ltd.
3. Solar energy, *S. P. Sukhative*, Tata McGraw, Hill Publishing Company Ltd.
4. Renewable Energy: Power for a sustainable future, *G. Boyle*, Oxford University

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Title of the Course: Mobile Phone Repairing Technology
Course Code: PHY-SEC-3-301C
Nature of the Course: Skill Enhancement Course (SEC)
Credit assigned: 3
Distribution of credits: Theory – 1, Practical -2
Distribution of marks: 60 (End-sem) + 40 (In-sem)

Course Objectives

1. Introduce students to the fundamentals of mobile phone technology and communication systems.
2. Develop practical skills in identifying, diagnosing, and repairing common mobile phone faults.
3. Familiarize students with mobile hardware components, tools, and instruments used in servicing.
4. Provide hands-on experience in software troubleshooting, flashing, and operating system management.
5. Encourage entrepreneurship and self-employment opportunities in mobile servicing.
6. Promote safe handling of electronic devices and e-waste management practices.

Course Outcomes

- Understand the basic architecture and working principles of mobile phones.
- Identify various hardware and software components of smartphones.
- Use mobile repairing tools safely and efficiently.
- Diagnose and repair common mobile phone faults.
- Perform software installation, flashing, and system recovery.
- Apply safety measures and e-waste management practices.
- Explore entrepreneurship opportunities in the mobile repair industry.

Course Contents:

1 credit Theory

THEORY (15 Hours)

Unit I: Introduction to Mobile Technology (3 Hours)

- Evolution of mobile communication
- Types of mobile phones and smartphones
- GSM, CDMA, 3G, 4G and 5G technologies
- Mobile phone architecture overview

Unit II: Mobile Hardware Components (4 Hours)

- Motherboard and PCB
- CPU, RAM, ROM, Storage devices
- Display and touchscreen assembly
- Battery, charging circuit, microphone, speaker, vibrator
- SIM and memory card interfaces

Unit III: Mobile Repairing Tools and Safety (2 Hours)

- Screwdriver sets
- Multimeter
- Soldering and desoldering tools
- DC power supply
- ESD protection
- Workplace safety practices

Unit IV: Mobile Software and Troubleshooting (3 Hours)

- Android operating system basics
- Mobile firmware
- Software faults and symptoms
- Flashing and software updating
- Factory reset and data recovery basics

Unit V: Entrepreneurship and E-Waste Management (3 Hours)

- Mobile service centre setup
- Customer handling and service records
- Cost estimation and spare parts management
- Electronic waste and environmental concerns
- Responsible disposal and recycling practices

PRACTICAL:

Practical Module I: Identification of Mobile Components

- Identification of motherboard sections
- Identification of mobile hardware components
- Identification of connectors and sockets

- Battery and charger testing

Practical Module II: Handling of Tools and Instruments

- Safe use of screwdrivers and opening tools
- Multimeter operation
- DC power supply operation
- Soldering and desoldering practice
- ESD safety procedures

Practical Module III: Mobile Disassembly and Assembly

- Opening and reassembling smartphones
- Screen removal and fitting
- Connector inspection
- Battery replacement

Practical Module IV: Hardware Fault Diagnosis

- Charging problems diagnosis
- Speaker and microphone fault detection
- Display fault identification
- Power ON/OFF fault diagnosis
- Water damage inspection

Practical Module V: Software Troubleshooting

- Factory reset procedures
- Android firmware installation
- Software update and recovery
- Backup and restore operations
- App-related troubleshooting

Practical Module VI: Service Centre Practice and Entrepreneurship

- Customer complaint recording
- Fault diagnosis documentation
- Repair estimation preparation
- Spare parts identification
- E-waste segregation and disposal practices

Assessment Pattern
Theory (30 Marks)

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- Internal Assessment: 10 Marks
- One Test - =10 Marks
- Students have to choose any one of the following suggested activities in a semester for their in semester assessment =10 marks

➢ Seminar presentation of any concept
➢ Peer Teaching and Discussion

- Writing report on study visits arranged by the institutes to organization practicing these skills.

- End Semester Examination: 20 Marks

Practical (70 Marks)

- Practical Performance: 30 Marks
- Practical Record Book: 10 Marks
- Viva-Voce: 10 Marks
- End Practical Examination: 20 Marks

Total: 100 Marks

Suggested Equipment

- Android Smartphones (faulty and working)
- Mobile Repair Toolkit
- Digital Multimeter
- DC Power Supply
- Soldering Station
- Hot Air Rework Station
- Magnifying Lamp
- Battery Tester
- Laptop/Desktop with Mobile Service Software
- ESD Mat and Wrist Strap

References

1. Mobile Phone Repairing and Troubleshooting – K. S. Bhatia.
2. Smartphone Servicing and Repairing Handbook.
3. Android Mobile Repairing Manual.
4. Mobile Communication Principles and Practice.
5. Training Manuals of Skill India/NSDC Mobile Repair Technician Courses.

DETAILED SYLLABUS OF GENERIC ELECTIVE COURSES

SEMESTER I

Course title: Evolution of Science *(With IKS-1)*
Course code: PHY-GEC-3-101
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Description: This generic elective course is designed for general students of this programme at the beginning level and students will be able to learn about the development of science as a whole starting from the very early stage to its modern state. From the early stage part of this course, students will know the invention of the wheel as the beginning of science up to the very famous Newton's Universal law of gravitation. From the middle stage part, which includes the development of science in the nineteenth century, students will learn about the development of electricity and magnetism, works of Maxwell to Thomas Alva Edison. These developments are indeed the beginning of modern science. The last part of this course covers almost all major modern developments of science, in which students will learn about the developments of special relativity, quantum mechanics to electronics and optical evolution. In addition, students will also know the Indian contributions to contemporary science evelopments.

Course Objectives: This 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. So, the course is designed with the following specific 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.

Course Outcomes (COs): The students will able to

CO1: Describe the Indian origin of the basic ideas of physical sciences.

LO1.1: Describe the Indian origin of the basic ideas of physical sciences.

CO2: Understand the historical development of scientific knowledge with key figures and their contributions.

LO2.1: Explain the invention of the wheel as the beginning of science to the industrial revolution.
LO2.2: Describe the contributions of Aristotle to Darwin, Kepler etc.
LO2.3: Discuss the contributions of Sir Isaac Newton and his famous laws.
LO2.4: Illustrate nineteenth century science such as developments of electricity and magnetism with contributions of Thomas Alva Edison and Maxwell. These developments led to the beginning of modern science.
LO2.5: Outline the developments of modern science from quantum mechanics, special theory. of relativity, field quantization, electronics, computer to Laser and optical evolution.
LO2.6: Explain contemporary science and India's contributions.

CO3: Describe the interdisciplinary nature of science and its impact on various fields and industries.
LO3.1: Explain the impacts of Darwin's, Newton's and Einstein's works and quantum mechanics on various branches of sciences.
LO3.2: Understand the impacts of Edison's, Maxwell's, Newton's etc. works and quantum evolutions on the industrial revolutions, technological developments and space science and technology etc. developments.

CO4: Relate the ethical and social implications of scientific advancements, and promote critical thinking about their consequences.
LO4.1: Understand the devotion, patience, ethical value and social responsibility of scientists in the development of their scientific works and achieving the goals.

CO5: Recognize the roles of scientific methods of experimentation and observation in advancing scientific knowledge.
LO5.1: Understand the necessity of dedicated experiments and observations in achieving scientific results and advancing scientific knowledge.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO2.1 LO2.2 LO2.3 LO2.4 LO2.5 LO2.6 CO2	LO3.1 LO3.2 CO3				
Conceptual	LO1.1 CO1	LO4.1 LO5.1 CO4 CO5				
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1										
CO1	M	M	S	M	M		M	M	M	
CO2	M	M	S	M	M		M	M	M	
CO3	M	M	S	S	M		M	M	M	

CO4	M	M	S	S	M		M	M	M	

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit 1: IKS-1:
Vaiseṣika Philosophy/Sutra, Idea of anu or paramanu, Kanad's laws of motion, Comparision of Kanada's laws and Newton's laws of motion, Theory of Gravitation according to Bhaskaracharya. Five-layered Universe **(L 4, H 4, M 4)**

Unit 2: Early Stage Invention of wheel and beginning of science, 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. **(L 12, H 12, M 18)**

Unit 3: Middle Stage
Nineteenth century and beginning of modern science: Developments of electricity and magnetism, Maxwell's contributions, contributions of Thomas A. Edison. **(L 13, H 13, M 16)**

Unit 4: Modern Stage
Einstein and special theory of relativity; The paradigm shift: quantum theory, general theory of Relativity, quantum generation; the second quantization: development of concept of field quantization, ups and downs; Nuclear era: space science and technology; Electronic age and birth of computers.
(L 16, H 16, M 22)

(Total Lectures 45, Total Contact Hours 45, Total Marks 60)

Recommended Readings:
1. Journey of Science and Technology in India: A Historical Perspective, *Ajay Ghatak*, National Academy of Sciences
2. Indian Contribution to Science, *Vijnana Bharati*
3. The Scientific Revolution, *Steven Shapin*, University of Chicago Press.
4. A History of Physics in its Elementary Branches: Including the Evolution of Physical Laboratories, *Florian Cajori*, Macmillan.
5. A Brief History of Physics, *Paul F. Kisak*, CreateSpace Independent Publishing Platform.

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Course title: Introduction to Communication Technology *(With IKS-1)*
Course code: PHY-GEC-3-102
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The course on Introduction to Communication Technology begins with a discussion on what is communication, what are the techniques used in communication systems. It describes the different types of modulation and multiplexing techniques which are of utmost importance in any modern-day communication system. The course also covers the introductory idea of Antennas, RADAR, and microwave communication. A brief discussion about optical communication systems has also been included in the course.

Course Objectives:

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

Course Outcomes (COs): The students will able to

CO1: Describe the Indian origin of the basic ideas of physical sciences.

LO1.1: Describe the Indian origin of the basic ideas of physical sciences.

CO2. Understand the basic blocks of a communication system.

LO2.1: Define the key components of a communication system and the concept of modulation.
LO2.2: Explain the block diagram of Pulse Code Modulation.
LO2.3: Explain how antennas work.
LO2.4: Define microwave communication, cellular communication and optical fiber communication.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		LO2.4				
Conceptual	LO1.1	LO2.1 LO2.2 LO2.3				
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO2	S	S	M	M	M	M	S	M	M	S

(S: Strong, M: Medium, W: Weak)

Unit I: IKS-1Vaiseṣika Philosophy/Sutra, Idea of anu or paramanu, Kanad's laws of motion, Comparision of Kanada's laws and Newton's laws of motion, Theory of Gravitation according to Bhaskaracharya. Five-layered Universe **(L 4, H 4, M 4)**

Unit II: Basics of Communication Systems

Basic Idea of communication system, Need of modulation, basic idea of Amplitude Modulation its advantages, disadvantages and application, Frequency modulation, advantages, disadvantages and its application, electromagnetic Spectrum.

Multiplexing in communication systems, Frequency Division Multiplexing and Time division multiplexing. **(L 15, H 15, M 16)**

Unit III: Digital Communication Processes

Digital communication, Block diagram of Pulse code modulation and its applications, digital modulation, advantages and disadvantages of digital modulation. **(L 5, H 5, M 9)**

Unit IV: Transmission Systems

Basic idea of Transmission line, and antenna Dipole antenna, Yagi antenna, different parameters used in antenna, Introduction to RADAR, RADAR block diagram, Pulse Repetition Frequency. **(L 5, H 5, M 9)**

Unit V: Microwave and Optical Communications

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,general system, advantages, disadvantages, and applications of optical fiber communication, cylindrical fiber, single mode fiber, cutoff wavelength. Optical Fiber materials **(L 20, H 20, M 22)**

(Total Lectures 45, Total Contact Hours 45, Total Marks 60)

Recommended Readings:

1. Journey of Science and Technology in India: A Historical Perspective, *Ajay Ghatak*, National Academy of Sciences
2. Indian Contribution to Science, *Vijnana Bharati*
3. Electronic Communications System: Fundamentals Through Advanced, *W. Tomasi*, Pearson Education.
4. Kennedy's Electronic Communication Systems (SIE), *I. G. Kennedy, Davis, Prasanna*, McGraw Hill Education.
5.Optical Fiber Communications, *G. Keiser*, Tata McGraw Hill Education.

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Course title: Indian Traditional Knowledge in Physical Sciences (IKS-1)
Course code: PHY-GEC-4-101C
Nature of the course: GEC
Total credits: 3
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Description: This course comprises of the Indian traditional knowledge system in Physical Sciences and Mathematics. It focuses on the developments of Astronomy and Mathematics in ancient India. The contributions of Mathematicians and Physicists in ancient India are also included in this course.

Course Objectives: The course aims to impart traditional Indian knowledge in the field of Physical Sciences, especially in Astronomy and Mathematics.

Course Outcomes (COs): After the completion of the course, a student will be able to
CO1: Acquire the knowledge of Indian origin of the basic ideas of physical sciences.
LO1.1: Describe the key developments of Astronomy in India.

CO2: Acquire the knowledge of Indian contributions towards the field of Mathematics from ancient time.
LO2.1: Describe the key developments of Mathematical knowledge in India.

CO3: Recognize the contributions of Great Indian scientists in the field of Astronomy and Mathematics in ancient India.
LO3.1: Describe the contributions of Great Indian scientists in the field of Astronomy and Mathematics in ancient India.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual	LO1.1 LO2.1 LO3.1 CO1, CO2, CO3	LO1.1 LO2.1 LO3.1 CO1, CO2, CO3				
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO1	**W**									

CO2	**W**									
CO3	**W**									

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit I: Development in Astronomy

Beginnings of Indian Astronomy, Early Historical Period, Siddhāntic Era, Kerala School, Other Post-Siddhāntic Developments; Traditional Wisdom of Astronomy in India: Jantar Mantar - Ancient Astronomical Observatories of India and some instruments, Laghu Samrat Yantra in Jaipur, Samrat Yantra, Rashivalaya (Star Sign), Ram Yantra, Misra Yantra **(L 15, H 15, M 20)**

Unit II: Development in Mathematics Early Historical Period, Concept of Zero, Number System, Arithmetic, Geometry, Pythagoras theorem, Algebra, Trigonometry, Vedic Mathematics, Kerala School of Mathematics, Concept of Pi; Features of Indian Mathematics; Mathematician and Physicists in Ancient India **(L 15, H 15, M 20)**

Unit III: Mathematicians and Physicists in Ancient India

Brief biography and contributions of Aryabhtatta, Varahamihira, Bhaskara I and Bhaskara II, Brahmgupta, Mahaviracharya, Shripati, Baudhayan, Kamalakara, Kanada, Nagarjuna, Lagadha, Lalla, Mahendra Suri, Nilakanthan Somayaji, Acyuta Pisaradi **(L 15, H 15, M 20)**

References:

1. Journey of Science and Technology in India: A Historical Perspective, *Ajay Ghatak*, National Academy of Sciences
2. Indian Contribution to Science, *Vijnana Bharati*
3. A Concise History of Science in India, Indian National Science Academy
4. History of Science, Technology and Medicine in India, *Binod Bihari Satpathy*, Himalaya Publishing House
5. Indian Physics: Outline of Early History, *Subhash Kak,* https://arxiv.org/abs/physics/0310001
6. https://sathee.iitk.ac.in/ncert-books/class-11/knowledge-traditions-and-practices-of-

SEMESTER II

Course title: Materials Today ***(With IKS-2)***
Course code: PHY-GEC-3-201A
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: The course on Materials Today defines different forms of matter and also introduces history and evolution of materials over ages. Classification of engineering materials and the trend of advanced materials are also included in this course.

Course Objectives:

1. To introduce different forms of matter along with the history and development of materials.
2. To familiarize the learners about various types of materials, their composition and properties.

Course Outcomes (COs): After successful completion of the course, the student will be able to

CO1: Classify different types of materials.

LO1.1: List forms of matter and match the development of materials in different ages

LO1.2: Summarize engineering materials.

CO2: Identify properties and application of nanomaterials.

LO2.1: List properties and application of nanomaterials.

LO2.2: Apply unique features of nanomaterials for a variety of applications.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1 LO2.1	LO1.2 CO1				
Conceptual			LO2.2 CO2			
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	M	S	S	S	S	S	S
	S	M	S	M	S	S	S	S	S	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit I: IKS-2:
Alchemy in Ancient India: Areas of Development: Glass making, Paints and Dyes, Perfumes and Cosmetics **(L 4, H 4, M 4)**

Unit II: Introduction to Matter
Overview of the different states of matter: Solid, Liquid, Gas, Plasma, Atomic structure and Bonding. **(L 7, H 7, M 10)**

Unit III: 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. **(L 10, H 10, M 15)**

Unit IV: Classification of Engineering Materials
Metals & Alloys, Non-Metals, Ceramics, Polymers, Composites etc. with examples and applications. Uses, Performance, Composition & Structure; Physical and Chemical properties; (**L 15, H 15, M 18)**

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. **(L 13, H 13, M 13)**

(Total Lectures 45, Total Contact Hours 45, Total Marks 60)

Recommended 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 *(With IKS-2)*
Course code: PHY-GEC-3-201B
Nature of the course: Generic Elective Course
Total credits: 3
Distribution of marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course comprises topics of digital and space technologies available in current time.

Course Objectives: To equip students with a comprehensive understanding of modern technologies, their societal implications, and their applications across various domains including communication, digital infrastructure, and space technology. To foster critical thinking and problem-solving skills essential for navigating the evolving technological landscape.

Course Outcomes (COs): A students will able to

CO1: Explain the Interdependence of Technology and Society.

LO1.1: Understand the impact of technology on societal development, emphasizing dependencies and vulnerabilities.

LO1.2: Understand the role of digital infrastructure in economic growth and global competitiveness.

CO2: Explain currently used Communication Systems in general terms.

LO2.1: Acquire Knowledge of various communication technologies and their applications.

LO2.2: Understand the issues in information security and optimize data uses.

CO3: Assess Emerging Technologies and Automation**.**

LO 3.1: Understand the societal and ethical implications of different technologies.

LO3.2: Discuss strategies to address technological disparities and enhance digital literacy

CO4: Analyse the applicability of Digital Technology/Software.

LO4.1: Apply knowledge of semiconductor devices, digital systems, and software development in practical scenarios.

LO4.2: Assess the feasibility and risk of technology/ software platforms for diverse applications related to societal problems.

CO5: Explain Space Technology and its Impact on Society.

LO5.1: Understand the impact of space-based technologies on communication, navigation, and disaster management.

LO5.2: Assess the tools of space technology for societal use.

LO5.3: Understand the importance of space technology for national development.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1 LO1.2 LO5.1 LO 5.3 CO1	LO2.1 CO2				
Conceptual		LO2.2 LO3.1 CO2	LO4.1 LO3.2 CO5	LO3.3 CO4	LO 4.2 LO 5.2 CO3	
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**

CO1	W	M	M	S	M	W	W	S	W	M
CO2	W	M	S	S	S	W	W	S	M	M
CO3	W	M	M	S	M	W	W	S	M	M

(S: Strong, M: Medium, W: Weak)

Course Contents:

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 to information age, wireless, satellite communicationradio 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.

(L 7, H 7, M 12)

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.

(L 20, H 20, M 25)

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 communicationnavigation 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)

(L 18, H 18, M 23)

(Total Lectures 45, Total Contact Hours 45, Total Marks 60)

Recommended Readings:

1. Digital Principles and Applications, *Donald P. Leach*, McGraw Hill.
2. Human Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications, *Editor: Julie A. Jacko*, CRC Press Inc.
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*, (ISBN - 9789384303068), Mahaveer Publications, Dibrugarh.

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Course title: History of Technological Developments in India (IKS-2)
Course code: PHY-GEC-3-201C
Nature of the course: GEC
Total credits: 3
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Description: This course comprises of the history of technological developments in India. It focuses on the technologies used in ancient India in different fields such as alchemy, metallurgy and nanotechnology. Various examples with application of these technologies are also included in this course.
Course Objectives: The course aims to impart the historical knowledge of the technologies used in India in the field of alchemy, metallurgy and nanotechnology.

Course Outcomes (COs): After the completion of the course, a student will be able to

CO1: Understand technological development of scientific ideas in ancient India in different fields such as Alchemy, Metallurgy and Nanotechnology
LO1.1: Describe the technological development of in ancient India in the fields of Alchemy, Metallurgy and Nanotechnology.
LO1.2: Compare the ancient Indian and modern technologies.
LO1.3: Identify the different areas of application of technology in ancient India.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1	LO1.2, LO1.3 CO1				
Procedural						

Metacognitive						

Factual Dimension Remember Understand Apply Analyze Evaluate Create

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	W	M	M	S	M	W	W	S	W	M

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit I: Alchemy in Ancient India

Alchemical Literature; Areas of Development: Glass making, Paints and Dyes, Perfumes and Cosmetics, Chemicals, Paper and Ink making, Alcoholic Liqours; Laboratory and apparatus **(L 15, H 15, M 20)**

Unit II: Metallurgy in Ancient India Metallurgy before, during and during the Harappan civilization; Metallurgy after the Harappans Wootz Steel, Iron, Copper, Zinc, Gold and Silver, Social Context **(L 15, H 15, M 20)**

Unit III: Ancient Indian Culture and Nanotechnology

Ancient handicrafts and iron equipment; Ancient Ayurveda and metallic Bhasmas, Ancient Goldsmith and Bhasmas **(L 15, H 15, M 20)**

References:

[1] Indian Contribution to Science, *Vijnana Bharati*

[2] https://sathee.iitk.ac.in/ncert-books/class-11/knowledge-traditions-and-practices-of-india/

[3] A Review on Nanotechnology from Prehistoric to Modern Age, *R. D. Prasad, N. R. Prasad, R. S. Prasad, N. Prasad, S. R. Prasad, M. Shrivastav, M. Gour, V. B. Kale, Z. Guo, C. B. Desai, G. M. Nazeruddin, Y. I. Shaikh, S. Banga, P. Sane, M. Saxena and J. Kamble*, ES General, 2024, 4, 1117 10.30919/esg1117

[4] Ancient Indian Culture and Nanotechnology, *R. Baboo*, IJRAR- International Journal of Research and Analytical Reviews, 2015, 2, 97 (https://ijrar.com/upload_issue/ijrar_issue_219.pdf)

DETAILED SYLLABUS OF MINOR COURSES

SEMESTER I

Course Title: Mechanics
Course code: PHY-MIN-4-101
Nature of the course: MINOR
Total credits: 4
Distribution of marks: 60 (End-sem) **+ 40** (In-sem)

Course Description: This course comprises Newtonian mechanics and the fundamental laws of motion. It focuses on important topics in mechanics such as reference frames, work-energy theorems, conservation laws, matter and its properties, types of oscillations, and fundamental ideas about the special theory of relativity for undergraduate students. It aims to provide students with a deep understanding of the laws governing the motion of objects and the nature of space and time.

Course Objectives: The course aims to impart knowledge of Newtonian mechanics, the properties of matter, oscillations, and rotating frames, as well as their role in relevant areas of physics. It will help the students develop the concepts of the special theory of relativity and help them understand space and time more.

Course Outcomes (COs): After the completion of the course, a student will be able to

CO1: Describe the Indian origin of the basic ideas of physical sciences.
- **LO1.1:** Describe the Indian origin of the basic ideas of physical sciences.

CO2: Understand the basic concepts of mechanics, reference frames, and conservation laws.
- **LO2.1:** Define key terms related to mechanics.
- **LO2.2:** Explain linear dynamics and rotational dynamics.
- **LO2.3**: Interpret relative transformations and the invariance of laws of physics

CO3: Correlate the consequences of non-inertial frame to our real world.
- **LO3.1:** Identify the nature of fictitious forces and their effect on the real world.
- **LO3.2:** Classify these forces arising due to non-inertial frames.
- **LO3.3:** Solve problems related to non-inertial frames and fictitious forces.

CO4: Define elastic properties of matter
- **LO4.1**: Define elastic constants of solid materials
- **LO4.2**: Establish relations among elastic constants of solid materials
- **LO4.3**: Describe motion of fluids through a pipe

CO5: Compare special relativity with Newtonian relativity.
- **LO5.1:** Define key terms related to special theory of relativity.
- **LO5.2:** Contrast the changes in motion occurred due to relativistic speed and non-relativistic speed.
- **LO5.3:** Interpret equivalence of mass and energy, relativistic transformation of momentum and energy and relativistic effects such as relativistic.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO2.1 LO3.1 LO5.1 CO1	LO2.2 LO2.3 LO4.2 LO3.2 LO3.3 LO5.2 LO5.3 CO2	LO4.1 LO4.3	CO4		
Procedural		CO5		CO3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**W**									
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S			M	M		S
CO5	S	S	S	S			M	M		S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit 1: IKS-1 Vaiseṣika Philosophy/Sutra, Idea of anu or paramanu, Kanad's laws of motion, Comparision of Kanada's laws and Newton's laws of motion, Theory of Gravitation according to Bhaskaracharya. Five-layered Universe **(L 4, H 4, M 4)**

Unit 2:

2.1: Newtonian Mechanics

Frames of Reference, Inertial Frames, Galilean Transformations, Galilean Invariance; Dynamics of a System of Particles, Center of Mass, Principle of Conservation of Linear Momentum

(L 7, H 7, M 7)

2.2: 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. **(L7, H 7, M 7)**

2.3: 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 **(L 9, H 9, M 9)**

Unit 3:

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. **(L 8, H 8, M 8)**

Unit 4:

Properties of Matter

4.1: Elasticity and Elastic Constants, Relation between Elastic constants, Twisting torque on a Cylinder or Wire. **(L 6, H 6, M 6)**

4.2: Kinematics of Moving Fluids, Poiseuille's Equation for Flow of a Liquid through a capillary Tube. **(L 5, H 5, M 5)**

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

(L 14, H 14, M 14)

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Indian Contribution to Science, *Vijnana Bharati*
2. A Concise History of Science in India, Indian National Science Academy
3. An introduction to Mechanics, *D. Kleppner, R. J. Kolenkow*, Cambridge University Press.
4. Mechanics: Berkeley Physics Course Vol. 1, *C. Kittel, W. Knight, et.al.*, Tata McGraw- Hill.
5. Fundamentals of Physics, *Halliday, Resnick, Walker,* John Wiley & Sons.
6. University Physics, *R. L. Reese*, Brooks/Cole Publishing Company.
7. Introduction to Special Relativity, *R. Resnick*, John Wiley & Sons.
8. Mechanics, *D. S. Mathur*, S. Chand and Company Ltd.
9. Theoretical Mechanics (Schaum's Outline series), *M. R. Spiegel*, Tata McGraw Hill.
10. Analytical Mechanics, *G. R. Fowles and G. L. Cassiday*, Thomson Brooks/Cole.

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SEMESTER II

Course title: Waves and Optics ***(With IKS-2)***
Course code: PHY-MIN-4-201
Nature of the course: Core
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides an introduction to the basic concepts of waves, oscillation, and optics. It aims to provide knowledge about superposition principles, give comprehensive ideas about simple harmonic oscillations, and introduce wave concepts, including group velocities and phase velocities. It depicts the electromagnetic nature of light and enters the domain of optics by providing in depth knowledge of optical phenomena and optical instruments based on these phenomena to undergraduate students.

Course Objectives: This course aims to develop theoretical knowledge of waves, oscillations, and the superposition principle. The course provides fundamental concepts in the study of wave phenomena and the behavior of light, especially in thin films. To acquaint the learner with the principles behind various optical instruments and to build a theoretical knowledge of them

Course Outcomes (COs): At the completion of the course, a student will be able to

CO1: Acquire the knowledge of Indian origin to the field of sound and light.
- **LO1.1:** Describe the basic origin of Indian concept sound and light

CO2: Analyze the principle of linearity and superposition, concepts of wave motion and standing waves.
- **LO2.1:** Define superposition, plane and spherical waves, and stationary waves.
- **LO2.2:** Explain the superposition of waves, the velocity of longitudinal and transverse waves in different media, and the role of standing waves in different physical systems.
- **LO2.3:** Construct Lissajous figures and develop the differential equation of a wave.

CO3: Connect the knowledge obtained from the wave with the behavior of light.
- **LO3.1:** Explain the phenomenon of interference in thin films.
- **LO3.2:** Develop theoretical knowledge of various optical instruments.
- **LO3.3:** Illustrate key concepts of diffraction.

CO4: Analyze simple harmonic oscillators in detail.
- **LO4.1:** Explain simple harmonic motion in an oscillatory system.
- **LO4.2:** Solve the differential equation of simple harmonic motion.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual	LO1.1 LO2.1 CO1	LO2.2 LO3.1 LO3.3	LO2.3 LO3.2 LO4.1 LO4.2	CO2 CO3 CO4		
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	W	S	S	S			M	M		S
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S			M	M		S

(S: Strong, M: Medium, W: Weak)

Course Contents: Unit 1: IKS-2:

Vedic philosophy of light and sound (*Vāk*) -four stages—Para, Pashyanti, Madhyama, and Vaikhari, (Tejas Theory) - Early philosophical inquiry into the speed and particle nature of light. Mirrors and Lenses in Ancient Indian Architecture **(L 4, H 4, M 4)**

Unit 2: Superposition of Harmonic Oscillations

2.1: Linearity and Superposition Principle. Superposition of two collinear harmonic oscillations having equal frequencies and different frequencies (Beats). Superposition of N collinear harmonic oscillations with equal phase differences and equal frequency differences **(L 5, H 5, M 5)**

2.2: Graphical and Analytical Methods: Lissajous Figures with equal and unequal frequency and their use. **(L 3, H 3, M 3)**

Unit 3: Wave Motion

3.1: Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling), Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of a Wave. **(L 3, H 3, M 3)**

3.2: Velocity of transverse vibrations of stretched strings, Velocity of longitudinal waves in a fluid in a pipe, Pressure of a longitudinal wave, Newton's formula for velocity of sound, Laplace's correction, Energy, power transport and intensity of wave **(L 6, H 6, M 6)**

Unit 4: Standing Waves

Standing (Stationary) Waves, Standing Waves in a String: Fixed and Free ends, Normal Modes of Stretched Strings, Comparison of Standing Wave with Travelling Waves, Plucked and Struck Strings, Melde's Experiment, Longitudinal Standing Waves in Open and Closed Pipes, Normal Modes of Longitudinal Waves, Phase and Group Velocities. **(L 6, H 6, M 6)**

Unit 5: 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. **(L 5, H 5, M 5)**

Unit 6: Wave optics

Electromagnetic nature of light, definition and properties of wave front, Huygens' principle, Temporal and Spatial coherence. (**L 3, H 3, M 3)**

Unit 7: Interference

7.1: Division of amplitude and wavefront, Young's double slit experiment, Phase change on reflection: Stokes' treatment, Fresnel's Biprism, Interference in Thin Films: parallel and wedge-shaped films. Newton's Rings: Measurement of wavelength and refractive index **(L 7, H 7, M 7)**

7.2: 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. Introduction to Fabry-Perot interferometer **(L 4, H 4, M 4)**

Unit 8: Diffraction

8.1: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula (Qualitative discussion only). **(L 2, H 2, M 2)**

8.2: Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit. **(L 6, H 6, M 6)**

8.3: Fraunhofer Diffraction: Single slit, Circular aperture. Resolving Power of a telescope, Double slit, Multiple slits. Diffraction grating, Resolving power of grating. **(L 6, H 6, M 6)**

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Indian Contribution to Science, *Vijnana Bharati*
2. A Concise History of Science in India, Indian National Science Academy
3. Waves: Berkeley Physics Course, *F. Crawford,* Tata McGraw-Hill.
4. Fundamentals of Optics, *F. A. Jenkins and H. E. White,* McGraw-Hill.
5. Principles of Optics, *M. Born and E. Wolf,* Pergamon Press.
6. Optics, *A. Ghatak*, Tata McGraw Hill.
7. Modern Optics, *A. B. Gupta*,Books & Allied (P) Ltd.
8. The Physics of Vibrations and Waves, *H. J. Pain,* John Wiley and Sons.
9. The Physics of Waves and Oscillations, *N. K. Bajaj*,Tata McGraw Hill.
10. Fundamental of Optics, *A. Kumar, H. R. Gulati and D. R. Khanna*,R. Chand Publications.

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SEMESTER III

Course title: Physics Lab 1 (Minor)
Course code: PHY-MIN-4-301
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course explores fundamental principles of physics through hands-on experiments and precise measurements. It utilizes techniques and optical instruments to study properties like elasticity, viscosity, and optical phenomena. Students analyze experimental data, apply mathematical models, and verify physical laws, enhancing skills in measurement, analysis, and scientific inquiry.

Course Objectives: This course is essential for developing practical skills in experimental physics, vital for understanding fundamental principles and verifying theoretical concepts through hands-on learning. It equips students with the ability to perform precise measurements, analyze data, and apply scientific methods in real-world scenarios. These skills are crucial for future scientists, engineers, and researchers who require a solid foundation in experimental techniques and scientific inquiry.

Course Outcomes (CO): After completion of this course the students will be able to

CO1: Understand and apply measurement techniques.

LO1.1: Explain the sources of errors in measurements and methods to minimize them.

LO1.2: Apply measurement techniques to determine physical quantities like length, diameter, and thickness accurately using vernier calipers and screw gauges.

CO2: Analyze Physical Phenomena.

LO2.1: Demonstrate experiments to investigate properties such as viscosity, elasticity, and optical dispersion.

LO2.2: Examine the accuracy of experimental results and compare them with theoretical predictions.

LO2.3: Analyze experimental data to calculate spring constants, modulus of rigidity, and moments of inertia.

CO3: Use Optical and Interferometric Techniques.

LO3.1: Apply optical techniques to measure refractive indices, wavelength using diffraction grating, and spectral characteristics of light sources.

LO3.2: Utilize interference patterns to determine parameters like dispersive power and resolving power of optical elements.

LO3.3: Construct experiments using interferometric techniques to verify physical laws like the $\lambda 2$ –T law and study coupled oscillators.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual		CO1 LO1.	CO1, LO1.2 LO3.1 LO3.2	CO2, LO2.3		
Procedural		LO2.1	CO3, LO3.3	LO2.2		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	S	M	W
CO2	S	S	M	M	M	S	S	S	M	W
CO3	S	S	M	M	M	S	S	S	M	W

(S: Strong, M: Medium, W: Weak)

Course Contents:

List of Experiments:

Unit I: Mechanics

1. Measurements of length (or diameter) using vernier caliper, screw gauge and traveling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique.
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of **g** using Bar Pendulum.

Unit 2: Waves and Optics

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda 2 - T$ law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. To determine the refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine the wavelength of sodium source using Michelson's interferometer.
7. To determine wavelength of sodium light using Fresnel Biprism.
8. To determine wavelength of sodium light using Newton's Rings.
9. To determine the thickness of a thin paper by measuring the width of the interference fringes Produced by a wedge-shaped Film.
10. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
11. To determine dispersive power and resolving power of a plane diffraction grating.

(Total Practical Classes 60, Total Contact Hours 120, Total Marks)

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

Recommended Readings:

1. Advanced Practical Physics for students, *B. L. Flint and H. T. Worsnop*, Asia Publishing House.
2. Advanced level Physics Practicals, *Michael Nelson and Jon M. Ogborn*, Heinemann

Educational Publishers.
3. A Text Book of Practical Physics, *I. Prakash and Ramakrishna,* Kitab Mahal.
4. Engineering Practical Physics, *S. Panigrahi and B. Mallick,* Cengage Learning India Pvt. Ltd.
5. Practical Physics, *G. L. Squires,* Cambridge University Press.
6. A Laboratory Manual of Physics for undergraduate classes, *D. P. Khandelwal*, Vani Publication.

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SEMESTER IV

Course title: Electricity and Magnetism *(With IKS-3)*
Course code: PHY-MIN-4-401
Nature of the course: Minor
Total credits: 4
Distribution of Marks: 60 (End sem) **+ 40** (In-sem)

Course Description: This course provides a fundamental understanding of electrostatics, magnetism, electromagnetic induction and Maxwell's equations. It begins with basics of vector calculus essential for physics and engineering. The curriculum covers the concept of electric fields, potential, capacitance, and dielectric effects. It also delves into the dielectric properties of matter, the principles of magnetostatics, and the magnetic properties of materials. The course also examines electromagnetic induction, including Faraday's and Lenz's laws. Finally, Maxwell's equations unify these concepts, leading to the study of electromagnetic wave propagation and energy dynamics in electromagnetic fields. This course is crucial for understanding electric and magnetic phenomena.

Course Objectives: The basic objective of this course is to
1. Introduce learners to the fundamental principles of electromagnetism.
2. Develop a basic understanding of electrostatics, magnetostatics, and electromagnetic induction.
3. Introduce learners to the dielectric properties of matter and the magnetic properties of materials.
4. Develop problem-solving skills and analytical techniques that will be useful in advanced studies.

Course Outcomes (COs): After the completion of the course the students will be able to

CO1: Understand the fundamental laws of electromagnetism and their importance in Physics.
- **LO1.1:** Define the key concepts of electric and magnetic fields.
- **LO1.2:** Explain the basic laws of electrostatics, magnetostatics and electromagnetic induction.
- **LO1.3:** Describe the concept of electromagnetic induction and Maxwell's equations.

CO2: Apply fundamental laws to solve practical problems.
- **LO2.1:** Use Gauss's law to solve problems involving symmetrical charge distributions.
- **LO2.2:** Solve problems involving magnetic fields in different geometries using Maxwell's equations.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1	LO1.2 LO1.3 CO1	LO2.1 LO2.2 CO2			
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	S	M	W
CO2	S	S	M	M	M	S	S	S	M	W
CO3	S	S	M	M	M	S	S	S	M	W

(S: Strong, M: Medium, W: Weak)

Unit1: IKS-3

Early Historical Period, Concept of Zero, Number System, Arithmetic, Pythagoras theorem; Vedic Mathematics; Kerala School of Mathematics, Concept of Pi; Mathematician and Physicists in Ancient India. **(L 4, H 4, M 4)**

Unit 2: Vector Analysis

Review of vector algebra (scalar and vector product), gradient, divergence, curl and their significance, vector integration, line, surface and volume integrals of vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). **(L 12, H 12, M 12)**

Unit 3: Electrostatics

Electrostatic field, electric flux, Gauss's theorem of electrostatics, applications of Gauss theorem: electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic fields. Dielectric medium, polarisation, displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor

completely filled with dielectric. **(L 22, H 22, M 22)**

Unit 4: Magnetism

Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro-magnetic materials.

(L 10, H 10, M 10)

Unit 5: Electromagnetic Induction

Faraday's laws of electromagnetic induction. Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in a magnetic field. **(L 6, H 6, M 6)**

Unit 6: Maxwell's equations and Electromagnetic wave propagation

Equation of continuity of current, displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization. **(L 10, H 10, M 10)**

(Total Lectures 60, Total Contact Hours 60, Total Marks 60)

Recommended Readings:

1. Electricity, Magnetism & Electromagnetic Theory, *S. Mahajan and Choudhury*, Tata McGraw Hill.
2. Electricity and Magnetism, *Edward M. Purcell*, McGraw Hill Education.
3. Introduction to Electrodynamics, *D. J. Griffiths*, Pearson Education.
4. Feynman Lectures Vol.2, *R. P. Feynman, R. B. Leighton, M. Sands*, Pearson Education.
5. Elements of Electromagnetics, *M. N. O. Sadiku*, Oxford University Press.
6. Electricity and Magnetism, *J. H. Fewkes & J. Yarwood*. Oxford University Press.

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