Curriculum Book

and

Assessment and Evaluation Scheme

based on

Outcome Based Education (OBE)

and

Choice-Based Credit System (CBCS)

in

Master of Science in Physics

M.Sc. (Physics)

2 Year Degree Program

Revised as on 01 August 2023
Applicable w.e.f. Academic Session 2023-24

AKS University

Satna 485001, Madhya Pradesh, India

Faculty of Basic Science
Department of Physics

AKS University

Faculty of Basic Science

Department of Physics

Curriculum & Syllabus of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

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Vice-Chancellor
AKS University
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A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Forwarding

I am thrilled to observe the updated curriculum of the Physics Department for Physics Master Program, which seamlessly integrates the most recent technological advancements and adheres to the guidelines set forth by UGC. The revised curriculum also thoughtfully incorporates the directives of NEP-2020 and the Sustainable Development Goals.

The alignment of course outcomes (COs), Program Outcome (POs) and Program specific outcomes (PSOs) has been intricately executed, aligning perfectly with the requisites of NEP-2020 and NAAC standards. I hold the belief that this revised syllabus will significantly enhance the skills and employability of our students.

With immense satisfaction, I hereby present the revised curriculum for the M.Sc. (Physics) program for implementation in the upcoming session.

ER. Anant Soni
Pro Chancellor &
Chairman

01 August 2023
AKS University, Satna

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

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From the Desk of the Vice-Chancellor

AKS University is currently undergoing a process to revamp its curriculum into an outcome-based approach, with the aim of enhancing the teaching and learning process. The foundation of quality of quality education lies in the implementation of a curriculum that aligns with both societal and industrial needs, focusing on relevant outcomes. This entails dedicated and inspired faculty members, as well as impactful industry internships.

Hence, it is of utmost importance to begin this endeavor by crafting an outcome-based curriculum in collaboration with academia and researchers. This curriculum design should be informed by the latest technological advancements, market demands, the guidelines outlined in the National Education Policy (NEP) of 2020, and sustainable goals.

I'm delighted to learn that the revised curriculum has been meticulously crafted by the Physics Department, in consultation with an array of experts from the cement industry, research institutes, and academia. This curriculum effectively integrates the principles outlined in the NEP-2020 guidelines, as well as sustainable goals. It also adaptly incorporates the latest advancements in science and research.

Furthermore, the curriculum takes into account the specific needs of the scientific industry, focusing research in academics. This inclusion not only imparts knowledge but also encourages students' independent thinking for potential enhancements in this area.

The curriculum goes beyond theoretical learning and embraces practical applications by incorporating the utilization of science and research in education. To enhance students' skills, the curriculum integrates Hands- On Training, industrial visits, and On-Job Training experiences, research and progress. This well-rounded approach ensures that students receive a comprehensive education, fostering their skill development and preparing them for success in this course.

I am confident that the updated curriculum for Physics will not only enhance students' technical skills but also contribute significantly to their employability. During the process of revising the curriculum, I am pleased to observe that the Physics department has diligently adhered to the guidelines provided by the UGC. Additionally, they have maintained a total credit requirement of 91 for the M.Sc.(Physics) program.
It's worth noting that curriculum revision is an ongoing and dynamic process, designed to address the continuous evolution of technological advancements and both local and global concerns. This ensures that the curriculum remains responsive and attuned to the changing landscape of education and industry.

AKS University warmly invites input and suggestions from researchers, scientists, academicians and Alumni students to enhance the curriculum and make it more student-centered. Your valuable insights will greatly contribute to shaping an education that best serves the needs and aspirations of our students.

Professor B. A. Chopade
Vice- Chancellor

AKS University, Satna
01 August 2023

Preface

As part of our commitment to ongoing enhancement, the Department of Physics consistently reviews and updates its M.Sc. (Physics) programs curriculum every three years. Through this process, we ensure that the curriculum remains aligned with the latest technological advancements, as well as local and global industrial and social demands.

During this procedure, the existing curriculum for the M.Sc. (Physics) Physics Program undergoes evaluation by a panel of scientists, researchers, industry specialists, and academics. Following meticulous scrutiny, the revised curriculum has been formulated and is set to be implemented starting from August 01, 2023. This implementation is contingent upon the endorsement of the curriculum by the University's Board of Studies and Governing Body.

This curriculum closely adheres to the UGC model syllabus distributed in May 2023. It seamlessly integrates the guidelines set forth by the Ministry of Higher Education, Government of India, through NEP-2020, as well as the principles of Sustainable Development Goals. In order to foster the holistic skill development of students, a range of practical activities, including Hands-On Training, Industrial Visits, Project planning and execution, Report Writing, Seminars, and Industrial On-Job Training, have been incorporated. Furthermore, in alignment with UGC's directives, the total credit allocation for the M.Sc. (Physics) program is capped at 91 credits.

This curriculum is enriched with course components in alignment with UGC guidelines, encompassing various disciplines such as Core Program Courses: 65 credits, Elective Program Courses: 12 credits, Open Electives: 04 credits, Project and Practical Training: 10 credits.

To ensure a comprehensive learning experience, detailed evaluation schemes and rubrics have also been meticulously provided.

For each course, a thorough mapping of Course Outcomes, Program Outcomes, and Program Specific Outcomes has been undertaken. As the course syllabus is being meticulously developed, various elements such as session outcomes, laboratory instruction, classroom instruction, self-learning activities, assignments, and mini projects are meticulously outlined.

We hold the belief that this dynamic curriculum will undoubtedly enhance independent thinking, skills, and overall employability of the students.

Professor G C Mishra
Director Physics

AKS University
01 August 2023

A K S University

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1. Introduction

The Department of Physics was established as a full-fledged, self-supporting post-graduate and research department in 2012. The Department offers M.Sc. (Physics) and Ph.D. Programs. The Department of Physics has been exerting a major thrust in research and innovative teaching. The academic Program of this department has been designed to meet the requirement of the latest technological developments and envisages becoming state-of-the-art department with high quality education and cutting edge interdisciplinary research in Physical Science.

- Competent and motivated scientific and academic staff members with a favorable age structure.
- The Young faculty members of the Department are extremely active in research activities, publishing research contents and dedicated for financial projects.

I. About the Subject

Physics is the natural science that studies the matter, its motion and behavior through space and time, and the related entities of energy and force. Physics is one of the most fundamental scientific disciplines and its main goal is to understand the behavior of universe and its characteristics. Physics uses the scientific method to help uncover the basic principles governing light and matter, and to discover the implications of those laws. It assumes that there are rules by which the universe functions, and that those laws can be at least partially understood by humans. It is also commonly believed that those laws could be used to predict everything about the universe's future if complete information was available about the present state of all light and matter. On inclusion of Astronomy, the Physics became one of the oldest academic disciplines. Physics intersects with many interdisciplinary areas of research. New ideas in Physics often explain the fundamental mechanisms studied by other branches of science and suggest new avenues of research in academic disciplines such mathematics etc. Advancement in Physics often leads to new technologies.

II. About the Program (Nature, extent and aims)

M.Sc. (Physics) is a two year regular Program. There four semesters in this Program. Each semester is of sixteen weeks duration. Teaching and learning process of M.Sc. (Physics) involves theory and practical classes along with seminar presentation and research project work.

The curriculum will be taught through formal lectures with the aid of power-point presentations, audio and video tools and other teaching aids can be used as and when required. Emphasis will be given to laboratory work and visit to National laboratories to give hands on experience to students.

Students will be encourage to do semester long project in their own institutes as well as in reputed institutes of National level. Aims of the Program are as follows

- Understand the underlying Physics in respective specializations, and, be able to teach and guide successfully
- Introduce advanced ideas and techniques that are applicable in respective fields.
- Provide the students with a broad spectrum of Physics Courses
- Emphasize the role of Physics in other disciplines such as (Chemical Sciences, MathematicalSciences, Life Sciences and their applied areas)
- Develop the ability of the students to observe, perform, analyse and report an experiment
- Develop the ability of the students to deal with physical models and formulas mathematically
- Equip the students with different practical, intellectual and transferable skills.
- Strengthen the student knowledge of Physics and its applications in real world.
- Provide the student with mathematical and computational tools and models to be used insolving professional problems
- Improve the student's inter disciplinary skills.
- To develop human resources with a solid foundation in theoretical and experimental aspects of respective specializations as a preparation for career in academia and industry.

III. Qualification Descriptors (possible career pathways)

Upon successful completion of the course, the students receive a M.Sc. Degree in Physics. The Department of Physics is expected to opt different paths seeking sphere of knowledge and domain of professional work that can fulfill their dreams. Students will be ableto demonstrate their knowledge in advance branches of Physics. This will establish a platform over which students can pursue higher studies. The possible career paths for postgraduate in M.Sc. (Physics) are:

1. Teaching Assignments
2. Scientific Assignments
3. Instruments development
4. Research and Development in Industries

5. Simulation Techniques Development in Science

6. Role in Renewable Energy Resources

7. University/Institute Administrative Assignments

8. Technician in Lasers, Accelerators, Detectors and Electronics

9. Astronomer

10. Medical Device Designer

11. Radiologist

2. Vision & Mission of the Physics Department:

The physics department is fully committed to impart quality education both in theoretical as well as experimental physics with special emphasis on 'learning by doing' for socio-economic growth.

The Department of Physics include continuous improvement of the quality of scientific research, the development of innovative curricula and techniques based on research and the latest scientific discoveries, greater international visibility and recognition of the Department, as well as the increasing impact on the development of the economy and society as a whole.

Department of Physics achieves its mission by trying to evenly represent the underlying sub-disciplines of physics in research and teaching, but also to promote new areas of research, with an emphasis on interdisciplinary and applied research.

The Department of Physics also encourages the development of educational physics through primary and secondary education by participating in the development of the curriculum, developing methodology of physics education, teaching aids and textbooks, through lifelong learning programs and training of teachers, and particularly through continued work with students that were recognized as extremely talented.

The Department of Physics actively promotes the highest ethical principles in scientific research, critical thinking, openness to social, scientific, technological and educational changes, as well as the working autonomy at the University, both scientific and educational.

Department of Physics is working on following objectives:

1. Construct basics of physics curriculum and smooth study plan.
2. Provide a sophisticated level of education for teaching of undergraduate and graduate studies.
3. To provide required contribution and support to other departments at AKSU.
4. Prepare the student in assets of physics and the principles of analytical methods required for the conclusion of physical tests.

5. Provide an opportunity for students to deepen their knowledge in the branches of physics.
6. Encouraging the students for the scientific research.
7. Work in the completion of applied research, basic scientific research, experimental, theoretical and applied.
8. To contribute to consulting services, training, addressing scientific and industrial problems
9. Continued development of faculty members by sending them for training courses so as to maintain a high degree of efficiency and performance.
10. Support and encourage the scientific cooperation between faculty members in the department and cooperation with other departments in the field of multi-purpose research.
11. Spread the spirit of competition and encouragement and give the opportunity to all members.
12. Preparation of national cadres by basic physics and knowledge that contribute to community service.

3. Program Educational Objectives (PEO)

PEO-1: To prepare science graduates to exhibit quality of excellence, critical thinking, creativity, inventiveness, and self-motivation for life-long learning to handle all kind of diverse situations in interdisciplinary and multidisciplinary environment.

PEO-2: To produce graduates who are globally acceptable professionals for government, corporate and research organizations along with skills for entrepreneurial pursuits in multidisciplinary areas.

PEO-3: To groom graduates who can demonstrate technical competence in the field of Physics and develop solutions to the complex problems.

PEO-4: To produce graduates who can ethically lead and work as a part of team towards the fulfillment of both individual and organizational goals.

PEO-5: To engage graduates in professional pursuits to enhance their own achievements along with serving the society at large.

4. Program Outcomes (POs)

M.Sc. (Physics) Program will able to perform:

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

5. Program Specific Outcomes (PSOs)

The post graduates shall be able to realise the following specific outcomes bythe end of program studies:

PSO 1: Identify, formulate, and solve Physics problems.

PSO 2: Design and conduct experiments, as well as to analyse and interpret data.

PSO 3: Apply knowledge of Physics in a different stream of science and to communicate effectively.

PSO 4: Ability to use the techniques, skills, and modern physical tools in real world application.

PSO 5: Engage in life-long learning and will have recognition.

Consistency/Mapping of PEOs with Mission of the Department

PEO	M 1	M 2	M 3	M 4
PEO 1	3	2	3	2
PEO 2	2	2	2	3
PEO 3	2	3	2	1
PEO 4	2	2	3	3
PEO 5	2	2	3	3

1*: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-": No correlation*

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Curriculum of M.Sc. (Physics) Program

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GENERAL COURSE STRUCTURE & THEME

1. Definition of Credit

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

2. Range of Credits:

In the light of the fact that a typical Model Two-year Post Graduate degree program in Physics has about 91 credits, the total number of credits proposed for the two-year M.Sc. (Physics) is kept as 91 considering NEP-20 and NAAC guidelines.

3. Structure of PG Program in Physics:

The structure of PG program in Physics shall have essentially the following categories of courses with the breakup of credits as given:

Components of the Curriculum

(Program curriculum grouping based on course components)

Sl No	Course Component	% of total number of credits of the Program	Total number of Credits
1	Program Core (PCC)	71.42	65
2	Program Electives (PEC)	13.20	12
3	Open Electives (OEC)	4.40	04
4	Project(s) (PRC)/ On job Plant Training (OJT)	10.98	10
5	Seminar(PSC)	-	-
	Total	100.00	**91**

General Couse Structure and Credit Distribution

Curriculum of M.Sc. (Physics)

Semester -I		Semester - II	
Course Title	Credit	Course Title	Credit
Mathematical Physics	4:0:0 = 4	Thermodynamics and Statistical Physics	4:0:0 = 4
Classical Mechanics	4:0:0 = 4	Solid State Physics	4:0:0 = 4
Condense Matter Physics	4:0:0 = 4	Quantum Mechanics-I	4:0:0 = 4
Electronics Devices	4:0:0 = 4	Atomic, Molecular and Laser Physics	4:0:0 = 4
General Physics Lab-I	0:0:3 = 3	General Physics Lab-II	0:0:3 = 3
Electronics Lab-I	0:0:3 = 3	Electronics Lab-II	0:0:3 = 3
Total Credit	**22**	**Total Credit**	**22**
Semester -III		**Semester - IV**	
Course Title	Credit	Course Title	Credit
Electrodynamics and Plasma Physics	4:0:0 = 4	Physics of Nano Materials	4:0:0 = 4
Quantum Mechanics-II	4:0:0 = 4	Solar Cell and other Renewable Energy Devices	4:0:0 = 4
Digital Electronics & Microprocessor	4:0:0 = 4	Computational and Experimental Techniques and Data Analysis	4:0:0 = 4
Nuclear and Particle Physics	4:0:0 = 4	Physics of Solar Energy	4:0:0 = 4
Digital signal processing	4:0:0 = 4	Astronomy and Space physics	4:0:0 = 4
General Physics Lab-III	0:0:3 = 3	General Energy and Computational Lab	0:0:3 = 3
Electronics Lab-III	0:0:3 = 3	Research Project Work	0:0:10 = 10
Total Credit	**22**	**Total Credit**	**25**

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Course code and definition:

L	=	Lecture
T	=	Tutorial
P	=	Practical
C	=	Credit
M.Sc.	=	Master of Science
PCC	=	Professional core courses
PEC	=	Professional Elective courses
OEC	=	Open Elective courses
LC	=	Laboratory course
MC	=	Mandatory courses

Course level coding scheme:

Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered. e.g.

101, 102 … etc. for first year.
201, 202 …. Etc. for second year.
301, 302 … for third year.
401. 402--- for Fourth year

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Category-wise Courses

PROGRAM CORE COURSES [PCC] (Total 20)

Sl.	Code No.	Subject	Semester	Credits
1	PCC-PH101	Mathematical Physics	1	4:0:0 = 4
2	PCC- PH102	Classical Mechanics	1	4:0:0 = 4
3	PCC- PH103	Condense Matter Physics	1	4:0:0 = 4
4	PCC- PH104	Electronics Devices	1	4:0:0 = 4
5	PCC- PH151	General Physics Lab-I	1	0:0:3 = 3
6	PCC- PH152	Electronics Lab-I	1	0:0:3 = 3
7	PCC- PH201	Thermodynamics and Statistical Physics	2	4:0:0 = 4
8	PCC- PH202	Solid State Physics	2	4:0:0 = 4
9	PCC- PH203	Quantum Mechanics-I	2	4:0:0 = 4
10	PCC- PH204	Atomic, Molecular and Laser Physics	2	4:0:0 = 4
11	PCC- PH251	General Physics Lab-II	2	0:0:3 = 3
12	PCC- PH252	Electronics Lab-II	2	0:0:3 = 3
13	PCC- PH301	Electrodynamics and Plasma Physics	3	4:0:0 = 4
14	PCC- PH302	Quantum Mechanics-II	3	4:0:0 = 4
15	PCC- PH303	Digital Electronics & Microprocessor	3	4:0:0 = 4
16	PCC- PH351	General Physics Lab-III	3	0:0:3 = 3
17	PCC- PH352	Electronics Lab-III	3	0:0:3 = 3
18	PCC- PH451	General Energy and Computational Lab	4	0:0:3 = 3
			Total Credits:	**65**

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PROGRAM ELECTIVE COURSES [PEC]

Total 3 to be taken, at least one from each group – Technology and Industry Sector, based on Project topic and individual interest. Illustrative courses are listed here

Sl.	Code No.	Subject	Semester	Credits
1	PEC-PH304	Nuclear and Particle Physics	3	4:0:0 = 4
2	PEC-PH305	Digital signal processing	3	4:0:0 = 4
3	PEC-PH401	Physics of Nano Materials	4	4:0:0 = 4
4	PEC-PH403	Computational and Experimental Techniques and Data Analysis	4	4:0:0 = 4
5	PEC-PH405	Astronomy and Space physics	4	4:0:0 = 4
Total Credit				**12**

Open Electives (OEC)

Sl.	Code No.	Subject	Semester	Credits
1	OEC-PH402	Solar Cell and other Renewable Energy Devices	4	4:0:0 = 4
2	OEC-PH404	Physics of Solar Energy	4	4:0:0 = 4
Total Credit				4:0:0 = 4

RESEARCH PROJECT (3 Stages)

Sl.	Code No.	Subject	Semester	Credits
1	PROJ-PH452	Research Project Work	4	0:0:10
Total Credit				**0:0:10**

Induction Program

Induction program for students to be offered right at the start of the first year. It is mandatory. AKS University has design an induction program for 1st year student, details are below:

i. Physical activity
ii. Creative Arts
iii. Universal Human Values
iv. Literary
v. Proficiency Modules
vi. Lectures by Eminent People
vii. Visits to local Areas
viii. Familiarization to Dept./Branch & Innovations

Mandatory Visits/ Workshop/Expert Lectures:

i. It is mandatory to arrange one industrial visit every semester for the students.
ii. It is mandatory to conduct a One-week workshop during the winter break after fifth semester on professional/ industry/ entrepreneurial orientation.
iii. It is mandatory to organize at least one expert lecture per semester for each branch by inviting resource persons from industry.

Evaluation Scheme:

1. For Theory Courses:

i. The weightage of Internal assessment is 50% and
ii. End Semester Exam is 50%

The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

2. For Practical Courses:

i. The weightage of Internal assessment is 50% and
ii. End Semester Exam is 50%

The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

3. For Summer Internship / Projects / Seminar etc.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc

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Semester wise Course Structure

Semester wise Brief of total Credits and Teaching Hours

Semester	L	T	P	Total Hour	Total Credit
Semester -I	16	00	06	28	22
Semester -II	16	00	06	28	22
Semester -III	16	00	06	28	22
Semester - IV	12	00	13	38	25
Total	60	00	31	122	91

Details of Semester Wise Course Structure

Semester – I

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	Program Core Courses (PCC)	77PH101	Mathematical Physics	4	0	0	4	4
2	Program Core Courses (PCC)	77PH 102	Classical Mechanics	4	0	0	4	4
3	Program Core Courses (PCC)	77PH103	Condense Matter Physics	4	0	0	4	4
4	Program Core Courses (PCC)	77PH104	Electronics Devices	4	0	0	4	4
5	Program Core Courses (PCC)	77PH151	General Physics Lab-I	0	0	3	6	3
6	Program Core Courses (PCC)	77PH152	Electronics Lab-I	0	0	3	6	3
Total				16	0	6	28	22

Semester – II

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	Program Core Courses (PCC)	77PH201	Thermodynamics and Statistical Physics	4	0	0	4	4
2	Program Core Courses (PCC)	77PH 202	Solid State Physics	4	0	0	4	4
3	Program Core Courses (PCC)	77PH203	Quantum Mechanics-I	4	0	0	4	4
4	Program Core Courses (PCC)	77PH204	Atomic, Molecular and Laser Physics	4	0	0	4	4
5	Program Core Courses (PCC)	77PH251	General Physics Lab-II	0	0	3	6	3
6	Program Core Courses (PCC)	77PH252	Electronics Lab-II	0	0	3	6	3
Total				16	0	6	28	22

Semester – III

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	Program Core Courses (PCC)	77PH301	Electrodynamics and Plasma Physics	4	0	0	4	4
2	Program Core Courses (PCC)	77PH 302	Quantum Mechanics-II	4	0	0	4	4
3	Program Core Courses (PCC)	77PH303	Digital Electronics & Microprocessor	4	0	0	4	4
4	Program Elective Courses (PEC)	77PH304	Nuclear and Particle Physics	4	0	0	4	4
5	Program Elective Courses (PEC)	77PH305	Digital signal processing	4	0	0	4	4
6	Program Core Courses (PCC)	77PH351	General Physics Lab-III	0	0	3	6	3
7	Program Core Courses (PCC)	77PH352	Electronics Lab-III	0	0	3	6	3
Total				16	0	6	28	22

Semester – IV

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	Program Electives (PEC)	77PH401	Physics of Nano Materials	4	0	0	4	4
2	Open Electives (OEC)	77PH 402	Solar Cell and other Renewable Energy Devices	4	0	0	4	4
3	Program Elective Courses (PEC)	77PH403	Computational and Experimental Techniques and Data Analysis	4	0	0	4	4
4	Open Electives (OEC)	77PH404	Physics of Solar Energy	4	0	0	4	4
5	Program Electives (PEC)	77PH405	Astronomy and Space physics	4	0	0	4	4
6	Program Core Courses (PCC)	77PH451	General Energy and Computational Lab	0	0	3	6	3
7	Project(s) (PRC)/ On job Plant Training (OJT)	77PH452	Research Project Work	0	0	10	20	10
Total				12	0	13	38	25

Total credits : 91

Semester-I

Course Code: PH101

Course Title : Mathematical Physics

Pre- requisite: The broad education necessary to understand the different applications of mathematics to understand physics.

Rationale: The students studying Physics should possess foundational understanding about historical binding materials employed in construction. This encompasses familiarity with the invention and evolution of Portland cement. Additionally, students ought to acquire fundamental insights into various cement types, their applications, as well as the Indian regulatory authorities responsible for supervising production standards and quality of cement.

Course Outcomes:

PH101.1: Describe the mathematics concepts and their applications to complex numbers, complex functions, analytic functions, complex integration and theory of residues problems of physics.

PH101.2: Understand and analyze the concept of Numerical Solution of Linear and Non-Linear Equations, Ordinary Differential Equations and Function of complex variable.

PH101.3: Identify the applications of complex variables, tensors and group theory.

PH101.4: Understand the concept of Bessel's function, Hermite function etc., with its properties like recurrence relations, orthogonal properties, generating functions etc. Understand how special function is useful in differential equations.

PH101.5: Evaluate the Fourier transform of a continuous function and be familiar with its basic properties, Solution of integral equation and their application, Solve differential & integral equations with initial conditions using Laplace transform.

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Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH101	Mathematical Physics	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	PH101	Mathematical Physics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH101.1: Describe the mathematics concepts and their applications to complex numbers, complex functions, analytic functions, complex integration and theory of residues problems of physics.

Approximate Hours

Item	AppX Hrs
CI	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (Sos)	**Class Room Instruction (CI)**	**Self Learning**
SO 1.1 understanding of the algebraic structures of vector spaces as well as their applications in solving problems across different domains. **SO 1.2** understanding of the algebraic structures of matrices, as well as their applications in solving problems across different domains. **SO1.3** Students should be able to perform computations involving vectors and matrices. **SO1.4** Solve problems related to linear equations and matrices. **SO1.5** analyzes linear transformations, eigen values and eigen vectors.	**Unit I (Vector spaces and Matrices)** 1.1 Definition of a linear vector space 1.2 Linear independence 1.3 basis and dimension 1.4 scalar Product 1.5 Orthonormal basis 1.6 Gram-Schmidt Orthogonalization process 1.7 Linear operators 1.8 Matrices 1.9 Orthogonal 1.10 Unitary and Hermitian matrices 1.11 Eigenvalues and eigenvectors of matrices 1.12 Matrix diagonalization.	1: Explanation about Basis and Dimension 2: Understand about (Orthogonal, Unitary, Hermitian matrices and Matrix diagonalization)

SW-1 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  Power Point Presentation

PH101.02: Understand and analyze the concept of Numerical Solution of Linear and Non-Linear Equations, Ordinary Differential Equations and Function of complex variable.

Approximate Hours

Item	AppX Hrs
Cl	7
LI	0
SW	2
SL	1
Total	10

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO2.1 students should have a solid understanding of how differential equations are used to model physical systems and the ability to solve a variety of differential equations encountered in mathematical physics using analytical and numerical techniques. **SO2.2** Methods for solving systems of linear and nonlinear differential equations. **SO2.3** Students should also be able to interpret solutions in the context of the physical phenomena being modeled. **SO2.4** ability to solve a variety of differential equations encountered in mathematical physics using analytical techniques. **SO2.5** ability to solve a variety of differential equations numerical techniques.	**Unit II (Differential equations)** 2.1 Second order linear differential equation with variable coefficients 2.2 ordinary point 2.3 singular point 2.4 series solution around an ordinary point 2.5 series solution around a regular singular point 2.6 the method of Frobenius and getting a second solution 2.7 Wronskian and getting a second solution 2.8 Solution of Legendre's equation 2.9 Solution of Bessel's equation 2.10 Solution of Laguarre equations 2.11 Solution of Hermite's equations 2.12 Problems	1: Explain about Second order linear differential equation with variable coefficients 2: Explain Solution of Laguarre and Hermite's equations

SW-2 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  Power Point Presentation

PH101.03: Identify the applications of complex variables, tensors and group theory.

Approximate Hours

Item	AppX Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO3.1 Mastery of the fundamental concepts of complex numbers, including representation, arithmetic operations, and geometric interpretation in the complex plane. SO3.2 Comprehension of analytic functions and the Cauchy-Riemann equations, understanding their significance and implications for differentiability in the complex plane. SO3.3 students should be equipped with the necessary knowledge and skills to understand and apply complex variable theory effectively in a variety of contexts. SO3.4 Familiarity with the residue theorem and its applications in evaluating complex integrals, particularly around singularities. SO3.5 Ability to apply complex variable techniques to solve problems in various fields, including physics, engineering, mathematics, and other sciences.	Unit – III (Elements of Complex Variable) 3.1 Functions of a complex variable 3.2 The derivative and the Cauchy-Riemann differential equations 3.3 Line integrals of complex functions 3.4 Cauchy's integral theorem 3.5 Cauchy's integral formula 3.6 Taylor's series 3.7 Laurent's series 3.8 Residues; Cauchy's residue theorem 3.9 Singular points of an analytic function 3.10 Evaluation of residues 3.11 Jordon-Lemma 3.12 Evaluation of definite integrals.	1. Mathematical explanation about Taylor's series & Laurent's series

SW-3 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  Power Point Presentation

PH101.04: Understand the concept of Bessel's function, Hermite function etc., with its properties like recurrence relations, orthogonal properties, generating functions etc. Understand how special function is useful in differential equations.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	0
SL	2
Total	13

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO 4.1 Mastery of the fundamental concepts and properties of various special functions, including their definitions, domains, and ranges. **SO4.2 Understanding the role of special functions in various branches of mathematics, including calculus, differential equations, number theory, and combinatorics.** **SO4.3 Understanding the applications of special functions in physics, engineering, and other applied sciences, including quantum mechanics, signal processing, fluid dynamics, and electromagnetism.** **SO4.4 Knowledge of important properties and identities associated with special functions, including recurrence relations, integral representations, and transformation formulas.** **SO4.5 Development of problem-solving skills through the application of special functions to solve mathematical and physical problems.**	**Unit IV (Special Functions)** 4.1 Definition of special functions 4.2 Generating functions for Bessel function of integral order $J_n(x)$ 4.3 Recurrence relations 4.4 Integral representation 4.5 Legendre polynomials $P_n(x)$ 4.6 Generating functions for $P_n(x)$ 4.7 Recurrence relations 4.8 Hermite Polynomials 4.9 Generating functions 4.10 Rodrigue's formula for Hermite polynomials 4.11 Laguerre polynomials 4.12 Generating function and Recurrence relations.	Mathematical explanation of Rodrigue's formula for Hermite polynomials

SW-4 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  Power Point Presentation

PH101.05: Evaluate the Fourier transform of a continuous function and be familiar with its basic properties. Solution of integral equation and their application. Solve differential & integral equations with initial conditions using Laplace transform.

Item	AppX Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO 5.1 Mastery of fundamental concepts of integral transforms, including the definition of transforms and their role in mathematical physics. SO5.2 Understanding of operations involving integral transforms, such as differentiation, integration, convolution, and modulation. SO5.3 Ability to solve differential equations, integral equations, and boundary value problems using integral transform techniques. SO5.4 Development of problem-solving skills through the application of integral transform theory to solve mathematical and physical problems. SO5.5 Development of critical thinking skills and the ability to analyze and interpret solutions involving integral transforms in mathematical and physical contexts.	**Unit V (Integral Transforms)** 5.1 Integral transform 5.2 Laplace transform 5.3 some simple properties of Laplace transform such as first and second shifting property 5.4 Inverse Laplace Transform by partial fractions method 5.5 Laplace transform of derivatives, 5.6 Laplace Transform of integrals 5.7 Fourier series 5.8 Evaluation of coefficients of Fourier series Cosine and Sine series 5.9 Fourier Transforms 5.10 Fourier sine Transforms 5.11 Fourier cosine Transforms 5.12 Problems	**Mathematical proof of Einstein's Coefficients**

SW-5 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  Power Point Presentation of Portland cement manufacture.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
PH101.01: Describe the mathematics concepts and their applications to complex numbers, complex functions, analytic functions, complex integration and theory of residues problems of physics.	8	1	1	10
PH101.02: Understand and analyze the concept of Numerical Solution of Linear and Non-Linear Equations, Ordinary Differential Equations and Function of complex variable.	7	2	1	10
PH101.03: Identify the applications of complex variables, tensors and group theory.	8	1	1	10
PH101.04: Understand the concept of Bessel's function, Hermite function etc., with its properties like recurrence relations, orthogonal properties, generating functions etc. Understand how special function is useful in differential equations.	11	0	2	13
PH101.05: Evaluate the Fourier transform of a continuous function and be familiar with its basic properties. Solution of integral equation and their application. Solve differential & integral equations with initial conditions using Laplace transform.	8	1	1	10
Total Hours	42	05	6	53

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Vector spaces and Matrices**	04	03	03	10
CO-2	**Differential equations**	04	03	03	10
CO-3	Elements of Complex Variable	04	03	03	10
CO-4	**Special Functions**	04	03	03	10
CO-5	**Integral Transforms**	04	03	03	10
Total		20	15	15	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Demonstration
7. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
8. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Mathematical Methods for Physicists	G.B. Arfken and H. J. Weber	Academic Press	Revised edition 21 edition 2020
2	A Course of Modern Analysis	E.T. Whittaker and E.W. Watson	Cambridge University Press	2014
3	Group Theory and Applications to Physical Problems	M. Hammermesh	Dover publications,	2001
4	Theory of Linear Operator in Hilbert Space	N. I. Akhiezer and I. M. Glazman	Dover Publications	2018

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc (Physics)

Course Code: PH101

Course Title: Mathematical Physics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	The ability to apply technical & engineering knowledge for production quality cement	Ability to understand the day to plant operational problems of cement manufacture	Ability to understand the latest cement manufacturin g technology.	Ability to use the research based innovative knowledge for SDGs	Engage in life-long learning and will have recognition.
CO 1: Describe the mathematics concepts and their applications to complex numbers, complex functions, analytic functions, complex integration and theory of residues. problems of physics.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	2
CO 2: Understand and analyze the concept of Numerical Solution of Linear and Non-Linear Equations, Ordinary Differential Equations and Function of complex variable.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	2
CO 3: Identify the applications of complex variables, tensors and group theory.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
CO 4: Understand the concept of Bessel's function, Hermite function etc., with its properties like recurrence relations, orthogonal properties, generating functions etc. Understand how special function is useful in differential equations.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
CO 5: Evaluate the Fourier transform of a continuous function and be familiar with its basic properties. Solution of integral equation and their application. Solve differential & integral equations with initial conditions using Laplace transform.	2	2	1	1	1	3	3	3	1	1	2	2	3	3	1	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 1: Describe the mathematics concepts and their applications to complex numbers, complex functions, analytic functions, complex integration and theory of residues problems of physics.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**Unit I (Vector spaces and Matrices)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 2: Understand and analyze the concept of Numerical Solution of Linear and Non-Linear Equations, Ordinary Differential Equations and Function of complex variable.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**Unit II (Differential equations)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11,2.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 3: Identify the applications of complex variables, tensors and group theory.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**Unit – III (Elements of Complex Variable)** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 4: Understand the concept of Bessel's function, Hermite function etc., with its properties like recurrence relations, orthogonal properties, generating functions etc. Understand how special function is useful in differential equations.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**Unit IV (Special Functions)** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 5: Evaluate the Fourier transform of a continuous function and be familiar with its basic properties. Solution of integral equation and their application. Solve differential & integral equations with initial conditions using Laplace transform.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**Unit V (Integral Transforms)** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	

Semester-I

Course Code: PH102

Course Title : **Classical Mechanics**

Pre- requisite: Student should have basic knowledge of mechanics of system of particles, D'Alembert'sprinciple, Lagrangian and Hamiltonian mechanics.

Rationale: The students studying Physics should possess foundational understanding about historical background of classical mechanics.

Course Outcomes:

PH102.1. Understand the mechanics of system of particles, D'Alembert'sprinciple, Lagrangian mechanics, & Euler's equation of motion.

PH102.2. Learn about Hamiltonian formulation, Hamilton's Equations of Motion and principle of least action.

PH102.3. Learn about Canonical Transformations & Hamilton-Jacobi theory.

PH102.4. Learn about Rigid body dynamics including problems.

PH102.5. Understand the Relativistic Mechanics and its related aspects.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH102	**Classical Mechanics**	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	PH102	**Classical Mechanics**	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH102.1. Understand the mechanics of system of particles, D'Alembert's principle, Lagrangian mechanics, & Euler's equation of motion.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 To understand the Newtonian mechanics of one and many particles systems and Conservation theorems for linear momentum, angular momentum and energy **SO1.2** To learn about the Constraints and their classification; Principle of virtual work; D'Alember's principle in generalized coordinates **SO1.3** To understand the Lagrangian and demonstrate Lagrange's equations; velocity dependent potential and dissipative function. Configuration space **SO1.4** To learn about Hamilton's principle; Generalized momenta and	**UNIT – I (Survey of Elementary Principles and Lagragian Formulation)** 1.1 Newtonian mechanics of one and many particles systems 1.2 Conservation theorems for linear momentum, angular momentum and energy 1.3 Constraints and their classification 1.4 Principle of virtual work; D'Alember's principle in generalized coordinates 1.5 The Lagrangian, Lagrange's equations 1.6 velocity dependent potential and dissipative function. 1.7 Configuration space, Hamilton's principle 1.8 Generalized momenta and Lagrangian formulation of the conservation theorems and Jacobi's integral	Survey of Elementary Principles related to mechanics

Lagrangian formulation of the conservation theorems and Jacobi's integral. **SO1.5** To learn about Reduction to the equivalent one body problem; The equation of motion and first integrals.	1.9 Reduction to the equivalent one body problem 1.10 The equation of motion and first integrals 1.11 The differential equation for the orbit 1.12 integration power law potentials	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Write conservation theorems for linear momentum, angular momentum and energy for a system of one or many particles.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH102.2. Learn about Hamiltonian formulation, Hamilton's Equations of Motion and Principle of least action.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 To understand The Kepler problem: inverse square law of force **SO2.2** To learn about Artificial satellites and Scattering in a central force field and Rutherford scattering **SO2.3** To learn about Legendre transformations and the Hamilton's equations of motion **SO2.4** Conservation theorems and the physical significance of the Hamiltonian. Derivation of Hamilton's equations from a variational principle **SO2.5** The principle of least action.	**UNIT – II (Kepler Problems)** 2.1 The Kepler problem 2.2 inverse square law of force 2.3 Artificial satellites 2.4 Scattering in a central force field 2.5 Rutherford scattering 2.6 Legendre transformations 2.7 Hamilton's equations of motion 2.8 Conservation theorems 2.9 physical significance of the Hamiltonian 2.10 variational principle 2.11 Derivation of Hamilton's equations from a variational principle 2.12 The principle of least action.	1. Learn about motion and its different types And Kepler's laws

SW-2 Suggested Sessional Work (SW):

a) Assignments:

i. Explain Legendre transformations.
ii. Discuss about physical significance of the Hamiltonian.

b) Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH102.3. Learn about Canonical Transformations & Hamilton-Jacobi theory.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 To learn about the equations of canonical transformations and generating functions **SO3.2** To understand Poisson's Brackets: their canonical invariance; Simple algebraic properties of Poisson Brackets **SO3.3** To learn about the equations of motion in Poisson's Brackets notation; Poisson's theorem **SO3.4** To understand Angular momentum PB's Hamilton's principal and characteristic functions **SO3.5** To understand Hamilton-Jacobi equation; Action Angle variables	**UNIT – III (Canonical Transformations)** 3.1 The equations of canonical transformations 3.2 generating functions 3.3 Poisson's Brackets 3.4Poisson's Brackets: their canonical invariance 3.5 Simple algebraic properties of Poisson Brackets 3.6 The equations of motion in Poisson's Brackets notation 3.7 Poisson's theorem 3.8 Angular momentum PB's Hamilton's principal 3.9 characteristic functions 3.10 The Hamilton-Jacobi equation 3.11 Action Angle variables (2)	1. Hamilton-Jacobi equation

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Poisson's Brackets: their canonical invariance Advantages of use of PPC in construction.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH102.4. Learn about Rigid body dynamics including problems.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO4.1 To understand Theory of small oscillations, Equations of motion, Eigen frequencies and general motion. **SO4.2** Learn about Normal modes and coordinates. Applications to coupled pendulum and linear triatomic molecule. **SO4.3** Learn about Rotating co-ordinate systems, Acceleration in rotating frames. Coriolis force and its terrestrial and astronomical applications. **SO4.4** Elementary treatment of Eulerian co-ordinates and transformation matrices. Angular momentum inertia tensor. **SO4.5** Understanding about Eular equations of motion for a rigid body. Torque free motion for a rigid body. Symmetrical top and gyroscopic forces.	**UNIT – IV (small oscillations and Moving coordinate systems)** 4.1 Theory of small oscillations 4.2 Equations of motion 4.3 Eigen frequencies and general motion 4.4 Normal modes and coordinates. 4.5 Applications to coupled pendulum 4.6 linear triatomic molecule 4.7 Rotating co-ordinate systems, 4.8 Acceleration in rotating frames. 4.9 Coriolis force and its terrestrial and astronomical applications 4.10 Elementary treatment of Eulerian co-ordinates and transformation matrices 4.11 Angular momentum inertia tensor 4.12 Eular equations of motion for a rigid body. Torque free motion for a rigid body. Symmetrical top and gyroscopic forces.	1. Rotational motion and oscillations

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Write Eular equations of motion for a rigid body.
ii. Describe briefly symmetrical top and gyroscopic forces.

b) Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH102.5. Understand the Relativistic Mechanics and its related aspects.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Lear ning (SL)**

SO5.1 To understand **s** ymmetries of space and time **SO5.2** Learn about Invariance under Galilion transformation, Covariant four- dimensional formulation. 4-Vectors and 4-Scalars **SO5.3** Learn about relativistic generalisation of Newton's laws, 4-momenturn and 4-force **SO5.4** Learn about invariance under Lorentz transformation relativistic energy **SO5.5** To understand Lagrangian and Gange invariance Hamiltonian formulation in relativistic mechanics. Covariant Lagrangian, covariant Hamiltonian, Examples.	**UNIT – V (Relativistic Mechanics)** 5.1 Symmetries of space and time 5.2 Invariance under Galilion transformation 5.3 Covariant four- dimensional formulation 5.4 4-Vectors 5.5 4-Scalars 5.6 Relativistic generalisation of Newton's laws 5.7 4-momenturn 5.8 4-force 5.9 Invariance under Lorentz transformation relativistic energy 5.10 Lagrangian and Gange invariance 5.11 Hamiltonian formulation in relativistic mechanics 5.12 Covariant Lagrangian	1. General theory and special theory of relativity with differences

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Explain Covariant four- dimensional formulation.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+ Sl)
PH102.1. Understand the mechanics of system of particles, D'Alembert'sprinciple, Lagrangian mechanics, & Euler's equation of motion.	**12**	1	1	14
PH102.2. Learn about Hamiltonian formulation, Hamilton's Equations of Motion andPrinciple of least action.	12	1	1	14
PH102.3. Learn about Canonical Transformations & Hamilton-Jacobi theory.	12	1	1	14
PH102.4. Learn about Rigid body dynamics including problems.	12	1	1	14
PH102.5. Understand the Relativistic Mechanics and its related aspects.	12	1	1	**14**
Total Hours	**60**	**5**	**5**	**70**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Survey of Elementary Principles and Lagragian Formulation	03	04	03	10
CO-2	Kepler Problems	03	04	03	10
CO-3	Canonical Transformations	03	04	03	10
CO-4	Small oscillations and Moving coordinate systems	03	04	03	10
CO-5	Relativistic Mechanics	03	04	03	10
Total		15	20	15	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Classical Mechanics	N. C. Rana and P.S. Jog	Tata Mc Graw Hill	1991
2	Classical Mechanics	H. Goldstein	Addision Wesley	1980
3	Mechanics	A Sommerfiels	Academi Press	1952
4	Introduction to Dynamics	I. Perceival and Richards	Cambridge Univ. Press	1982
5	Lecture note provided by Department of Physics, AKS University, Satna (M. P.)			

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH102

Course Title: Classical Mechanics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Cond uct investigatio ns of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH102.1. Understand the mechanics of system of particles, D'Alembert's principle, Lagrangian mechanics, & Euler's equation of motion.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1
PH102.2. Learn about Hamiltonian formulation, Hamilton's Equations of Motion and Principle of least action.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	1
PH102.3. Learn Canonical Transformations & Hamilton-Jacobi theory.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
PH102.4. Learn about Rigid body dynamics including problems.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
PH102.5. Understand the Relativistic Mechanics and its related aspects.	2	1	2	1	1	3	3	3	1	1	2	2	3	3	1	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH102.1. Understand the mechanics of system of particles, D'Alembert's principle, Lagrangian mechanics, & Euler's equation of motion.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**UNIT – I (Survey of Elementary Principles and Lagragian Formulation)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11	.Survey of Elementary Principles related to mechanics
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH102.2. Learn about Hamiltonian formulation, Hamilton's Equations of Motion andPrinciple of least action.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**UNIT – II (Kepler Problems)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10	Learn about motion and its different types And Kepler's laws
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH102.3. Learn Canonical Transformations & Hamilton-Jacobi theory.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**UNIT – III (Canonical Transformations)** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11	. Hamilton-Jacobi equation
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH102.4. Learn about Rigid body dynamics including problems.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**UNIT – IV (small oscillations and Moving coordinate systems)** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	. Rotational motion and oscillations
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH102.5. Understand the Relativistic Mechanics and its related aspects.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**UNIT – V (Relativistic Mechanics)** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	General theory and special theory of relativity with differences

A K S University

Faculty of science and Technology

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Semester-I

Course Code: PH103

Course Title : Condense Matter Physics

Pre- requisite: To study this course, a student must have had the subject Physics in Graduation.

Rationale: The students studying Physics should possess a foundational understanding of Crystal Structure, X-ray and its Applications, Defects in Crystals, Crystal Mechanism, and Free Electron Theory.

Course Outcomes:

PH103.1: The course would empower the students to develop an idea about Crystal Structure.
PH103.2: The students would be able to understand all about X-ray and Its Applications.

PH103.3: The students would be able to understand and identify Defects in crystals and can relate it to their daily life.
PH103.4: The students would acquire the knowledge of Crystal Mechanism.

PH103.5: The students would be able to understand the free electron theory.

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH103	Condense matter physics	4	0	1	1	6	6

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) And others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional work (including assignments, seminars, mini-projects, etc.).),
SL: Self Learning,
C: Credits.

Note: **SW and** SL must be planned and performed under the continuous guidance and feedback of the teacher to ensure the outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (RA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 numbers 3 marks each (CA)	Class Test2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
PCC	PH103	Condense matter physics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction, including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH103.1: The course would empower the students to develop an idea about Crystal Structure.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Students will learn all about crystals, their structure, symmetry, and other properties. **SO1.2** Students will be able to understand the unit cell and their plan and spacing and other properties. **SO1.3** Students will be able to recognize the structure of crystals they are using in their daily life. **SO1.4** Students will identify the crystals they are surrounded by. **SO1.5** Study about the difference between several kinds of crystals.	**Unit-I (Crystal Structure)** 1.1 Crystalline and amorphous solids. 1.2 The crystal lattice. Basis vectors. 1.3 Unit cell. Symmetry operations. 1.4 Point groups and space groups. 1.5 Plane lattices and their symmetries. 1.6 Three-dimensional crystal systems. 1.7 Miller indices. 1.8 Directions and planes in crystals. 1.9 Inter-planar spacing. 1.10 Simple crystal structures: FCC, BCC, 1.11 Nacl, CsCl, 1.12 Diamond and ZnS structure, HCP structure.	1. Simple crystal structures: FCC, BCC. 2. Nacl, Diamond, and ZnS structure, HCP structure.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Write a note on crystals and make a list of crystals we are using in our daily life.

b. Mini Project:

(i) Prepare a chart on Crystal and its types.

(ii) Prepare a chart on Crystal's structure of different types of crystals (Simple crystal structures: FCC, BCC. Nacl, NaCl, Diamond and ZnS structure, HCP structure).

c. Other Activities:

Take a crystal for an experiment and try to find out its properties by doing some experiments.

PH103.2: The students would be able to understand all about X-ray and Its Applications.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 Students will learn about X-rays and their interaction with matter. **SO2.2** Students will learn about Scattering of X-ray. **SO2.3** Students will Study the reciprocal lattice and its application. **SO2.4** Students will learn about different methods of X-ray diffraction. **SO2.5** Students will learn about different types of defects in crystals.	**Unit - II (X-ray and Its Application)** **2.1** Interaction of X-rays with matter, **2.2** absorption of X-rays, **2.3** elastic scattering from a perfect lattice. **2.4** The reciprocal lattice and its application to diffraction techniques, **2.5** the Laue, Powder, and **2.6** Rotating crystal methods. **2.7** Crystal structure factor and intensity diffraction maxima. 2.8 Extinction due to lattice centering. 2.9 Point defects, line defects, and planar (stacking) faults. 2.10 The role of dislocation in plastic deformation and crystal growth. 2.11 The observation of imperfections in crystals. 2.12 X-ray and electron microscopic techniques.	1. What are point defects, line defects, and planar (stacking) faults? 2. What is the observation of imperfections in crystals?

SW-2 Suggested Sessional Work (SW):

a. Assignments:
  i. Describe X-ray interactions and scattering with some examples of their applications.
  ii. Write a short note on X-rays and how they are applicable in our lives.

b. Mini Project:
Make a list of applications of X-ray interactions and scattering.

c. Other Activities (Specify):

Try to identify crystals with defects and make a list of different types of defects.

PH103.3: The students would be able to understand and identify Defects in crystals and can relate it to their daily life.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Students will learn about defects and impurities in crystals. **SO3.2** Students will learn about the structure and symmetries of crystals. **SO3.3** Students will learn about Vacancies, interstitial in ionic crystals. **SO3.4** Students will learn about the Fibonacci sequence and interstitials be recognized n daily life. **SO3.5** Students will learn about lattices and their	**Unit III (Defects in Crystals):** 3.1 Point defects 3.2 Shallow impurity states in semiconductors 3.3 Localized lattice vibrational states in solids 3.4 Vacancies and interstitials in ionic crystals. 3.5 Colour centers in ionic crystals 3.6 Structure and symmetries of liquids 3.7 Structure and symmetries of liquid crystals 3.8 Structure and symmetries of amorphous solids 3.9 Structure and symmetries of aperiodic solids 3.10 Structure and symmetries of quasicrystals 3.11 Fibonacci sequence,	1. Structure and symmetries of liquids, liquid crystals, and amorphous solids 2.

extension in three dimensions.	3.12 Penrose lattice and their extension to three dimensions	

SW-3 Suggested Sessional Work (SW):

-

a. Assignments:

i. Study the structure and symmetry of different crystals

ii. -

b. Mini Project:

Prepare a chart on defects in crystals.

c. Other Activities (Specify):

Identify some real-life examples of the Fibonacci sequence and how it is applicable everywhere.

PH103.4: The students would acquire the knowledge of Crystal Mechanism.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Students will learn about order and disorder in condensed matter. **SO4.2 Study** about structural descriptions of glasses. **SO4.3** Students will study the structure of different types of crystals.	**UNIT – IV (Crystal Mechanism)** 1.1 Disorder in condensed matter, 1.2 substitutional, positional, and 1.3 Topographical disorder. 1.4 Short and long-range order, 1.5 Atomic correlation function, 1.6 structural descriptions of glasses	**1.** Application of the idea to amorphous semiconductors and hopping conduction.

SO4.4 Students will learn about electron localization and mobility edge. **SO4.5** Students will study the qualitative application of hopping conduction.	1.7 Structural descriptions of liquids. 1.8 Anderson model for random systems 1.9 Electron localization. 1.10 Mobility edge. 1.11 Qualitative application of the idea to amorphous semiconductors 1.12 Qualitative pping conduction.	

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Write a short note on disorder in crystals.

d. Mini Project:

i. Describe the qualitative application of the idea to amorphous semiconductors with some examples.

C. Other Activities (Specify):

Power Point Presentation of different types of disorder in crystals.

PH103.5: The students would be able to understand the free electron theory.

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO5.1 students will learn about free electrons and Fermi gas, while **SO5.2 students** will know about energy levels of orbitals in all directions. **SO5.3** Study about solids, their theorems, and classifications.	**Unit -V (Free Electron Theory)** 5.1 Free electron Fermi gas 5.2 Energy levels of orbitals in one and 5.3 Energy levels of orbital in three dimensions. 5.4 Electrons in a periodic lattice, 5.5 Bloch theorem,	1. Study of metals, semimetals, semiconductors, and insulators.

SO5.4 students will learn about different types of metals and their properties. **SO5.5** covers the De Hass Alphen effect and ts process.	5.6 band theory of solids, 5.7 Classification of solids, 5.8 effective mass, Kronig Penney model 5.9 Metals–Semimetals–Semiconductors–Insulators, 5.10 Tight-binding, cellular, and pseudopotential methods. 5.11 Drude model, Lorentz theory, Sommerfeld theory of metals, Fermi surface. 5.12 De Hass van Alphen effect.	

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
   1. Introduction to the free electron theory.

b. **Mini Project:**
   Write in detail about the band theory of solids and the classification of solids.

c. **Other Activities (Specify):**
   Prepare a chart on the Drude Model.

Brief of Hours suggested for the Course Outcome.

Course Outcomes:	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hours (Cl+SW+Sl)
PH103.1: The course would empower the students to develop an idea about Crystal Structure.	12	1	1	14
PH103.2: The students would be able to understand all about X-ray and Its Applications.	12	1	1	14
PH103.3: The students would be able to understand and identify Defects in crystals and can relate it to their daily life.	12	1	1	14
PH103.4: The students would acquire the knowledge of Crystal Mechanism.	12	1	1	14

PH103.5: The students would be able to understand the free electron theory.	12	1	1	14
Total hours:	60	5	5	70

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Crystal Structure	6	2	2	10
CO-2	X-ray and Its Applications	6	2	2	10
CO-3	Defects in Crystals	6	2	2	10
CO-4	Crystal Mechanism	6	2	2	10
CO-5	Free Electron Theory	6	2	2	10
Total		30	10	10	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end-ofof-semester assessment for Mechanics and General Properties of Matter will be held with a writtenexamination of 50 marks.

Note. Detailed assessment rubrics need to be prepared by the course-wise teachers for the above tasks.

Teachers can also design different tasks as per requirements for the end-semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Science Museum
7. Demonstration

8. ICT-Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, WhatsApp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	10	Author	Publisher	Edition & Year
1	Solid State Physics	Charles Kittle	Wiley	2018
2	Solid State Physics	Aschroft & Mermin	Saunders College	1976
3	Introduction to Solid State Physics	L.V. Azaroff Materials	McGraw-Hill Education - Europe	1985
4	Crystallographic Solid State Physics	Verma & Srivastava	New Age International	1991
5	Solid State Physics	A.J. Dekker	Macmillan	1965
6	Principles of Condense Matter Physics	P.M. Chaiken& T.C. Lubensky	Cambridge University Press; Reprint edition	(28 September 2000)
7	Lecture notes provided by Dept. of Physics, AKS University, Satna.			

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH103

Course Title: Condensed Matter Physics

Course Outcomes:	Program Outcomes:												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Sience knowledge	Prob lem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The scientist and society	Environment and sustain ability:	Ethics	Individual and team work :	Communication:	Project management and finance:	Life-long learning	The ability to apply science knowledge for Quality of technologies.	Ability to Understand the day-to-day science problems of science.	Ability to understandthe latest sience and technology.	Ability to usethe research-based innovative knowledgefor SDGs	Engage in life-long learning and will have recognition
CO1 : The course would empower the students to develop an idea about crystal structure.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	2
CO 2 : The students would be able to understand all about X-ray and its applications.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	2
CO3 : The students will be able to understand and identify defects in crystals and relate them to their daily life.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	3
CO 4: The students would acquire the knowledge of Crystal Mechanism.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
CO 5: The students would be able to understand the free electron theory.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.,	COs No.& Titles,	SOs No.	Classroom Instruction(CI),	Self Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO-1: The course would empower the students to develop an idea about crystal structure.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	Unit-1. Crystal Structure, 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10, 1.11,1.12	1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 2 : The students would be able to understand all about X-ray and its applications.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	Unit-2 X-ray and Its Applications, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10,2.11,2.12	1,2
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO3 : The students would be able to understand and identify defects in crystals and relate them to their daily life.	SO3. 1 SO3. 2 SO3.3 SO3.4 SO3.5	Unit-3 :Defects in Crystals, 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9 3.10,3.11,3.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 4: The students would acquire the knowledge of crystal mechanism.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	Unit-4 : Crystal Mechanism, 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10, 4.11,4.12	1
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 5: The students would be able to understand the free electron theory.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	Unit 5: Free Electron Theory 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9, 5.10,5.11,5.12	1

Semester-I

Course Code:	**PH104**
Course Title :	**Electronic Devices**
Pre- requisite:	Understanding fundamental concepts in physics like electricity, magnetism, voltage, current, resistance, and power is crucial. This knowledge forms the foundation of electronics.
Rationale:	The students studying Physics should possess foundational understanding about electronic devices lies in their ability to manipulate and control the flow of electrons to perform specific functions. Electronic devices are designed to process, store, transmit, or display information, and they have become an integral part of modern technology. Here are some key rationales behind electronic devices.

Course Outcomes

PH104.1: Understand the characteristics, properties, and functions of common electronic components such as resistors, capacitors, inductors, diodes, transistors, and integrated circuits.

PH104.2: Gain knowledge about semiconductor materials, their properties, and the operation of semiconductor devices such as diodes and transistors. Understand their applications in rectification, amplification, and switching

PH104.3: Learn about different types of amplifiers and their characteristics. Understand the operation and applications of operational amplifiers (op-amps) in various electronic circuits.

PH104.4: Explore the world of integrated circuits, including their types, fabrication methods, and applications. Understand the functionality and operation of common ICs, such as operational amplifiers, timers, voltage regulators, and digital logic ICs.

PH104.5: Dive deeper into the applications of operational amplifiers (op-amps). Explore op-amp circuits such as active filters, oscillators, comparators, voltage regulators, and instrumentation amplifiers. Understand the design principles and analysis techniques for these circuits.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH104	Electronic Devices	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	**PH104**	Electronic Devices	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH104.1: Knowledge of Electronic Components: Understand the characteristics, properties, and functions of common electronic components such as resistors, capacitors, inductors, diodes, transistors, and integrated circuits

Approximate Hours	
Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	3
Total	17

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Understanding the principles of radiative and non-radiative transitions in thin film materials. **SO1.2** Exploring the factors affecting the efficiency of radiative transitions, such as material properties and defect states. **SO1.3** Analyzing the responsivity, quantum efficiency, and noise characteristics of photodetectors. **SO1.4** Understanding the principles and operation of solar cells. **SO1.**5 Analyzing the open circuit voltage, short circuit current, and fill factor of solar cells. **SO1.6.** Understanding the high-frequency limits of LED operation. **SO1.7.** Exploring the operation and characteristics of LEDs, including efficiency, color emission, and temperature dependence. **SO1.8.** Understanding the conditions required for population inversion and lasing in diode lasers. .	**Unit 1: Diodes** **1.1.** Radiative and non-radiative transitions in thin films **1.2.** Introduction to diode photodetectors **1.3.** Principles of diode photodetection **1.4.** Characteristics and performance parameters of diode photodetectors **1.5.** Introduction to solar cells **1.6.** Open circuit voltage and short circuit current in solar cells **1.7.** Fill factor and its significance in solar cell performance **1.8.** Analysis of solar cell characteristics and efficiency **1.9.** Introduction to light-emitting diodes (LEDs) **1.10.**High-frequency limit of LEDs and considerations for high-speed operation **1.11.**Effect of surface recombination and indirect recombination current in LEDs **1.12.**LED operation principles and applications **1.13.**Introduction to diode lasers **1.14.**Conditions for population inversion in diode lasers **1.15.**Inactive region and its significance in diode lasers **1.16.**Optical gain and threshold current for lasing in diode lasers	**i.**Photodetectors **ii.** Open circuit voltage **iii.** population inversion

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. To Study bipolar junction transistors (BJT) and their construction, working and its Applications.

ii. LED operation principles and applications

b. Other Activities (Specify): Seminar and group discussion related to subject

PH104.2: Understanding of Semiconductor Devices: Gain knowledge about semiconductor materials, their properties, and the operation of semiconductor devices such as diodes and transistors. Understand their applications in rectification, amplification, and switching

Approximate Hours	
Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1. Understanding the construction and structure of JFET. **SO2.2.**Exploring the high-frequency limitations of JFET. **SO2.3.** Understanding the construction and structure of BJT (both NPN and PNP). **SO2.4.** Analyzing the working principle of BJT and its modes of operation (active, cutoff, and saturation). **SO2.5.**Exploring the high-frequency limitations of BJT. **SO2.6.**.Understanding the construction and structure of MOSFET (both N-channel and P-channel). **SO2.7.**Understanding the construction and structure of MESFET. **SO2.8.**Exploring the I-V characteristics of MESFET and its high-frequency limitations.	**Unit 2: Transistors** **2.1.** Introduction to junction field-effect transistors (JFET) and their construction **2.2.** Working principles of JFETs and analysis of their I-V characteristics **2.3.** High-frequency limits of JFETs and considerations for high-frequency applications **2.4.** Introduction to bipolar junction transistors (BJT) and their construction **2.5.** Working principles of BJTs and analysis of their I-V characteristics **2.6.** High-frequency limits of BJTs and considerations for high-frequency applications **2.7.** Introduction to metal-oxide-semiconductor **2.8.** field-effect transistors (FET) **2.9.** MESFET **2.10.** Construction and working principles of MOSFETs and MESFETs **2.11.** Derivation of equations for I-V characteristics under different conditions **2.12.** High-frequency limits of MOSFETs and MESFETs	**i.** Transistor **ii.** Frequency **iii.** Semiconductor

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Construction and working principles of MOSFETs and MESFETs

ii. Working principles of BJTs and analysis of their I-V characteristics

b. **Other Activities (Specify):** Seminar and group discussion related to subject

PH104.3: Amplifiers and Operational Amplifiers: Learn about different types of amplifiers and their characteristics. Understand the operation and applications of operational amplifiers (op-amps) in various electronic circuits.

Approximate Hours	
Item	AppX Hrs
Cl	10
LI	0
SW	2
SL	3
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Understanding the characteristics and operating principles of different logic families used in digital circuits. **SO3.2** Analyzing parameters such as power consumption, speed, noise immunity, voltage levels, and fan-out of logic families. **SO3.3** Comparing and evaluating the advantages and disadvantages of different logic families. **SO3.4** Analyzing the circuit configurations, voltage levels, and performance characteristics of saturated logic families. **SO3.5** Understanding non-saturated bipolar logic families such as TTC (Transistor-Transistor Logic) and ECL (Emitter-Coupled Logic). **SO3.6** Analyzing the circuit configurations, voltage levels, speed, and power consumption of non-saturated bipolar logic families. **SO3.7** Understanding unipolar logic families, which are based on a single type of charge carrier (either electrons or holes). **SO3.8** Understanding the classification of digital integrated circuits based on their complexity and functionality.	**Unit 3: Digital Integrated Circuits** **1.1.** Characteristics of logic families: RTL, DCTL, **1.2.** DTL, **1.3.** TTL, **1.4.** IIL, **1.5.** HTL **1.6.** Overview of non-saturated bipolar logic families: TTC, ECL **1.7.** Unipolar logic families: MOS and CMOS **1.8.** Introduction to digital integrated circuits: SSI, **1.9.** MSI, LSI, **1.10.** VLSI circuits	**i.** Logic gates **ii.** Noise **iii.** Digital Circuit

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**

i. Unipolar logic families: MOS and CMOS

ii. VLSI circuits

b. Other Activities (Specify): Seminar and group discussion related to subject

PH104.4: Integrated Circuits (ICs): Explore the world of integrated circuits, including their types, fabrication methods, and applications. Understand the functionality and operation of common ICs, such as operational amplifiers, timers, voltage regulators, and digital logic ICs.

Approximate Hours	
Item	AppX Hrs
Cl	10
LI	0
SW	2
SL	3
Total	15

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Understanding the principles of a differential amplifier and its applications.. **SO4.2** Analyzing the common-mode rejection ratio (CMRR) and differential gain of a differential amplifier. **SO4.3** Understanding the basics of operational amplifiers, their internal circuitry, and the golden rules of op-amp analysis. **SO4.4**Exploring the real-world limitations of op-amps, including finite gain, input bias currents, and input offset voltage. **SO4.**5. Understanding the key parameters of operational amplifiers, such as gain bandwidth product (GBW), slew rate, input and output voltage ranges, and noise characteristics. **SO4.**6.Understanding the inverting and non-inverting configurations of op-amps. **SO4.**7.Exploring the applications and advantages of inverting and non-inverting amplifiers. **SO4.**8.Exploring the use of op-amps as adders, subtractors, inverters, differentiators, integrators, and function generators.	**Unit-4:**Operational Amplifiers **4.1.** Introduction to differential amplifiers **4.2.** operational amplifiers (OP-AMP) **4.3.** Parameters and specifications of OP-AMPs **4.4.** Inverting modes of OP-AMP operation **4.5.** non-inverting modes of OP-AMP operation **4.6.** Applications of OP-AMPs: adder, subtractor, **4.7.** inverter, differentiator, **4.8.** integrator, **4.9.** function generator **4.10.**Active filters and their implementation using OP-AMPs.	**i.** Amplifiers **ii.** Inverting modes **iii.** Active filters.

SW-4 Suggested Sessional Work (SW):

a) Assignments:

(i) Inverting modes of OP-AMP operation

(ii) Active filters and their implementation using OP-AMPs.

c. Other Activities (Specify): Seminar and group discussion related to subject

PH104.5: Operational Amplifier Applications: Dive deeper into the applications of operational amplifiers (op-amps). Explore op-amp circuits such as active filters, oscillators, comparators, voltage regulators, and instrumentation amplifiers. Understand the design principles and analysis techniques for these circuits**.**

Approximated Hours	
Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	3
Total	17

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO5.1 Comprehending the principles, structures, and operation of static random access memory (SRAM) and dynamic random access memory (DRAM). **SO5.2** Differentiating between CMOS and NMOS technologies and their applications in memory devices. **SO5.3** Understanding the basics of magnetic, optical, and ferroelectric memories and their uses in data storage. **SO5.4** Understanding the principles and operation of charge-coupled devices (CCD) and their applications in imaging and signal processing. **SO5.5.** Analyzing the working principles of CCDs as image sensors and their advantages in capturing high-quality images. **SO5.6** Understanding the principles of electro-optic, magneto-optic, and acousto-optic effects. **SO5.7.** Exploring examples of active devices in integrated optics based on these effects, such as modulators, switches, and detectors.	**Unit 5: Memory Devices and Other Electronic Devices** **5.1.** Static and dynamic random-access memories (SRAM and DRAM) **5.2.** CMOS and NMOS technologies in memory devices **5.3.** Introduction to non-volatile memories: magnetic, optical, and ferroelectric memories **5.4.** Charge-coupled devices (CCD) and their applications **5.5.** Introduction to electro-optic, magneto-optic, and acousto-optic effects **5.6.** Active devices in integrated optics based on these effects **5.7.** Liquid crystal display (LCD) devices and their operation **5.8.** Piezoelectric effect and materials exhibiting this property **5.9.** Piezoelectric filters, resonators, **5.10.** High-frequency piezoelectric devices **5.11.** Capacitors, electrets, **5.12.** piezoelectric electromechanical transducer devices	**i.** Memorie **ii.** Active device **iii.** Piezoelectric materials

SW-5 Suggested Sessional Work (SW):

a. Assignments:

a. Study of non-volatile memories: magnetic, optical, and ferroelectric memories.

b. Study of piezoelectric electromechanical transducer devices .

b. Other Activities (Specify): Seminar and group discussion related to subject

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH104.1: Knowledge of Electronic Components: Understand the characteristics, properties, and functions of common electronic components such as resistors, capacitors, inductors, diodes, transistors, and integrated circuits.	16	2	3	21
PH104.2: Understanding of Semiconductor Devices: Gain knowledge about semiconductor materials, their properties, and the operation of semiconductor devices such as diodes and transistors. Understand their applications in rectification, amplification, and switching	12	2	3	17
PH104.3: Amplifiers and Operational Amplifiers: Learn about different types of amplifiers and their characteristics. Understand the operation and applications of operational amplifiers (op-amps) in various electronic circuits.	10	2	3	15
PH104.4: Integrated Circuits (ICs): Explore the world of integrated circuits, including their types, fabrication methods, and applications. Understand the functionality and operation of common ICs, such as operational amplifiers, timers, voltage regulators, and digital logic ICs.	10	2	3	15
PH104.5: Operational Amplifier Applications: Dive deeper into the applications of operational amplifiers (op-amps). Explore op-amp circuits such as active filters.	12	2	3	17
Total Hours	**60**	**10**	**15**	**85**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Diodes	03	01	01	05
CO-2	Transistors	02	06	02	10
CO-3	Digital Integrated Circuits	03	07	05	15
CO-4	Operational Amplifiers	-	10	05	15
CO-5	Memory Devices and Other Electronic Devices	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Semi-Conductor Devices – Physics and Technology :	SM Sze	Wiley,	1985
2	Instrumentation and Experimental Design in Physics and Engineering :	M. Sayer and A. Mansingh	Prentice Hall India Learning Private Limited	(1 January 1999)
3	Optical Electronics :	Ajoy Ghatak and K. Thygarajan	Cambridge Univ. Press.).	
4	Introduction to Semiconductor devices	M.S. Tyagi	(John Wiley and Sons)	

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)
Course Code: PH104
Course Title: Electronic Devices

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH104.1: Knowledge of Electronic Components: Understand the characteristics, properties, and functions of common electronic components such as resistors, capacitors, inductors, diodes, transistors, and integrated circuits.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	2	1
PH104.2: Understanding of Semiconductor Devices: Gain knowledge about semiconductor materials, their properties, and the operation of semiconductor devices such as diodes and transistors. Understand their applications in rectification, amplification, and switching	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	3	1
PH104.3: Amplifiers and Operational Amplifiers: Learn about different types of amplifiers and their characteristics. Understand the operation and applications of operational amplifiers (op-amps) in various electronic circuits.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
PH104.4: Integrated Circuits (ICs): Explore the world of integrated circuits, including their types, fabrication methods, and applications. Understand the functionality and operation of common ICs, such as operational amplifiers, timers, voltage regulators, and digital logic ICs.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2

PH1045: Operational Amplifier Applications: Dive deeper into the applications of operational amplifiers (op-amps). Explore op-amp circuits such as active filters.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH104.1: Knowledge of Electronic Components: Understand the characteristics, properties, and functions of common electronic components such as resistors, capacitors, inductors, diodes, transistors, and integrated circuits.**	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	Unit-1. Diodes 1.1,1.2,1.3,1.4,1.5,1.6,1.7, 1.8, 1.9,1.10,1.11,1.12,1.13,1.14,1.15,1.16	i, ii,iii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH104.2: Understanding of Semiconductor Devices: Gain knowledge about semiconductor materials, their properties, and the operation of semiconductor devices such as diodes and transistors. Understand their applications in rectification, amplification, and switching**	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8	Unit-2 Transistors 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10,2.11,2.12	i, ii,iii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH104.3: Amplifiers and Operational Amplifiers: Learn about different types of amplifiers and their characteristics. Understand the operation and applications of operational amplifiers (op-amps) in various electronic circuits.**	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8	Unit-3 : Digital Integrated Circuits 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10	i, ii,iii

PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH104.4: Integrated Circuits (ICs): Explore the world of integrated circuits, including their types, fabrication methods, and applications. Understand the functionality and operation of common ICs, such as operational amplifiers, timers, voltage regulators, and digital logic ICs.**	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	Unit-4 : Operational Amplifiers 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	i, ii,iii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH1045: Operational Amplifier Applications: Dive deeper into the applications of operational amplifiers (op-amps). Explore op-amp circuits such as active filters.**	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	Unit 5: Memory Devices. 5.1,5.2,5.3,5.4,5.5,4.6,4.7,4.8,4.9,4.10,4.11,4.12	i, ii,iii

Semester-I

Course Code: PH151

Course Title : **General Physics Lab-I**

Pre- requisite: Student should have basic knowledge of practical instruments in graduation.

Rationale: The students studying Physics should possess foundational understanding about historical background of graduation.

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

PH151.1. learn various Physics aspects by performing the experiments related to light, wave optics, interference, diffraction and polarization.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH151	**General Physics Lab-I**	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Lab work Assignment 5 number 7 marks each (LA)	Viva-Voice on Lab work 10 marks each (VV)	Lab Attendance (LA)	Total Marks (LA+VV+LA)		
PCC	PH151	General Physics Lab-I	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH151.1. learn various Physics aspects by performing the experiments related to light, wave optics, interference, diffraction and polarization.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	90
SW	15
SL	15
Total	120

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Self Learning (SL)**
SO1.1 Learn about vernier calipers, screw gage and spherometer, microscope and spectrometer **SO1.2** Understand spectral lines, grating spectra, and interference fringes **SO1.3** Study and determine the phenomenon of interference. **SO1.4** Study and determine the phenomenon of diffraction. **SO1.5** Learn about Error analysis.	1. To determine the refractive index of a water/glycerin by using a hollow prism and spectrometer. 2. To determine diameter of the odd and even rings by using Newton's rings apparatus. 3. To determine the wavelength of light by using diffraction grating with the help of spectrometer. 4. Measurement of the wavelength separation of sodium D-lines using a diffraction grating and to calculate the angular dispersive power of the grating. 5. Determination of the Plank's Constant by Photo cell. 6. To study polarizer & analyzer and hence verify the Malu's law. 7. To determine the refractive index and Brewster's angle of air-glass interface and also verify the Brewster's law. 8. To study single slit diffraction using laser.	1. Learn about basic instruments like- vernier calipers, screw guage

	9. Determine angle of specific rotation of sugar solution by using Polarimeter. 10. Measurement of thickness of thin wire with laser. 11. To determine the wavelength of light by using Michelson Interferometer. 12. Determine the fringe width β of an interference pattern by using Bi-prism experiments.	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Arrangement of Newton's rings apparatus by part

b. Other Activities (Specify):

Perform experiment individual and present to others.

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH151.1. learn various Physics aspects by performing the experiments related to light, wave optics, interference, diffraction and polarization.	**90**	15	15	120
Total Hours	**90**	**15**	**15**	**120**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	General Physics Lab-I	11	26	13	50
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Experimental Physics	**Worsnop and Flint**	Little hampton Book Services Ltd, United Kingdom	9th Edition, 1951
2	Experiments in Modern Physics	**A. C. Melissinos, J. Napolitano**	Academic Press, Cambridge, Massachusetts	2nd Edition, 2003
3	Lab manuals provided by Department of Physics, AKS University, Satna (M. P.)			

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH151

Course Title: General Physics Lab-I

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engin e ering knowle dge	Prob lem anal ysis	Desig n/dev elop ment of soluti ons	Cond uct invest igatio ns of compl ex probl ems	Mod e rn tool usag e	The engi neer and soci ety	Enviro n ment and sustain ability:	Ethic s	Indivi dual and team work:	Com munic ation:	Project manage ment and finance:	Life-long learnin g	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communic ate effectively.	Ability to use the techniqu es, skills, and modern physical tools in real world applicati on.	Engage in life-long learning and will have recogniti on.
PH151.1. learn various Physics aspects by performing the experiments related to light, wave optics, interference, diffraction and polarization.	2	1	2	1	1	3	3	3	1	1	2	2	3	3	3	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Self Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH151.1. learn various Physics aspects by performing the experiments related to light, wave optics, interference, diffraction and polarization.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	15

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Semester-I

Course Code: PH152

Course Title : Electronics Lab-I

Pre- requisite: To study this course, a student must have had the Experimental knowledge of Physics in Graduation.

Rationale: The students studying this course would have practical (Experimental) Knowledge of Diodes, Gates and Transistors.

Course Outcomes:

PH152: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH152	Electronic Devices (General)	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) And others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional work (including assignments, seminars, mini-projects, etc.).),
SL: Self Learning,
C: Credits.

Note: **SW and** SL must be planned and performed under the continuous guidance and feedback of theteacher to ensure the outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (RA)				End Semester Assessment	Total Marks
			Lab work Assignment 5 number 7 marks each (LA)	Viva-Voice on Lab work 10 marks each (VV)	Lab Attendance (LA)	Total Marks (LA+VV+LA)	(ESA)	(PRA+ ESA)
PCC	PH152	Electronic Devices	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction, including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH152.1: The course would empower the students to develop an idea about Crystal Structure.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	90
SW	15
SL	15
Total	120

Session Outcomes (SOs)	LaboratoryInstruction (LI)	Self-Learning (SL)
SO1 Students will learn all about Basic electronic devices and their working.	**1.** To Study Characteristics curve of P-N Junction Diode and Zener Diode.	1. Identify all the electronic devices you use in your

SO2 Students will learn to verify truth table for basic logic gates. **SO3** Students will be able to Understand the characteristic curve of electronic devices. **SO4** Students will be able to understand the Circuit diagram of all mentioned electronic devices. **SO5** Students will learn to calculate error and analysis.	**2.** To study characteristics of PNP and NPN transistor s with CB mode. **3.** To study characteristics of tunnel diode. **4.** To study characteristics curve of FET. **5.** To Study characteristics curve of UJT. **6.** To study characteristics curve of MOSFET. **7.** Characteristics and application of silicon controller rectifier. **8.** Response curve for CE mode amplifier with feedback and without feedback circuits. **9.** Verification of truth table for basic logic electronic gates i.e. AND gate, OR gate and NOT gate by using basic passive electronic components. **10.** Use Operational amplifier (OP Amplifier) as a) Inverting and b) Non-inverting amplifier.	daily life. 2. Identify the use of these electronic devices in your daily life electronic devices.

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**

i. Write a note on Electronic devices and make a list of devices (Having diodes and transistors) we are using in our daily life.

b. **Mini Project:**

(i) Prepare a chart of Diode and its types.

(ii) Prepare a chart of Transistor and its Characteristics curve.

c. **Other Activities:**

Try to do simple experiments using diode.

.

Brief of Hours suggested for the Course Outcome.

Course Outcomes:	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning (SL)	Total hours(LI+SW+SL)=

PH152: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	90	15	15	120

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO	Electronic devices(General)	30	10	10	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end-of-semester assessment for Mechanics and General Properties of Matter will be held with a writtenexamination of 50 marks.

Note. Detailed assessment rubrics need to be prepared by the course-wise teachers for the above tasks. Teachers can also design different tasks as per requirements for the end-semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Science Museum
7. Demonstration
8. ICT-Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) **Books** :

S.No.	Books Name	Author	Publisher	Edition &Year
1.	Practical Physics	S.L. GUPTA, V. KUMAR	Pragati Prakashan	2018
2.	Semi Conductor Devices- Physics and Technology	SM Sze	Wiley	1985
3.	Introduction to Semiconductor devices	M.S. Tyagi	John Wiley and Sons	1991
4.	Measurement, Instrumentation and Experimental Design in Physics and Engineering	M. Sayer and A. Mansingh	Prentice-hall of india private limited	2000
5.	Optical Electronics	Ajoy Ghatak and K. Thygarajan	Cambridge Univ. Press.	1989
6.	Lab Manuals provided by Dept. of Physics, AKS University, Satna.			

Curriculum Development Team

1. Dr O.P. Tripathi, Head of the Department, Department of Physics
2. Dr C.P. Singh, Assistant Professor , Department of Physics
3. Dr Lovely Singh, Assistant Professor , Department of Physics
4. Mr. Saket Kumar, Assistant Professor , Department of Physics
5. Mr. Manish Agrawal, Assistant Professor , Department of Physics
6. Miss Swati Kushwaha, Lab Assistant (Teaching Associate), Department of Physics, AKS University

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Cos,POs and PSOs Mapping

Course Title: M.Sc. Physics

Course Code: PH152

Course Title: Electronics Lab - I

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engin e ering knowle dge	Prob lem anal ysis	Desig n/dev elop ment of soluti ons	Cond uct invest igatio ns of compl ex probl ems	Mod e rn tool usag e	The engi neer and soci ety	Enviro n ment and sustain ability:	Ethic s	Indivi dual and team work:	Com munic ation:	Project manage ment and finance:	Life-long learnin g	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communic ate effectively.	Ability to use the techniqu es, skills, and modern physical tools in real world applicati on.	Engage in life-long learning and will have recogniti on.
CO: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	2	1	2	1	1	3	3	3	1	1	2	2	3	3	2	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.,	COs No.& Titles,	SOs No.	Laboratory Instruction (LI)	Self Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4,5	CO- The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	SO1 SO2 SO3 SO4 SO5	Electronic Devices 1,2,3,4,5,6,7,8,9,10	1,2

Semester-II

Course Code:	PH201
Course Title :	**Thermodynamics and Statistical Physics**
Pre- requisite:	Student should have basic knowledge of thermodynamics, laws of thermodynamics and basic knowledge of statistical physics.
Rationale:	The students studying Physics should possess foundational understanding about historical background of Thermodynamics and Statistical Physics.

Course Outcomes:

PH201.1 Explain the various thermodynamical quantities and Maxwell's relations and apply the thermodynamics in ideal gas, magnetic and dielectric materials

PH201.2 D escribe various statistical approaches which describe systems of particles and compare microstates, macrostates, and statistical ensembles.

PH201.3 Understand the theories and mathematical approaches of statistical ensembles, equipartition theorem and Maxwell-Boltzmann statistics.

PH201.4 Illustatre the fundamental concepts of Bose-Einstein Statistics and phase transition.

PH201.5 Evaluate the formulae of random walk and diffusion equation and thermodynamical fluctuations.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH201	**Thermodynamics and Statistical Physics**	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	PH201	Thermodynamics and Statistical Physics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

CO201.1 Explain the various thermodynamical quantities and Maxwell's relations and apply the thermodynamics in ideal gas, magnetic and dielectric materials.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learnin g (SL)
SO1.1 To understand the Concept of entropy **SO1.2** To understand the entropy of a perfect gas and Kelvin's thermodynamic scale of temperature **SO1.3** Learn about laws of Thermodynamics and their consequences **SO1.4** Identity perfect gas scale and absolute scale and Heat death of the universe **SO1.5** To understand the Relation between thermodynamic variables (Maxwell's relations).	**UNIT-I (Thermodynamics)** 1.1 Concept of entropy 1.2 Change in entropy in adiabatic process 1.3 Change in entropy in reversible cycle 1.4 Principle of increase of entropy 1.5 Change in entropy in irreversible process 1.6 T-S diagram, Physical significance of Entropy 1.7 Entropy of a perfect gas 1.8 Kelvin's thermodynamic scale of temperature, The size of a degree, 1.9 Laws of Thermodynamics and their consequences. Thermodynamic and chemical potentials, phase equilibria 1.10 Identity of a perfect gas scale and	1. Introduction of thermodynamics and laws of thermodynamics

	absolute scale. Zero point energy, Negative temperatures (not possible) 1.11 Heat death of the universe 1.12 Relation between thermodynamic variables (Maxwell's relations)	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Explain Laws of Thermodynamics and their consequences, Thermodynamic and chemical potentials and phase equilibrium condition.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO201.2 D escribe various statistical approaches which describe systems of particles and compare microstates, macrostates, and statistical ensembles.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 Learn about foundations of statistical mechanics **SO2.2** To understand contact between statistics and thermodynamics **SO2.3** To understand ensembles and Phase space **SO2.4** To understand density of states and derive Liouville's theorem **SO2.5** To understand partition function and calculate for statistical quantities	**UNIT-II (Fundamentals of Statistical Mechanics)** 2.1 Foundations of statistical mechanics 2.2 Specification of states of a system 2.3 contact between statistics and thermodynamics 2.4 classical ideal gas 2.5 entropy of mixing and Gibb's paradox 2.6 Microcanonical ensemble 2.7 Phase space 2.8 trajectories 2.9 density of states 2.10 Liouville's theorem 2.11 canonical and grand canonical ensembles 2.12 partition function calculation of statistical quantities, Energy and density fluctuations.	1. Concept of thermodynamics and statistics

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**

Explain entropy of mixing and Gibb's paradox.

b. **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO201.3 Understand the theories and mathematical approaches of statistical ensembles, equipartition theorem and Maxwell-Boltzmann statistics.

fluctuations.Approximate Hours

Item	AppX Hrs
Cl	12

LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 To understand statistics of ensembles and statistics of indistinguishable particles **SO3.2** To understand Density matrix, Maxwell- Boltzmann **SO3.3** Learn about Fermi-Dirac and Bose- Einstein statistics **SO3.4** To understand Properties of ideal Bose gases and ideal Fermi gas **SO3.5** To understand Boltzmann's transport equation	**UNIT – III (Condensation)** 3.1 Statistics of ensembles 3.2 Statistics of indistinguishable particles 3.3 Density matrix 3.4 Maxwell- Boltzmann statistics 3.5 Fermi-Dirac statistics 3.6 Bose- Einstein statistics 3.7 properties of ideal Bose gases 3.8 Bose-Einstein condensation 3.9 Properties of ideal Fermi gas 3.10 electron gas in metals (2) 3.11 Boltzmann's transport equation	1. Basics **of Statistical Mechanics**

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Explain Statistics of distinguishable and indistinguishable particles with examples.

b. Other Activities (Specify):
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO201.4 illustrates the fundamental concepts of Bose-Einstein Statistics and phase transition.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0

SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Learn about Cluster expansion for a classical gas **SO4.2** Learn about Virial equation of state **SO4.3** Learn about Dynamical model of phase transition **SO4.4** Learn about Ising model **SO4.5** Learn about Landau theory of phase transition	**UNIT – IV (Phase Transition)** 4.1 Cluster expansion for a classical gas (2) 4.2Virial equation of state 4.3 Dynamical model of phase transition (2) 4.4 Ising model in zeroth approximation (2) 4.5 Ising model in first approximation 4.6 Exact solution in one-dimension 4.7 Landau theory of phase transition (2) 4.8 scaling hypothesis for thermodynamic functions	1. Basics of condensation and B. E. Condensation

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**

Explain Dynamical model of phase transition with neat and clean diagram.

b. **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO201.5 Evaluate the formulae of random walk and diffusion equation and thermodynamical fluctuations.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Learn about Thermodynamics fluctuation, **SO5.2** To understand Spatial correlation and Brownian motion **SO5.3** To Understand and evaluate Langevin theory **SO5.4** To Understand and evaluate fluctuation dissipation theorem and Fokker-Planck equation **SO5.5** To Understand and evaluate Onsager reciprocity relations.	**UNIT – V (Thermodynamics fluctuations)** 5.1 Thermodynamics fluctuation (2) 5.2 spatial correlation 5.3 Brownian motion (2) 5.4 Langevin theory (2) 5.5 fluctuation dissipation theorem 5.6 The Fokker-Planck equation 5.7 Onsager reciprocity relations (3)	1. General theory of motion and thermo dynamical fluctuations

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
   Discuss about Thermodynamics fluctuation.

b. **Other Activities (Specify):**
   Present any one topic of this unit by power point presentation in front of departmental student and faculty.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
CO201.1 Explain the various thermodynamical quantities and Maxwell's relations and apply the thermodynamics in ideal gas, magnetic and dielectric materials	**12**	1	1	14

CO201.2 Describe various statistical approaches which describe systems of particles and compare microstates, macrostates, and statistical ensembles.	12	1	1	14
CO201.3 Understand the theories and mathematical approaches of statistical ensembles, equipartition theorem and Maxwell-Boltzmann statistics.	12	1	1	14
CO201.4 Illustatre the fundamental concepts of Bose-Einstein Statistics and phase transition.	12	1	1	14
CO201.5 Evaluate the formulae of random walk and diffusion equation and thermodynamical fluctuations.	12	1	1	**14**
Total Hours	**60**	**5**	**5**	**70**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Thermodynamics**	03	04	03	10
CO-2	**Fundamentals of Statistical Mechanics**	03	04	03	10
CO-3	**Condensation**	03	04	03	10
CO-4	**Phase Transition**	03	04	03	10
CO-5	**Thermodynamics fluctuations**	03	04	03	10
Total		15	20	15	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Statistical Mechanics	R.K. Pathria	Elsevier	1916
2	Statistical Mechanics	Satya Prakash	KNRN	2004
3	Fundamentals of Statistical and Thermal Physics	F. Reif	McGraw Hill, New York	1965
4	Statistical Mechanics	K. Huang	Wiley	2^{nd} Ed. 1987
5	Lecture note provided by Department of Physics, AKS University, Satna (M. P.)			

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH201

Course Title: Thermodynamics and Statistical Physics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
CO201.1 Explain the various thermodynamical quantities and Maxwell's relations and apply the thermodynamics in ideal gas, magnetic and dielectric materials	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1
CO201.2 Describe various statistical approaches which describe systems of particles and compare microstates, macrostates, and statistical ensembles.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	1
CO201.3 Understand the theories and mathematical approaches of statistical ensembles, equipartition theorem and Maxwell-Boltzmann statistics.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
CO201.4 Illustatre the fundamental concepts of Bose-Einstein Statistics and phase transition.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
CO201.5 Evaluate the formulae of random walk and diffusion equation and thermodynamical fluctuations.	2	1	2	1	1	3	3	3	1	1	2	2	3	3	1	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6, 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO201.1** Explain the various thermodynamical quantities and Maxwell's relations and apply the thermodynamics in ideal gas, magnetic and dielectric materials	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**UNIT-I (Thermodynamics)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11	As mentionedin page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO201.2** D escribe various statistical approaches which describe systems of particles and compare microstates, macrostates, and statistical ensembles.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**UNIT-II (Fundamentals of Statistical Mechanics)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO201.3** Understand the theories and mathematical approaches of statistical ensembles, equipartition theorem and Maxwell-Boltzmann statistics.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**UNIT – III (Condensation)** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO201.4** Illustatre the fundamental concepts of Bose-Einstein Statistics and phase transition.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**UNIT – IV (Phase Transition)** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO201.5** Evaluate the formulae of random walk and diffusion equation and thermodynamical fluctuations.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**UNIT – V (Thermodynamics fluctuations)** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	

Semester-II

Course Code: PH202

Course Title: **Solid State Physics**

Pre- requisite: To understand the fundamentals of intriguing phenomena such as direct lattice, reciprocal lattice, lattice vibration in solids, specific heat of metals, band formation in solids, effective mass, and superconductivity.

Rationale: The solid-state physics is the branch of physics dealing with physical properties of solids particularly crystals, including the behavior of electrons in these solids. The course solid state physics is basically designed for fundamental understanding of several breakthrough phenomena such as crystal structure, lattice dynamics, various crystal bonding, free electrons theory, band theory and superconductivity in solids.

Course Outcomes:

PH202.01: Describe the mathematics concepts and their applications to complex numbers, complex functions, analytic functions, complex integration and theory of residues. problems of physics.

PH202.02: Understand and analyze the concept of Numerical Solution of Linear and Non-Linear Equations, Ordinary Differential Equations and Function of complex variable.

PH202.03: Identify the applications of complex variables, tensors and group theory.

PH202.04: Understand the concept of Bessel's function, Hermite function etc., with its properties like recurrence relations, orthogonal properties, generating functions etc. Understand how special function is useful in differential equations.

PH202.05: Evaluate the Fourier transform of a continuous function and be familiar with its basic properties. Solution of integral equation and their application. Solve differential & integral equations with initial conditions using Laplace transform.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH202	Solid State Physics	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	PH202	Solid State Physics	15	20	5	5	5	50	50	100

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

77PH202.01: Describe the basic principles of semiconductor physics, including band theory, carrier transport, and semiconductor device behavior.

Approximate Hours

Item	AppX Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

SESSION OUTCOMES (SOs)	**CLASS ROOM INSTRUCTION (CI)**	**SELF LEARING**
SO 1.1 Energy Bands, carrier concentration and Fermi levels for Intrinsic and extrinsic semiconductors	Module 1.1 Understanding energy bands, carrier concentration, and Fermi levels in intrinsic and extrinsic semiconductors is crucial in semiconductor physics. Here's a breakdown for classroom instruction: Energy Bands (Valence Band & Conduction Band), Intrinsic Semiconductor (Definition, Energy band diagram, Carrier Concentration & Fermi Level), Extrinsic Semiconductor (Definition, Doping, N-type Semiconductor, P-type Semiconductor, Energy Band Diagram, Carrier Concentration & Fermi Level)	**Role of Temperature:** Discuss how temperature influences carrier concentration by providing energy for electrons to move between bands (through thermal excitation).
SO 1.2 Direct and Indirect band semiconductors	1.2 Understanding the differences between direct and indirect bandgap semiconductors is essential in various fields, including material science, semiconductor physics, and electronic device engineering. It forms a foundational concept in the design and optimization of semiconductor devices for specific applications.	2: Connecting these concepts to real-world applications helps students understand the significance of direct and indirect bandgap materials in various technologies.
SO 1.3 Degenerate and compensated semiconductors	1.3: When teaching about degenerate and compensated semiconductors in a classroom setting, it's essential to cover the following points: **Basic Semiconductor Concepts:** Begin by explaining the basics of semiconductors, intrinsic and extrinsic semiconductors, doping, and the behavior of charge carriers. **Degenerate Semiconductors:** Discuss the conditions under which semiconductors become degenerate, emphasizing the high concentration of charge carriers and the impact on the semiconductor's behavior and energy levels. **Compensated Semiconductors:** Explain how compensated semiconductors are created by intentionally adding impurities to balance the effects of dopants, resulting in a controlled carrier concentration. **Applications and Importance:** Highlight the significance of these concepts in practical applications such as in semiconductor devices, electronics, and how understanding these states helps in designing semiconductor materials with	

	specific electrical properties.	
SO 1.4 Elemental (Si) and compound semiconductors (GaAs)	1.4: Elemental semiconductors like silicon (Si) and compound semiconductors like gallium arsenide (GaAs) are fundamental materials in the field of semiconductor physics and technology. When teaching about these materials in a classroom setting, it's essential to cover various aspects, including their properties, structures, and applications.	
SO 1.5 Replacement of group III element and Group V elements to get tertiary alloys such as Alx Ga(1-x) As or GaPyAs(1-y) and quaternary InxGa(1-x) PyAs(1-y) alloys and their important properties such as band gap and refractive index changes with x and Y	1.5 Replacement of group III element and Group V elements to get tertiary alloys such as Alx Ga(1-x) As or GaPyAs(1-y) and quaternary InxGa(1-x)PyAs(1-y) alloys and their important properties such as band gap and refractive index changes with x and Y AlxGa(1-x)As: Band Gap: The bandgap of this alloy changes continuously with the composition x. For instance, as you increase the aluminum (Al) content (increase in x), the bandgap of the alloy will increase. It's used in semiconductor devices like LEDs, lasers, and solar cells. Refractive Index: The refractive index also changes with the composition x. Typically, as the bandgap increases, the refractive index also tends to increase. **GaPyAs(1-y):** Band Gap: Similar to AlxGa(1-x)As, the bandgap of GaPyAs(1-y) changes with the composition y. As you increase the phosphorus (P) content (increase in y), the bandgap decreases. Refractive Index: The refractive index also changes with y, but it's not as directly correlated as with the bandgap. Quaternary Alloy: **InxGa(1-x)PyAs(1-y):** Band Gap: This quaternary alloy has a more complex composition, where both x (Indium) and y (Phosphorus) contribute to the bandgap. The bandgap can be tuned by varying both x and y. Refractive Index: Similar to the bandgap, the refractive index changes with variations in x and y. However, predicting the exact change in refractive index with these compositional changes might require more sophisticated modeling.	3: Discuss ongoing research or advanced concepts like strain engineering, defect control, and other methods used to further manipulate and optimize these materials for specific applications.
SO 1.6 Doping of Si (Group III (n) and Group V (P) compounds) and GaAs (Group II (P) , IV (n-p) and VI (n compounds)	1.6: Doping is a fundamental process in semiconductor physics that involves intentionally introducing impurities into a semiconductor material to modify its electrical properties. The most commonly used semiconductors for doping include silicon (Si) and gallium arsenide (GaAs).	
SO 1.7 Diffusion of impurities (Thermal Diffusion, constant surface concentration)	1.7: Diffusion of impurities, particularly through thermal diffusion with constant surface concentration, is a phenomenon encountered in various scientific disciplines, including material science, chemistry, and physics. In a classroom setting, this topic is often covered in courses related to transport phenomena, physical chemistry, or materials science.) Overview of Thermal Diffusion with Constant Surface Concentration **1. Introduction to Diffusion:** Explain the concept of diffusion: the movement of particles from an area of high concentration to an area of low concentration. Describe the driving force behind diffusion: the tendency of particles to spread out and achieve a more uniform distribution. **2. Thermal Diffusion:** Define thermal diffusion as the movement of particles due to a temperature gradient. Discuss Fick's laws of diffusion, particularly Fick's Second Law, which describes the rate of change of concentration of a diffusing substance. **3. Constant Surface Concentration:** Explain the scenario where the concentration of the diffusing substance at the surface remains constant.	Discuss numerical methods or computational approaches used to simulate and predict diffusion processes with constant surface concentration.

	Explore scenarios like the diffusion of impurities in solids or gases with a fixed surface concentration. **4. Governing Equations:** Introduce the mathematical formulation for diffusion, emphasizing the equation that governs the concentration profile over time and space. Discuss boundary conditions that include the constant surface concentration. **5. Factors Affecting Diffusion:** Explore factors influencing the rate of diffusion, such as temperature, concentration gradient, surface area, and the medium through which diffusion occurs. **6. Applications and Examples:** Discuss real-world applications of thermal diffusion with constant surface concentration, such as doping semiconductors, chemical processing, and material synthesis. Provide examples or case studies illustrating how this phenomenon is utilized in various industries.	
SO 1.8 Constant total dopant diffusion & ion implantation	1.8: In a classroom setting, these concepts can be taught using theoretical explanations, diagrams, and possibly practical demonstrations or simulations. Here are some teaching approaches: Theory and Principles: Explain the fundamental concepts behind dopant diffusion and ion implantation, covering topics such as diffusion mechanisms, concentration profiles, energy levels, and their impact on semiconductor behavior. Visual Aids and Diagrams: Use diagrams, graphs, and animations to illustrate the diffusion process and ion implantation setup. Visual aids can help students understand how dopants are introduced and distributed within the semiconductor material. Simulation Tools: Utilize simulation software or online tools that simulate dopant diffusion or ion implantation processes. Students can experiment with different parameters to observe their effects on dopant profiles and understand the practical implications. Real-life Examples: Discuss real-life applications of these processes in semiconductor manufacturing. Highlight how constant total dopant diffusion and ion implantation are critical steps in the production of electronic devices and integrated circuits.	

SW-1 Suggested Sessional Work (SW):

- Assignments
- Other Activity

  Power Point Presentation

  Conduct simple experiments or demonstrations (even on a small scale) to showcase the diffusion or ion implantation process. This can offer students a tangible understanding of these concepts.

77PH202.02: A course on Carrier Transport in Semiconductors typically covers fundamental concepts related to the movement of charge carriers (electrons and holes) within semiconductor materials. The course outcomes may include, but are not limited to: Understanding Semiconductor Basics, Carrier Statistics and Equilibrium, Carrier Transport Mechanisms & Semiconductor Devices and Applications.

Approximate Hours

Item	AppX Hrs
Cl	7
LI	0
SW	2
SL	1
Total	10

SESSION OUTCOMES (SOs)	**CLASS ROOM INSTRUCTION (CI)**	**SELF LEARING**
SO 2.1 Carrier Drift under low and high fields in (Si and GaAs) saturation of drift velocity	2.1: Carrier drift refers to the movement of charge carriers, such as electrons or holes, in a semiconductor material in response to an applied electric field. The drift velocity of carriers in a material depends on various factors, including the magnitude of the electric field and the material properties.	1: In a classroom setting, the study of high-field effects in two-valley semiconductors involves theoretical concepts and mathematical models to describe carrier behavior under strong electric fields. This often includes discussions on the band structure of specific semiconductor materials, carrier scattering mechanisms, transport properties, and their practical implications in device design and technology.
SO 2.2 High field effects in two valley semiconductors	2.2 High field effects in two-valley semiconductors refer to the behavior exhibited by certain semiconductor materials when subjected to strong electric fields, particularly those with two distinct	2: Explain Solution of Laguarre and Hermite's equations

	energy valleys in their band structure. Two-valley semiconductors often possess an anisotropic band structure, meaning they have multiple minima (valleys) in their energy bands, resulting in different effective masses for charge carriers in different directions. This characteristic becomes significant when these materials are subjected to high electric fields. When a high electric field is applied to a semiconductor, such as in a diode or transistor under strong biasing conditions, the electrons and holes experience an acceleration due to the force exerted by the field. In two-valley semiconductors, this acceleration can cause the carriers to occupy different valleys in the energy band.	
SO 2.3 Carrier Diffusion carrier injection	2.3: Carrier diffusion and carrier injection are fundamental concepts in semiconductor physics, particularly in understanding how charge carriers (electrons and holes) move within a semiconductor material.	
SO 2.4 Generation Recombination processes- Direct, indirect bandgap semiconductors	2.4: The generation and recombination processes in semiconductors are essential phenomena that influence their electrical properties. This explanation will focus on direct and indirect bandgap semiconductors and their associated generation and recombination processes. Direct Bandgap Semiconductors: Efficient light emission and absorption. Generation via optical absorption, excitation by light. Recombination through radiative and non-radiative processes. Indirect Bandgap Semiconductors: Inefficient light emission and absorption. Generation through thermal effects and impact ionization. Recombination via Auger, trap-assisted processes.	
SO 2.5 Minority carrier Life Time	2.5: **"Minority carrier lifetime"** refers to the average time a minority carrier (either electrons in the P-type material or holes in the N-type material of a semiconductor) survives in a semiconductor device before recombination. This is a crucial parameter in the performance of semiconductor devices like transistors, diodes, and solar cells.	
SO 2.6 Drift and Diffusion of minority carriers (Haynes= Shockley Experiment)	2.6: In real semiconductor devices, both drift and diffusion occur simultaneously and influence the behavior of carriers. The net movement of carriers is the result of these two mechanisms acting together. The study of these mechanisms is crucial in understanding the behavior of semiconductor devices like diodes, transistors, and integrated circuits. This experiment conducted by Shockley and Haynes provided valuable insights into how minority carriers behave in semiconductor materials under the influence of electric fields and concentration gradients, forming the basis for the understanding of semiconductor physics and device operations.	

SO 2.7 Determination of conductivity (a) four probe and (b) van der Pauw techniques. Hall coefficient, minority carrier Life Time.	**Four-Probe Technique:** The four-probe technique is commonly used to measure the resistivity (and thereby conductivity) of thin films or small semiconductor samples. Here's a simplified explanation of the process: **Setup:** Four equally spaced probes are placed on the sample material. Two of the probes are used to pass a known current through the sample, while the other two measure the voltage across the sample. **Measurement:** By applying a known current through the outer probes and measuring the voltage with the inner probes, the resistance of the sample can be determined using Ohm's law (R = V/I). **Calculation of Conductivity:** Once the resistance is obtained, the conductivity (σ) can be calculated using the formula: σ = 1 / (R * A), where A is the cross-sectional area of the sample and R is the resistance measured. **Van der Pauw Technique:** The van der Pauw method is another way to measure the resistivity and conductivity of a thin film or semiconductor material, particularly useful for irregularly shaped or non-uniform samples. **Setup:** Similar to the four-probe technique, four equally spaced probes are placed on the sample. However, the van der Pauw method involves passing a current between two probes and measuring the voltage between the other two. **Measurement:** By changing the current path and measuring voltages across different pairs of probes, a series of resistance measurements are taken. This data is then used to solve the van der Pauw equation to obtain the resistivity/conductivity of the material. **Hall Coefficient:** The Hall coefficient (RH) is a parameter that describes the relationship between the induced electric field and the applied magnetic field perpendicular to the current flow in a conducting material. It's determined by measuring the Hall voltage (VH) produced when a magnetic field is applied perpendicular to the current flow. The formula for Hall coefficient is given by: RH = VH / (IB), where VH is the Hall voltage, I is the applied current, and B is the magnetic field strength. **Minority Carrier Lifetime:** Minority carrier lifetime refers to the average time it takes for minority carriers (electrons in p-type material or holes in n-type material) to recombine in a semiconductor. It's a crucial parameter for semiconductor devices, as it affects their performance and efficiency.	These techniques are typically taught with hands-on demonstrations, theoretical explanations, and possibly laboratory experiments to help students understand their applications in material characterization and semiconductor device analysis.

SW-2 Suggested Sessional Work (SW):

- Assignments
- Other Activity

  Power Point Presentation

77PH202.03: Understanding the dielectric properties of materials is crucial in various fields, including electrical engineering, materials science, and telecommunications.

Approximate Hours

Item	AppX Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING (SL)
SO 3.1 Atomic and molecular Polariziblity	3.1 When teaching about atomic and molecular polarizability, instructors often cover several key points: Theory and Conceptual Understanding: Explain the concept of polarizability, emphasizing how atoms or molecules respond to external electric fields. Introduce terms like induced dipoles, electric fields, and the relationship between polarizability and atomic/molecular size. Factors Affecting Polarizability: Discuss factors influencing atomic and molecular polarizability, such as size, electron cloud distribution, and molecular geometry. Illustrate examples to showcase how different atoms or molecules exhibit varying polarizabilities. Measurement and Units: Introduce methods used to measure polarizability experimentally. Explain relevant units of polarizability, such as cubic angstroms (Å³) or square Bohr radii (a.u.). Real-life Applications: Connect polarizability concepts to real-world applications, such as explaining the behavior of substances in electric fields, the optical properties of materials, or the formation of intermolecular	Provide problems and examples for students to calculate or estimate polarizabilities and understand their significance in various contexts

	forces. Mathematical Treatment (if applicable): For advanced courses, delve into mathematical models or equations that describe polarizability quantitatively, such as the relationship between induced dipole moment and electric field strength.	
SO 3.2 Claussius-Mossotti relation	3.2 The Clausius-Mossotti relation is an equation in physics that describes the polarizability of a dielectric material in an electric field. This relation is particularly important in understanding how materials respond to an external electric field and how this response affects their optical properties.	
SO 3.3 Types of polarizability	3.3 Polarizability refers to the ability of a molecule or atom to form instantaneous dipoles in the presence of an external electric field. In a classroom setting, the types of polarizabilities that might be discussed can include: **Atomic Polarizability:** This refers to the ability of individual atoms to polarize when subjected to an external electric field. It varies depending on the size of the atom and the distribution of its electron cloud. Larger atoms or atoms with more electrons tend to have higher polarizability. **Molecular Polarizability:** Molecules, composed of multiple atoms, can also exhibit polarizability. It depends on the arrangement of atoms within the molecule, the type of bonds present, and the overall geometry of the molecule. **Isotropic and Anisotropic Polarizability:** Isotropic polarizability is when the polarizability of a substance is the same in all directions, while anisotropic polarizability varies with direction. Anisotropic polarizability is common in crystals or elongated molecules where the electron cloud can be easily distorted along specific axes. **Electronic Polarizability:** This relates to the movement of electrons within atoms or molecules in response to an external electric field. The more easily electrons can move, the higher the electronic polarizability. **Ionic Polarizability:** It refers to the ability of ions in a crystal lattice to shift their positions in	

	response to an electric field. Ionic polarizability is significant in ionic compounds where ions are held together by electrostatic forces. **Static and Dynamic (Frequency-dependent) Polarizability:** Static polarizability refers to the polarizability when the frequency of the applied electric field is zero or very low, while dynamic polarizability considers the variation of polarizability with changing frequency of the electric field.	
SO 3.4 Dipolar polarizability and frequency dependence of dipolar polarizability	3.4 The dipolar polarizability refers to the ability of a molecule or an atom to form an induced dipole moment in response to an external electric field. This polarizability is a measure of how easily the electron cloud within the molecule or atom can be distorted by an external electric field.	
SO 3.5 Ionic and Electronic polarizability	3.5 Ionic and electronic polarizability are concepts in physics and chemistry that describe how a particle or a system responds to an external electric field by developing an induced dipole moment. Electronic Polarizability: Electronic polarizability refers to the ability of electrons within an atom or a molecule to shift from their equilibrium positions when subjected to an external electric field. In molecules, this is primarily associated with the distortion of the electron cloud around the atomic nuclei. Larger molecules with more electrons generally have higher electronic polarizability because the electrons are more loosely bound and can move more easily in response to an electric field. Ionic Polarizability: Ionic polarizability pertains to the ability of ions in a crystal lattice or ionic compound to rearrange under the influence of an external electric field. In ionic materials, the positive and negative ions can be displaced from their equilibrium positions, creating temporary dipoles within the material. Ionic polarizability is often significant in materials composed of ions, such as salts or crystals, where the ions are relatively large and can shift positions.	Discussing how the electronic structure of atoms or molecules influences their polarizability.
SO 3.6 Hall Effect	3.6 Mathematical explanation about Hall Effect	

SO 3.7 Quantum Hall Effects	3.7 Explore the applications of QHE in metrology, particularly in defining a precise standard for resistance.	
SO 3.8 Magneto Resistance	3.8 Mathematical Explanation about Magneto Resistance	

SW-3 Suggested Sessional Work (SW):

- Assignments
- Other Activity

  Power Point Presentation

  Providing problems or exercises to help students understand the quantitative aspects of polarizability and how to calculate it for different systems.

  Drawing comparisons between electronic and ionic polarizability, emphasizing their differences and similarities.

77PH202.04: Understanding how magnetic properties are utilized in various technological applications such as magnetic storage devices, sensors, motors, generators, medical imaging (MRI), and magnetic materials used in industries.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	0
SL	2
Total	13

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO 4.1 Magnetic properties of solids	4.1 Definition of special functions Magnetic Materials: Materials can be classified based on their magnetic properties into three categories: Diamagnetic Materials: These materials have no permanent magnetic moment and are weakly repelled by both poles of a magnet. They create their own magnetic field in the opposite direction to an externally applied magnetic field. Paramagnetic Materials: These materials have unpaired electrons, leading to a weak attraction when placed in an external magnetic field. However, they don't retain magnetization when the field is removed.	

	Ferromagnetic and Ferrimagnetic Materials: These materials have domains where the magnetic moments of the atoms align spontaneously. They exhibit strong attraction to magnetic fields and retain some magnetization even after the removal of the external field. Magnetic Moments and Domains: The microscopic behavior of magnetic materials involves understanding atomic magnetic moments. In ferromagnetic materials, these moments tend to align spontaneously in regions called domains. Application of an external magnetic field can align these domains, resulting in macroscopic magnetization. Magnetic Hysteresis: When a ferromagnetic material is magnetized in one direction and then demagnetized, it doesn't return to its original state; it retains some residual magnetization. The relationship between the magnetic field and the magnetization of the material is described by a hysteresis loop. Curie Temperature: For ferromagnetic and ferrimagnetic materials, there's a temperature called the Curie temperature above which the material loses its permanent magnetic properties. Magnetic Susceptibility: This refers to how much a material can be magnetized under the influence of an external magnetic field. Applications: Discussing real-world applications of magnetic materials, such as in data storage devices (hard disks), electric motors, transformers, MRI machines, etc., can further illustrate the importance and relevance of understanding magnetic properties.	
SO 4.2 Langevin equation	4.2 In a classroom setting, instructors might introduce the Langevin equation while discussing concepts related to statistical physics, Brownian motion, or stochastic processes. Students often learn how to interpret the equation's components and how it relates to the behavior of particles undergoing random motion influenced by external forces and the surrounding medium. Understanding the Langevin equation can provide insights into the behavior of particles in diverse physical systems and how random fluctuations affect their motion.	
SO 4.3 Quantum theory of Para magnetism	4.3 In a classroom setting, teaching the quantum theory of paramagnetism might involve the following key points: Overview of Magnetism: Begin by discussing the basics of magnetism and its types (ferromagnetism, paramagnetism, and diamagnetism). Explain that paramagnetism arises from the alignment of atomic or molecular magnetic dipoles in a material. Atomic Structure: Review the atomic structure, emphasizing the concept of electron spin and its relation to magnetism. Explain that unpaired electrons in an atom possess magnetic moments due to their intrinsic angular momentum or spin. Pauli Exclusion Principle: Discuss the Pauli Exclusion Principle, which states that no two electrons in an atom can have the same set of quantum numbers, particularly their spin. This leads to the existence of unpaired electrons in certain atoms or ions.	

	Paramagnetic Materials: Introduce paramagnetic materials as substances containing atoms or ions with unpaired electrons. These unpaired electrons give rise to magnetic moments within the material. Zeeman Effect: Explain the Zeeman Effect, where the energy levels of atoms or ions with unpaired electrons split when exposed to an external magnetic field. This splitting occurs due to the interaction between the magnetic moment of the electron and the external field. Quantum Mechanical Model: Use the principles of quantum mechanics to describe how the magnetic moments of individual atoms or ions align with an external magnetic field. Discuss the quantization of angular momentum and the alignment of magnetic moments along the field or against it. Magnetic Susceptibility: Introduce the concept of magnetic susceptibility, which quantifies a material's response to an applied magnetic field. Paramagnetic materials have positive magnetic susceptibility, indicating their weak attraction to the magnetic field. Temperature Dependence: Explain how temperature influences paramagnetism. At higher temperatures, thermal energy disrupts the alignment of magnetic moments, reducing the overall magnetic effect. Applications and Examples: Provide real-world examples of paramagnetic materials and their applications, such as in MRI machines, magnetic materials used in electronics, or certain chemical compounds.	
SO 4.4 Curie law	4.4 Understanding the Curie Law helps in comprehending the magnetic behavior of materials and is essential in fields like material science, condensed matter physics, and electrical engineering.	
SO 4.5 Hund's rules	4.5 Summarize Hund's rules, emphasizing their importance and practical implications.	
SO 4.6 Para magnetism in rare earth and iron group ions	4.6 Para magnetism in rare earth and iron group ions arises from the presence of unpaired electrons, allowing them to weakly attract to an external magnetic field. Understanding these properties is crucial in various scientific and technological applications, including magnetic materials, data storage, and medical imaging.	One way to demonstrate Para magnetism is by using a paramagnetic salt (e.g., gadolinium sulfate or ferric chloride). When a strong magnet is brought close to the sample, it shows attraction due to the alignment of its magnetic moments with the external magnetic field.
SO 4.7 Elementary idea of crystal field effects	4.7 Crystal field theory is a model used in chemistry to explain the behavior of transition metal complexes. It focuses on the interaction	Demonstration: Visual Aids: Use

	between the electrons of a transition metal ion and the surrounding ligands (ions or molecules) in a crystal lattice.	diagrams or models to illustrate the crystal field splitting in different geometries (octahedral and tetrahedral) and how it correlates to observed colors. Spectral Data: Show spectral data, such as absorption spectra, to relate the energy gaps caused by crystal field splitting to the observed colors.
SO 4.8 Curie- weiss law for susceptibility	4.8 Mathematical explanation about Curie- weiss law for susceptibility	
SO 4.9 Heisenberg exchange interaction	4.9 Discuss how the Heisenberg exchange interaction leads to an exchange energy between neighboring spins. The energy associated with this interaction depends on the relative orientation of the spins. When spins are aligned parallel (ferromagnetic alignment), the exchange energy is usually lower than when they are anti-aligned (antiferromagnetic alignment).	
SO 4.10 Mean field theory	4.10 Mean field theory is a concept used in various fields, such as physics, neuroscience, and materials science, to simplify complex systems by approximating the interactions among individual components. In the context of physics, it's often applied to describe the behavior of many interacting particles, such as atoms or spins in a magnetic material.	
SO 4.11 Neel point	4.11 The Neel point is a significant concept in the study of magnetism, particularly in the context of antiferromagnetic materials. It's named after Louis Neel, a French physicist who made notable contributions to the understanding of magnetism.	
SO 4.12 Nuclear magnetic resonance	4.12 In a classroom setting, teaching NMR in the context of magnetism involves several key concepts: Magnetic Moments: Atoms with an odd number of protons or neutrons have a non-zero nuclear spin, resulting in a magnetic moment. When placed in an external magnetic field, these nuclei align either parallel or antiparallel to the field. Energy Levels: The nuclei have different energy states based on their alignment in the magnetic field. The energy difference	

	between these states is directly proportional to the strength of the magnetic field. Resonance Condition: When the frequency of an applied electromagnetic field matches the energy difference between these states, the nuclei absorb energy and transition between energy levels. This is known as the resonance condition. Larmor Frequency: The frequency at which the magnetic moments precess around the magnetic field is called the Larmor frequency. It's directly proportional to the strength of the magnetic field and the gyromagnetic ratio of the nucleus. NMR Spectroscopy: By applying a varying magnetic field or radiofrequency pulses to the sample, and then detecting the resulting emitted radio waves, an NMR spectrometer can provide detailed information about the chemical environment and structure of molecules, aiding in chemical analysis. Applications: Explain various applications of NMR, such as in chemistry for structure determination, in medical diagnostics for imaging (Magnetic Resonance Imaging - MRI), and in physics for studying material properties and dynamics.	

SW-4 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  Power Point Presentation

77PH202.05: Students or participants should acquire a comprehensive understanding of the principles behind superconductivity, including the theories, properties, and phenomena associated with superconducting materials.

Item	AppX Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

SESSION OUTCOMES (SOs)	**CLASS ROOM INSTRUCTION (CI)**	**SELF LEARING**
SO 5.1 Concept of superconducting state	Module 5.1 The superconducting state is a fascinating phenomenon observed in certain materials when they are cooled to extremely low temperatures. In this state, these materials exhibit zero electrical resistance and expel magnetic fields, allowing currents to flow perpetually without any loss of energy. This phenomenon was first discovered in 1911 by Heike Kamerlingh Onnes when he observed the sudden disappearance of electrical resistance in mercury at very low temperatures. Key aspects of the superconducting state include: Zero Resistance: One of the most distinctive properties of superconductors is their ability to conduct electricity without any resistance. When a current starts flowing in a superconductor, it can continue indefinitely without losing any energy to resistance. Meissner Effect: Superconductors expel magnetic fields from their interiors when they transition into the superconducting state. This phenomenon is known as the Meissner effect and leads to the expulsion of magnetic flux lines, causing the superconductor to repel magnetic fields. Critical Temperature: Each superconductor has a critical temperature below which it transitions into the superconducting state. This temperature varies from material to material. Some superconductors require extremely low temperatures (near absolute zero), while others, called "high-temperature superconductors," exhibit superconductivity at temperatures achievable using more practical cooling methods, though still very low by everyday	

	standards. Type I and Type II Superconductors: Superconductors can be categorized into Type I and Type II based on their response to magnetic fields. Type I superconductors expel all magnetic fields below their critical magnetic field strength. Type II superconductors allow partial penetration of magnetic fields even below their critical magnetic field strength. Applications: Superconductors have numerous practical applications, especially in fields such as medical imaging (MRI machines), magnetic levitation trains (maglev), particle accelerators, sensitive detectors, and high-speed electronic circuits.	
SO 5.2 Persistent current & Critical temperature	5.2 Understanding these concepts can be fundamental in exploring the intriguing behavior of superconductors and their potential applications in various technological advancements.	
SO 5.3 Meissner’s effect	5.3 Meissner's effect might be taught as a significant discovery in the field of superconductivity, explaining how superconductors behave in the presence of magnetic fields at low temperatures. Teachers may demonstrate this effect using simple experiments involving superconducting materials, magnets, and cooling agents to illustrate the expulsion of magnetic fields from the superconductor's interior when it transitions to a superconducting state.	
SO 5.4 Thermodynamics of the superconducting transitions	5.4 Understanding the thermodynamics of superconducting transitions is crucial in developing applications such as superconducting magnets, power transmission lines, and sensitive instrumentation, as superconductors offer unique and advantageous properties in these fields due to their zero resistance and other extraordinary characteristics.	
SO 5.5 Isotope effect	5.5 The isotope effect refers to the change in the reaction rate or properties of a chemical reaction due to the substitution of isotopes of the same element in the reactants. Isotopes are atoms of the same element that have different numbers of neutrons and, consequently, different atomic masses. There are two primary types of isotope effects: Kinetic Isotope Effect (KIE): This effect occurs when the rate of a chemical reaction is influenced by the substitution of isotopes. It's particularly noticeable in reactions involving the breaking or forming of chemical bonds, where the mass difference between isotopes influences the reaction rate. Typically, lighter isotopes often react faster than heavier	Mathematical proof of Einstein’s Coefficients

	isotopes due to their higher mobility and faster vibrational frequencies. Equilibrium Isotope Effect: This effect refers to the influence of isotopic substitution on the position of chemical equilibrium. It's observed in reactions where the isotopic composition affects the stability of reactants and products, thereby altering the equilibrium position.	
SO 5.6 Manifestations of energy gap	5.6 The concept of an "energy gap" can manifest in various ways across different fields such as physics, electronics, and materials science. Here are a few manifestations or instances where the concept of an energy gap is important: Semiconductors and Electronics: In solid-state physics, semiconductors have an energy gap between their valence band (where electrons are tightly bound to atoms) and the conduction band (where electrons can move freely). This energy gap determines the conductivity properties of the material. When electrons gain enough energy (often through thermal or optical excitation), they can jump the energy gap and move into the conduction band, allowing the material to conduct electricity. This forms the basis of electronic devices like diodes and transistors. Photovoltaic Devices: Energy gaps are crucial in solar cells. When photons of light strike a semiconductor material, they can provide enough energy to electrons, allowing them to cross the energy gap and become free to conduct electricity. This process generates an electric current, converting light energy into electrical energy. Superconductors: In the field of superconductivity, there's an energy gap involved as well. Superconductors have a "superconducting gap" which is related to the energy required for electrons to pair up and move without resistance through the material. This gap prevents the scattering of electrons and allows for zero resistance electrical conduction at low temperatures. Optoelectronics: The energy gap also plays a significant role in optoelectronic devices such as light-emitting diodes (LEDs) and lasers. When electrons transition from a higher energy state to a lower one, they release energy in the form of light. The energy difference between these states determines the wavelength or color of the emitted light. Band Theory in Materials Science: In materials science, the concept of energy bands and gaps between them helps to	

	explain the electrical properties of materials. Conductors have overlapping energy bands, insulators have a large energy gap between bands, while semiconductors have a small but finite energy gap.	
SO 5.7 London equation & penetration depth	5.7 The London equations describe how the supercurrent responds to changes in the vector potential in a superconductor. They illustrate that in a superconductor, the electromagnetic response to an applied field is immediate and there's no delay in the establishment of currents. This is why superconductors can expel magnetic fields and remain in a state of perfect diamagnetism (Meissner effect) when cooled below their critical temperature.	
SO 5.8 Two fluid model	5.8 The "two-fluid model" is a concept used in various scientific disciplines, particularly in physics and fluid dynamics. In the context of fluid dynamics, it refers to a theoretical framework that describes certain phenomena by considering two distinct fluids that interact with each other.	Elementary Proof of Fourier Sine & Fourier Cosine Transforms
SO 5.9 Flux quantization	5.9 The concept of flux quantization is often discussed in courses related to condensed matter physics, electromagnetism, or advanced topics in quantum mechanics. It's a fundamental aspect of superconductivity that showcases the unique behavior of materials at extremely low temperatures and has implications for various technological advancements. Teachers might use visual aids, demonstrations, and mathematical explanations to help students understand this concept.	
SO 5.10 single particle tunneling	5.10 This phenomenon has various real-world applications, especially in electronics and nanotechnology. For instance, it's crucial in the operation of tunneling diodes, where the tunneling effect is exploited for creating extremely fast and efficient electronic devices.	
SO 5.11 *dc* and *ac* Josephson effect	5.11 The DC and AC Josephson effects are fundamental phenomena in superconductivity that involve the flow of electrical current across a weak link between two superconducting materials. DC Josephson Effect: In the DC (direct current) Josephson effect, a supercurrent flows through a junction of two superconductors separated by a thin insulating barrier or a very thin normal conducting region. When two superconductors are brought into close proximity but are not physically connected, Cooper pairs (pairs of electrons bound together at low temperatures) can tunnel through the barrier between the superconductors without any resistance. This tunneling of Cooper pairs results in the flow of a	

	supercurrent, which is characterized by a constant phase difference between the wave functions of the superconductors. The current-voltage relationship in a Josephson junction is described by the Josephson equations, which relate the voltage across the junction to the phase difference between the superconducting wave functions. AC Josephson Effect: The AC (alternating current) Josephson effect occurs when an external electromagnetic field is applied to the Josephson junction. When an AC voltage is applied across the junction, the phase difference between the two superconductors oscillates with the frequency of the applied voltage. This leads to an alternating supercurrent, where the direction of the current periodically reverses in response to the changing phase difference induced by the applied AC voltage. The relationship between the applied voltage and the frequency of the supercurrent oscillations is described by the AC Josephson effect. Both DC and AC Josephson effects have numerous applications in superconducting electronics, including superconducting quantum interference devices (SQUIDs), high-speed digital circuits, and highly sensitive magnetometers. They are also used in metrology to create extremely precise voltage standards.	
SO 5.12 quantum interference	5.12 Quantum interference can be demonstrated using various experiments, simulations, or visual aids to help students comprehend this fascinating aspect of quantum mechanics. Explaining the concept through analogies and real-world examples often aids in students' understanding of this complex but intriguing phenomenon.	
SO 5.13 Cooper pairing	Cooper pairing relies on quantum mechanical principles, specifically the interaction between electrons and the condensation of these pairs into a coherent quantum state, where they behave collectively.	
SO 5.14 Interaction of electrons with acoustic and optical phonons	Quantum interference involving the interaction of electrons with acoustic and optical phonons is a fundamental concept in condensed matter physics, especially in the study of semiconductor materials. Electrons: In a crystal lattice, electrons behave as both particles and waves due to their quantum nature. When an electric field is applied or when electrons move through the lattice, they can interact with lattice vibrations known as phonons.	

	Phonons: Phonons are quantized lattice vibrations or quasiparticles representing the collective motion of atoms in a crystal lattice. There are two main types: acoustic and optical phonons. Acoustic Phonons: These are associated with the elastic deformation of the crystal lattice. They have lower energies and longer wavelengths compared to optical phonons. Optical Phonons: These arise due to the displacement of ions with respect to the equilibrium positions in the lattice and have higher energies than acoustic phonons. Electron-Phonon Interaction: When electrons move through a crystal lattice, they can scatter off phonons, altering the electron's momentum and energy. This interaction is crucial for various physical phenomena observed in semiconductors, such as electrical resistivity, thermal conductivity, and electronic band structure modifications. Quantum Interference: Quantum interference occurs when the wave nature of electrons leads to constructive or destructive interference. This interference pattern is influenced by the paths electrons take and their interactions along these paths. Electron-Phonon Scattering and Interference: The interaction of electrons with phonons introduces different scattering mechanisms. Depending on the momentum and energy transfer during scattering events, interference effects can arise. These effects can affect electron transport properties, like conductivity or mobility. Applications: Understanding electron-phonon interactions and quantum interference is crucial for developing semiconductor devices. It impacts the design and performance of transistors, diodes, and other electronic components. Manipulating these interactions can lead to advancements in materials science and quantum technologies.	
SO 5.15 BCS theory of superconductivity	5.15 The Bardeen-Cooper-Schrieffer (BCS) theory is a fundamental explanation of superconductivity, developed by John Bardeen, Leon Cooper, and Robert Schrieffer in 1957. It provides a framework for understanding how certain materials conduct electricity without resistance at low temperatures.	
SO 5.16 High temperature	5.16 High-temperature superconductors (HTS) are a type of material that can conduct electricity with zero resistance at	

superconductors and their applications	relatively higher temperatures compared to conventional superconductors. These materials, typically ceramics or compounds containing copper, can superconduct at temperatures above the boiling point of liquid nitrogen (77 Kelvin or -196 degrees Celsius). This is in contrast to conventional superconductors that require much colder temperatures, often near absolute zero.	

SW-5 Suggested Sessional Work (SW):

- Assignments
- Other Activity

  Power Point Presentation

  Discuss ongoing research efforts aimed at discovering new HTS materials with higher critical temperatures and better performance.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
97PH202.01: Describe the basic principles of semiconductor physics, including band theory, carrier transport, and semiconductor device behavior.	8	1	1	10
97PH202.02: A course on Carrier Transport in Semiconductors typically covers fundamental concepts related to the movement of charge carriers (electrons and holes) within semiconductor materials. The course outcomes may include, but are not limited to: Understanding Semiconductor Basics, Carrier Statistics and Equilibrium, Carrier Transport Mechanisms & Semiconductor Devices and Applications.	7	2	1	10
97PH202.03: Understanding the dielectric properties of materials is crucial in various fields, including electrical engineering, materials science, and telecommunications.	8	1	1	10
97PH202.04: Understanding how magnetic properties are utilized in various technological applications such as magnetic storage devices, sensors, motors, generators, medical imaging (MRI), and magnetic materials used in industries.	11	0	2	13

97PH202.05: Students or participants should acquire a comprehensive understanding of the principles behind superconductivity, including the theories, properties, and phenomena associated with superconducting materials.	8	1	1	10
Total Hours	42	05	6	53

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Understanding the fundamental concepts of semiconductors, crystal structures, band theory, doping, and intrinsic/extrinsic semiconductor properties.	03	01	01	05
CO-2	Understanding the significance of carrier transport in the development of new semiconductor materials, devices, and technologies.	02	06	02	10
CO-3	Understanding dielectric properties is crucial in various fields like electrical engineering, materials science, and physics.	03	07	05	15
CO-4	Students gain a fundamental understanding of the principles behind magnetism, including the behavior of magnetic fields, magnetic forces, and magnetic materials.	-	10	05	15
CO-5	Understanding the Basics: Gain a comprehensive understanding of the fundamental principles underlying superconductivity, including the Meissner effect, critical temperature, critical magnetic field, and Cooper pairs.	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Group Discussion
4. Role Play
5. Demonstration
6. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
7. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Introduction to Solid State Physics	L.V. Azaroff	Academic Press	Revised edition 21 edition 2020
2	Crystellographic Solid State Physics	Verma & Srivastava	Cambridge University Press	2014
3	Solid State Physics	A.J. Dekker	Dover publications,	2001
4	Principles of Condense Matter Physics	P.M. Chaiken& T.C. Lubensky	Dover Publications	2018

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc (Physics)
Course Code: 77PH202
Course Title: Solid State Physics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustain ability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	The ability to apply technical & engineering knowledge for production quality cement	Ability to understand the day to plant operational problems of cement manufacture	Ability to understand the latest cement manufacturing technology.	Ability to use the research based innovative knowledge for SDGs	Engage in life-long learning and will have recognition
CO 1: Understanding the fundamental concepts of semiconductors, crystal structures, band theory, doping, and intrinsic/extrinsic semiconductor properties.	2	2	2	2	3	2	3	2	2	1	3	2	2	3	3	1	3
CO 2: Understanding the significance of carrier transport in the development of new semiconductor materials, devices, and technologies.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	2
CO 3: Understanding dielectric properties is crucial in various fields like electrical engineering, materials science, and physics.	2	1	2	1	3	2	2	2	1	2	1	2	3	2	2	2	2
CO 4: Students gain a fundamental understanding of the principles behind magnetism, including the behavior of magnetic fields, magnetic forces, and magnetic materials.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	3
CO 5: Understanding the Basics: Gain a comprehensive understanding of the fundamental principles underlying superconductivity, including the Meissner effect, critical temperature, critical magnetic field, and Cooper pairs.	1	2	3	1	2	3	3	3	1	1	2	2	3	3	2	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 1 Understanding the fundamental concepts of semiconductors, crystal structures, band theory, doping, and intrinsic/extrinsic semiconductor properties.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**UNIT-I (Semiconductor Materials)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12	As mentioned in page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 2: Understanding the significance of carrier transport in the development of new semiconductor materials, devices, and technologies.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**UNIT-II (Carrier Transport in Semiconductors)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 3: Understanding dielectric properties is crucial in various fields like electrical engineering, materials science, and physics.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**UNIT-III (Dielectric Properties)** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 4: Students gain a fundamental understanding of the principles behind magnetism, including the behavior of magnetic fields, magnetic forces, and magnetic materials.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**UNIT-IV (Magnetic Properties)** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 5: Understanding the Basics: Gain a comprehensive understanding of the fundamental principles underlying superconductivity, including the Meissner effect, critical temperature, critical magnetic field, and Cooper pairs.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**UNIT-V (Superconductivity)** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	

Semester-II

Course Code: PH203

Course Title : Quantum Mechanics-I

Pre- requisite: A thorough understanding of mechanics. Knowledge of partial differential equation and variable separable method. Commendable knowledge of integral and differential calculus.

Rationale: This course gives an insight of applying different approximation methods for stationary states and deals with alternative pictures of time evolution and relativistic quantum mechanics. It also helps the students to acquire basic knowledge of quantum field theory.

Course Outcomes:

CO203.1. To explain the theories and phenomena of vector space, operators, Dirac's notations, matrices, and commutators which are very helpful in solving the various Quantum mechanics problems and understand the uncertainty relation between two arbitrary operators.

CO203.2. To understand and solve the Schrödinger equation for a free particle. A comprehensive understanding of the behavior of particles in one and three dimensions enabling them to analyze and solve problems in a wide range of quantum systems.

CO203.3. Understand the potential energy function for a linear harmonic oscillator. Interpret the wave functions associated with harmonic oscillator states. To understand the significance of vibrational energy levels in molecular spectra.

CO203.4. To understanding the angular momentum, spin, and their applications in quantum mechanics, enabling them to analyze and solve problems in systems with angular momentum and spin. Understand the coupling of two angular momenta to obtain the total angular momentum.

CO203.5. Understanding of time-independent perturbation theory, variational methods, WKB approximation, Fermi's Golden Rule, and the semiclassical theory of interaction with radiation.

Scheme of Studies:

Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
		Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
PH203.3	Quantum Mechanics-I	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Couse Code	Course Title	Scheme of Assessment (Marks)							
		Progressive Assessment (PRA)						End Semester Assessment	Total Marks
		Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
PH203	Quantum Mechanics-I	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI).

PH203.1: To explain the theories and phenomena of vector space, operators, Dirac's notations, matrices, and commutators which are very helpful in solving the various Quantum mechanics problems and understand the uncertainty relation between two arbitrary operators.

Approximate Hours

Item	Approx. Hrs.
CI	8
LI	0
SW	2
SL	1
Total	11

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)

SO1.1 The state of a system is described by a mathematical function called the wave function. **SO1.2** The concept of wave-particle duality, suggesting that particles like electrons can exhibit both wave and particle like properties. Using Heisenberg Uncertainty Principle for position and momentum operators in quantum mechanics. **SO1.3** Explain the physical meaning of each term in the Schrödinger equation. Emphasize the significance of the kinetic and potential energy terms. **SO1.4** Discuss the mathematical idealization of the Dirac delta function and its limitations in practical applications. **SO1.5** Introduce approximations, such as a narrow rectangular pulse, that approach the behavior of the Dirac delta function. The evolution of a quantum system is governed by the Schrödinger equation, describing how the wave function changes over time.	**Unit-1 Foundation of Quantum mechanics** 1.1Why QM? Brief prevision. Basic postulates of quantum mechanics 1.2 Wave-particle duality, wave packets, wave function, expectation values, continuity equation 1.3 Ehrenfest theorem, Heisenberg uncertainty principle. 1.4 Equation of continuity, Normality, orthogonality and closure properties of eigen functions, Expectation values 1.5 Free particle solution of Schrodinger equation, Box normalization. 1.6 Dirac delta-function and its properties 1.7 Solution of Schrodinger equation for one dimensional (a) potential well (b) potential step and (c) potential barrier (2).	Developing a deep understanding of these postulates, solving problems using the mathematical formalism of quantum mechanics and challenges posed by the theory.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Heisenberg uncertainty principle.
2. Schrodinger wave equations

PH203.2: To understand and solve the Schrödinger equation for a free particle. A comprehensive understanding of the behavior of particles in one and three dimensions enabling them to analyze and solve problems in a wide range of quantum systems.

Approximate Hours

Item	Approx. Hrs.
Cl	09
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 To understand Introduce the concept of a free particle with no external forces or potentials. Introduce the concept of a potential step, where a particle encounters a sudden change in potential energy. **SO2.3** Discuss the physical interpretation of the variation of constants, emphasizing how the method provides insights into the evolution of quantum states under time-dependent perturbations. Time-independent perturbation theory to set the foundation for harmonic perturbation. **SO2.3** Understanding the concept of separating variables in the Schrödinger equation for the three-dimensional free particle. The quantization of energy levels for the linear harmonic oscillator. **SO2.4** Bridging the gap between Cartesian and spherical coordinates. A comprehensive understanding of the quantum mechanics of a particle in a three-dimensional square well. **SO2.5** Emphasizing a rigorous mathematical approach in solving the Schrödinger equation and understanding the eigen states and eigenvalues for each potential.	**Unit-2 One and Three dimensional problems** 2.1 One-dimensional problems: Free particle, potential step 2.2 Methods of variation of constant and harmonic perturbation 2.3 One-dimensional problems: Free particle, potential step 2.4 Rectangular barrier, tunneling, infinite square well 2.5 Finite square well, periodic lattice and linear harmonic oscillator. 2.6 Three-dimensional problems: Free particle (in Cartesian and Spherical coordinates) 2.7 Three dimensional Square well 2.8 Three-dimensional linear harmonic oscillator (in Cartesian and in Spherical coordinates) 2.9 Rigid rotator, Hydrogen atom and potential barrier.	A comprehensive understanding of Perturbation Theory

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**

1. Schrodinger wave equation for rectangular potential barrier.
2. Linear harmonic oscillator.

PH203.3: Understand the potential energy function for a linear harmonic oscillator. Interpret the wave functions associated with harmonic oscillator states. To analyze the significance of vibrational energy levels in molecular spectra.

Approximate Hours

Item	Approx. Hrs.
Cl	09
LI	0
SW	2

SL	1
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 To develop a comprehensive understanding of the quantum mechanics of a particle in a three-dimensional square well and its implications for various physical systems. Solving by appropriate potential and boundary conditions **SO3.2** Understanding the solutions for a harmonic oscillator potential. Explore the solutions for the hydrogen atom, involving spherical harmonics and radial wave functions. **SO3.3** The theory of scattering in quantum mechanics deals with the study of how particles interact with each other or with potentials **SO3.4** Understand the theory of scattering in quantum mechanics and interaction with each other or with potentials **SO3.5** The focus is likely on imparting a broader understanding of the physical concepts underlying scattering processes.	**Unit-3: Solution and application of Schrodinger equation** 3.1 Solution of Schrodinger equation 3.2 Solution of Schrodinger equation for: linear harmonic oscillator (2) 3.3 hydrogen-like atom 3.4 three-dimensional harmonic oscillator 3.5 Square well potential and their respective 3.6 Applications to atomic spectra 3.7 Molecular spectra 3.8 Low energy nuclear states (deuteron).	Explore real-world applications of the solutions, such as their role in understanding atomic and molecular structures, electronic properties of materials, and the behavior of particles in different potentials.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1. Three dimensional harmonic oscillator.
2. Applications to atomic and molecular spectra.

PH203.4: To understanding the angular momentum, spin, and their applications in quantum mechanics, enabling them to analyze and solve problems in systems with angular momentum and spin. Understand the coupling of two angular momenta to obtain the total angular momentum.

Approximate Hours

Item	Approx. Hrs.
Cl	05
LI	0
SW	4
SL	1
Total	10

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO4.1 Downfall of Klein-Gordon equation **SO4.2** Relativistic quantum mechanics is a theoretical framework that merges quantum mechanics with special relativity. **SO4.3** Interpretation of probability and current density. **SO4.4** To understand how the Klein-Gordon equation is modified when an electromagnetic field is present. **SO4.5** T he ability to derive and solve the Klein-Gordon equation in the presence of electromagnetic fields.	**Unit-4 : Quantum Equation-I** 4.1 Short comings of Klein-Gordon Equation 4.2 Introduction to relativistic quantum mechanics 4.3 Probability and current density 4.4 Klein-Gordon equation in the presence of electromagnetic field (2)	The ability to derive and solve the equation in the presence of electromagnetic fields and understand the implications of such solutions in the context of particle physics.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

1. Short comings of Klein-Gordon Equation
2. Klein-Gordon equation in the presence of electromagnetic field
3. Introduction to relativistic quantum mechanics
4. Probability and current density

PH203.5: Understanding of time-independent perturbation theory, variational methods, WKB approximation, Fermi's Golden Rule and the semiclassical theory of interaction with radiation.

Item	Approx. Hrs.
Cl	09
LI	0
SW	3
SL	2
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 To describe the time evolution of operators corresponding to physical observables. For electrons, this includes operators for position, momentum, angular momentum and spin. . **SO5.2** Dirac's equation is a relativistic quantum mechanical wave equation. **SO5.3** Understanding of Zitterbewegung refers to Dirac's equation predicts for an electron. **SO5.4** Dirac's equation predicts both positive and negative energy solutions. **SO5.5** Hyperfine splitting showing the energy difference between atomic energy levels that arise from the interaction between the magnetic moment associated with the electron's spin and the nuclear magnetic moment.	**Unit 5: Quantum Equation-II** 5.1 Hydrogen atom 5.2 Equation of motion for operators, position momentum and angular momentum, spin of an electron 5.3 Dirac's relativistic equation for a free electron 5.4 Zitterbewegung Dirac's relativistic equation in electromagnetic field (2) 5.5 Negative energy states and their interpretation (2) 5.6 Hyperfine splitting 5.7 Dirac's matrices	Applying Dirac matrices to formulate and solve problems in relativistic quantum mechanics. Interpreting physical implications of solutions obtained using Dirac matrices

SW-5 Suggested Sessional Work (SW):

a. Assignments:

1. Matrix representation of angular momentum.
2. Hyperfine splitting
3. Dirac matrices.

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Class Lecture (Cl)**	**Sessional Work (SW)**	**Self Learning (Sl)**	**Total hour (Cl+SW+Sl)**

CO 203.1. To explain the theories and phenomena of vector space, operators, Dirac's notations, matrices, and commutators which are very helpful in solving the various Quantum mechanics problems and understand the uncertainty relation between two arbitrary operators.	8	2	1	11
CO 203.2. To understand and solve the Schrödinger equation for a free particle. A comprehensive understanding of the behavior of particles in one and three dimensions enabling them to analyze and solve problems in a wide range of quantum systems.	9	2	1	12
CO 203.3. Understand the potential energy function for a linear harmonic oscillator. Interpret the wave functions associated with harmonic oscillator states. To understand the significance of vibrational energy levels in molecular spectra.	9	2	1	12
CO 203.4. To understanding the angular momentum, spin, and their applications in quantum mechanics, enabling them to analyze and solve problems in systems with angular momentum and spin. Understand the coupling of two angular momenta to obtain the total angular momentum.	5	4	1	10
CO 203.5. Understanding of time-independent perturbation theory, variational methods, WKB approximation, Fermi's Golden Rule, and the semiclassical theory of interaction with radiation.	9	3	2	14
Total Hours	40	13	6	59

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**CO203.1.** To explain the theories and phenomena of vector space, operators, Dirac's notations, matrices, and commutators which are very helpful in solving the various Quantum mechanics problems and understand the uncertainty relation between two arbitrary operators.	03	01	01	05
CO-2	**CO203.2.** To understand and solve the Schrödinger equation for a free particle. A comprehensive understanding of the behavior of particles in one and three dimensions enabling them to analyze and solve problems in a wide range of quantum systems.	02	06	02	10
CO-3	**CO203.3.** Understand the potential energy function for a linear harmonic oscillator. Interpret the wave functions associated with harmonic oscillator states. To understand the significance of vibrational energy levels in molecular spectra.	03	07	05	15
CO-4	**CO203.4.** To understanding the angular momentum, spin, and their applications in quantum mechanics, enabling them to analyze and solve problems in systems with angular momentum and spin. Understand the coupling of two angular momenta to obtain the total angular momentum.	-	10	05	15
CO-5	**CO203.5.** Understanding of time-independent perturbation theory, variational methods, WKB approximation, Fermi's Golden Rule, and the semiclassical theory of interaction with radiation.	03	02	-	05
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement for end semester assessment.

Suggested Learning Resources:

(a) **Books** :

S. No.	Title	Author	Publisher	Edition & Year
1	Quantum Mechanics	L.I. Schiff	McGraw Hill Education	2017
2	Quantum Physics	S. Gasiorowicz	Wiley	2003
3	Quantum Mechanics	B. Craseman and J.L. Powel	Courier Dover Publications	2015
4	Quantum Mechanics	A.P. Messiah	Dover Publications Inc.	2014
5	A Text book of Quantum Mechanics	P.M. Mathews & K. Venkatesan	McGraw Hill Education	2017
6	Modern Quantum Mechanics	J.J. Sakurai & Jim Napolitano	Cambridge University Press	1985
7	Quantum Mechanics Concepts and Applications	Nouredine Zettili	Wiley	2017

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A K S University
Faculty of Basic Science
Department of Physics
Curriculum of M.Sc. (Physics) Program
(Revised as on 01 August, 2023)

Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code : PH203

Course Title: Quantum Mechanics-I

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems	Design and conduct experiments, as well as to analyse and interpret data	Apply knowledge of Physics in a different stream of science and to communicate effectively	Ability to use the techniques, skills, and modern physical tools in real world application	Engage in life-long learning and will have recognition.
CO 203.1. To explain the theories and phenomena of vector space, operators, Dirac's notations, matrices, and commutators which are very helpful in solving the various Quantum mechanics problems and understand the uncertainty relation between two arbitrary operators.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	2
CO 203.2. To understand and solve the Schrödinger equation for a free particle. A comprehensive understanding of the behavior of particles in one and three dimensions enabling them to analyze and solve problems in a wide range of quantum systems.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	3
CO 203.3. Understand the potential energy function for a linear harmonic oscillator. Interpret the wave functions associated with harmonic oscillator states. To understand the significance of vibrational energy levels in molecular spectra.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2

CO 203.4. To understanding the angular momentum, spin, and their applications in quantum mechanics, enabling them to analyze and solve problems in systems with angular momentum and spin. Understand the coupling of two angular momenta to obtain the total angular momentum.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	1
CO 203.5. Understanding of time-independent perturbation theory, variational methods, WKB approximation, Fermi's Golden Rule, and the semiclassical theory of interaction with radiation.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction (CI)	Self Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO 203.1.** To explain the theories and phenomena of vector space, operators, Dirac's notations, matrices, and commutators which are very helpful in solving the various Quantum mechanics problems and understand the uncertainty relation between two arbitrary operators.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	Unit-1 Foundation of Quantum mechanics 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	1
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO 203.2.** To understand and solve the Schrödinger equation for a free particle. A comprehensive understanding of the behavior of particles in one and three dimensions enabling them to analyze and solve problems in a wide range of quantum systems.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	Unit-2 One and Three dimensional problems 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9	1

PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO 203.3.** Understand the potential energy function for a linear harmonic oscillator. Interpret the wave functions associated with harmonic oscillator states. To understand the significance of vibrational energy levels in molecular spectra.	SO3.1 SO3.2 (2) SO3.3 SO3.4 SO3.5	Unit-3: Solution and application of Schrodinger equation 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO 203.4.** To understanding the angular momentum, spin, and their applications in quantum mechanics, enabling them to analyze and solve problems in systems with angular momentum and spin. Understand the coupling of two angular momenta to obtain the total angular momentum.	SO4.1 SO4.2 SO4.3 SO4.4	Unit-4 : Quantum Equation-I 4.1, 4.2,4.3,4.4 (2)	1
PO 1,2,3,4,5,6	**CO 203.5.** Understanding of time-independent perturbation theory, variational methods, WKB approximation, Fermi's Golden Rule, and the semiclassical theory of interaction with radiation.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	Unit 5: Quantum Equation-II 5.1,5.2,5.3,5.4,5.5, 5.6, 5.7	2

Semester-II

Course Code: **PH204**

Course Title : **Atomic, Molecular and Laser Physics**

Pre- requisite: It's important to note that specific course prerequisites may vary based on the institution and the level of the course. Students are advised to check the course catalog or consult with the instructor for the most accurate information regarding prerequisites for a particular Atomic, Molecular, and Laser Physics course.

Rationale: The study of Atomic, Molecular, and Laser Physics is essential for understanding the fundamental nature of matter and has wide-ranging applications in technology, medicine, chemistry, physics, and various interdisciplinary fields. The knowledge gained in this field continues to drive innovations and discoveries with profound implications for diverse scientific and technological endeavors.

Course Outcomes:

PH204.1: Atomic Spectra: To provide students with a comprehensive understanding of atomic spectra and quantum mechanics, preparing them for advanced studies and applications in the field. Students should be able to apply theoretical concepts to interpret experimental data.

PH204.2: Molecular Spectra: To equip students with a strong foundation in molecular spectroscopy, enabling them to understand and analyze rotational spectra for different types of molecules. Students are expected to develop critical thinking, problem-solving skills.

PH204.3: Oscillator: Students have a comprehensive understanding of the theoretical principles, mathematical models, and practical applications of molecular vibrations and spectroscopy in diatomic molecules.

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PH204.4. Spectroscopy: To provide students with a comprehensive understanding of various spectroscopic techniques and experimental methods, preparing them for applications in research, industry, and analytical chemistry.

PH204.5. Laser: Course aims to provide students with a comprehensive understanding of laser physics and its applications, preparing them for advanced studies in optics, photonics, and laser technology.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH204	Atomic, Molecular and Laser Physics	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	PH204	Atomic, Molecular and Laser Physics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH204.1: Atomic Spectra: To provide students with a comprehensive understanding of atomic spectra and quantum mechanics, preparing them for advanced studies and applications in the field. Students should be able to apply theoretical concepts to interpret experimental data.

Approximate Hours	
Item	AppX Hrs
Cl	14
LI	0
SW	2
SL	3
Total	19

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO1.1.: Understand the fundamental principles of quantum mechanics and their applications in atomic and molecular physics. **SO1.2.:** Analyze and interpret atomic and molecular spectra. **SO1.3.:** Understand the methods and models used in molecular quantum mechanics. **SO1.4.:** Explain the principles behind statistical models such as the Thomas-Fermi model. **SO1.5.:** Analyze the behavior of electrons in complex systems, including the two-electron system. **SO1.6.:** Understand the mechanisms behind hyperfine structure and line broadening in atomic and molecular spectra	**Unit 1: Atomic Spectra** **1.1.** Introduction to Quantum Mechanics **1.2.** Schrodinger Equation **1.3.** Atomic Orbitals **1.4.** Hydrogen Spectrum **1.5.** Pauli's Principle **1.6.** Overview of Alkali Elements **1.7.** Spin-Orbit Interaction **1.8.** Line Structure of Alkali Spectra **1.9.** Molecular Quantum Mechanics **1.10.** Hartree and Hartree-Fock Methods **1.11.** Two-Electron System **1.12.** Interaction Energy in LS and JJ Coupling **1.13.** Hyperfine Structure **1.14.** Line Broadening Mechanisms	**i.** Quantum Mechanics **ii.** Alkali Spectra **iii.** Orbitals

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Pauli's Principle

ii. Line Broadening Mechanisms

b. Other Activities (Specify):

Seminar and group discussion related to subject

PH204.2: Molecular Spectra: To equip students with a strong foundation in molecular spectroscopy, enabling them to understand and analyze rotational spectra for different types of molecules. Students are expected to develop critical thinking, problem-solving skills

Approximate Hours	
Item	AppX Hrs
Cl	09
LI	0
SW	2
SL	3
Total	13

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1.: Classify molecules based on their structural and symmetry characteristics. **SO2.2.:** Understand the principles of rotational spectroscopy for diatomic molecules. **SO2.3.:** Analyze the rotational spectra of diatomic molecules using the rigid rotor model. **SO2.4.:** Extend the understanding to non-rigid rotators and analyze deviations from the rigid rotor model. **SO2.5.:** Understand the factors influencing the intensity of rotational spectral lines. **SO2.6.:** Describe the rotational motion and spectral features of symmetric top, asymmetric top, and spherical top molecules. **SO2.7.:** Analyze real-world applications of rotational spectroscopy.	**Unit2: Molecular Spectra** **2.1.** Overview of Molecular Types **2.2.** Diatomic Linear Molecules **2.3.** Symmetric Top Molecules **2.4.** Rotational Spectra of Diatomic Molecules (Rigid Rotor Model) **2.5.** Asymmetric Top Molecules **2.6.** Energy Levels and Spectra of Non-Rigid Rotator **2.7.** Spherical Top Molecules **2.8.** Intensity of Rotational Lines **2.9.** Applications of Rotational Spectroscopy	**i.** Energy Levels **ii.** Spectra **iii.** Molecules

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Rotational Spectra of Diatomic Molecules (Rigid Rotor Model)

ii. Spherical Top Molecules

b. Other Activities (Specify):

Seminar and group discussion related to subject

PH204.3: Oscillator: Students have a comprehensive understanding of the theoretical principles, mathematical models, and practical applications of molecular vibrations and spectroscopy in diatomic molecules.

Approximate Hours	
Item	AppX Hrs
Cl	09
LI	0
SW	2
SL	3
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self -Learning (SL)
SO3.1.: Understand the principles of molecular vibrations and their significance. **SO3.2.:** Analyze the diatomic molecule as a simple harmonic oscillator and extend it to vibrational energy levels. **SO3.3.:**Describe the characteristics of vibrational spectra in diatomic molecules, considering both simple harmonic oscillators and Morse potential models. **SO3.4.:**Understand the combined vibrational and rotational motion in molecules. **SO3.5.:** Explain the PQR branches in the infrared spectrum and understand qualitative aspects of IR spectrometry.	**Unit3: Oscillator** **1.1.** Overview of Molecular Vibrations **1.2.** Diatomic Molecule as a Simple Harmonic Oscillator **1.3.** Energy Levels of Vibrating Diatomic Molecules **1.4.** Vibrational Spectrum of Diatomic Molecules **1.5.** Morse Potential Energy Curve **1.6.** Vibrational Energy Levels and Spectrum with Morse Potential **1.7.** Molecules as Vibrating Rotators **1.8.** PQR Branches in the Infrared Spectrum **1.9.** Qualitative Aspects of IR Spectrometry	**i.** Vibrations **ii.** Spectrum **iii.** Potentia

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. IR Spectrometry

ii. Molecules as Vibrating Rotators

b. Other Activities (Specify):

Seminar and group discussion related to subject

PH204.4. Spectroscopy: To provide students with a comprehensive understanding of various spectroscopic techniques and experimental methods, preparing them for applications in research, industry, and analytical chemistry.

Approximate Hours	
Item	AppX Hrs
Cl	13
LI	0
SW	2
SL	3
Total	18

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO4.1: Understand the principles and applications of various spectroscopic techniques. **SO4.2:** Analyze electronic, vibrational, and rotational transitions in UV-Vis, IR, and Raman spectra. **SO4.3:** Describe the techniques and instrumentation used in UV-Vis, IR, and Raman spectroscopy. **SO4.4:** Understand advanced Raman techniques, including stimulated Raman spectroscopy. **SO4.5:** Explain the principles and applications of experimental techniques such as photoelectron spectroscopy, photoacoustic spectroscopy, Mossbauer spectroscopy, and NMR spectroscopy. **SO4.6:** Analyze real-world applications of various spectroscopic techniques.	**UNIT.4: Spectroscopy** **4.1.**Overview of Spectroscopy **4.2.**UV-Visible Spectroscopy **4.3.**Infrared (IR) Spectroscopy **4.4.**Introduction to Raman Spectroscopy **4.5.**Pure Rotational and Vibrational Spectra in Raman **4.6.**Techniques and Instrumentation in UV-Vis and IR Spectroscopy **4.7.**Raman Spectroscopy Techniques **4.8.**Stimulated Raman Spectroscopy **4.9.**Experimental Techniques: Photoelectron Spectroscopy **4.10.** Introduction to Photoacoustic Spectroscopy **4.11.** Introduction to Mossbauer Spectroscopy **4.12.** Introduction to NMR Spectroscopy **4.13.** Applications of Various Spectroscopic Techniques.	**i.** Raman Effect **ii.** Rotational Spectra **iii.** Photoelectron

SW-

Suggested Sessional Work (SW):

a) Assignments:

i. To Study of NMR Spectroscopy
ii. To Study Mossbauer Spectroscopy

c. Other Activities (Specify):

Seminar and group discussion related to subject

PH204.5. Laser: Course aims to provide students with a comprehensive understanding of laser physics and its applications, preparing them for advanced studies in optics, photonics, and laser technology.

Approximated Hours	
Item	AppX Hrs
Cl	15
LI	0
SW	2
SL	3
Total	20

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1: Understand the fundamental principles of laser physics, including stimulated emission and population inversion. **SO5.2:** Describe the characteristics of laser light and the conditions for laser amplification. **SO5.3:** Analyze line broadening mechanisms, spectral narrowing, and gain clamping in lasers. **SO5.4:** Understand spatial and spectral hole burning and their consequences. **SO5.5:** Describe the principles and applications of various types of lasers, including gas lasers, solid-state lasers, and dye lasers. **SO5.6:** Analyze real-world applications of laser technology in different scientific and industrial domains.	**UNIT.5: Laser** **5.1.** Introduction to Stimulated Emission **5.2.** Population Inversion **5.3.** Laser Amplification **5.4.** Oscillation Condition for Lasers **5.5.** Characteristics of Laser Light **5.6.** Line Broadening Mechanism **5.7.** Spectral Narrowing in a Laser **5.8.** Gain Clamping **5.9.** Spatial and Spectral Hole Burning **5.10.** Power in Laser Oscillator **5.11.** Optimum Coupling **5.12.** Atomic and Molecular Gas Lasers **5.13.** Solid State Lasers **5.14.** Dye Lasers **5.15.** Applications of Lasers	i. Absorption ii. Emission iii. Coupling

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Dye Lasers
ii. Applications of Lasers

b. Other Activities (Specify):

Seminar and group discussion related to subject

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH204.1: Atomic Spectra: To provide students with a comprehensive understanding of atomic spectra and quantum mechanics, preparing them for advanced studies and applications in the field. Students should be able to apply theoretical concepts to interpret experimental data.	14	2	3	19
PH204.2: Molecular Spectra: To equip students with a strong foundation in molecular spectroscopy, enabling them to understand and analyze rotational spectra for different types of molecules. Students are expected to develop critical thinking, problem-solving skills.	09	2	3	14
PH204.3: Oscillator: Students have a comprehensive understanding of the theoretical principles, mathematical models, and practical applications of molecular vibrations and spectroscopy in diatomic molecules.	09	2	3	14
PH204.4. Spectroscopy: To provide students with a comprehensive understanding of various spectroscopic techniques and experimental methods, preparing them for applications in research, industry, and analytical chemistry.	13	2	3	18
PH204.5. Laser: Course aims to provide students with a comprehensive understanding of laser physics and its applications, preparing them for advanced studies in optics, photonics, and laser technology.	15	2	3	20
Total Hours	**60**	**10**	**15**	**85**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Atomic Spectra	03	01	01	05
CO-2	Molecular Spectra	02	06	02	10
CO-3	Oscillator	03	07	05	15
CO-4	Spectroscopy	2	10	05	17
CO-5	Laser	03	02	3	08
Total		11	26	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Introduction to Atomic Spectra	H.E. White	MCGRAWHILL EXCLUSIVE (CBS)	(1 January 2019)
2	Fundamentals of molecular spectroscopy	C.B. Banwell	VISIONIAS	(1 January 2022)
3	Spectroscopy vol.I, II & III	Walker and Stanghen	Cambridge Univ. Press.)	
4	Introduction to molecular spectroscopy	G.M. Barrow	(John Wiley and Sons)	
4	Spectra of diatomic molecules	Herzberg.	Krieger Publishing Company;	2ndedition(1 December 1950)
5	Molecular spectroscopy	Jeanne L. Mc Hale	CRC Press;	2nd edition (16 May 2017)
6	Molecular spectroscopy	J.M.Brown	Oxford University Press	
7	Spectra of atoms and molecules	P.F.Bemath.	OUP USA;	4th edition (29 June 2020)
8	Modern spectroscopy	J.M. Halian	Wiley–Blackwell;	3rd edition (14 June 1996)
9	Lasers and Non-Linear Optics	B.B. Laud.	(Wiley Eastern Ltd.)	1991
10	Lasers principles and Applications (Lied) –	Wilson & Hawkes	Prentice Hall	1987
11	Laser Fundamentals	William T. Silfvast	Cambridge Univ. Press.	

Curriculum Development Team

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2. Dr C. P. Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
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Cos,POs and PSOs Mapping

Course Title: M.Sc. Physics

Course Code: PH204

Course Title: Atomic, Molecular and Laser Physics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH204.1: Atomic Spectra: To provide students with a comprehensive understanding of atomic spectra and quantum mechanics, preparing them for advanced studies and applications in the field. Students should be able to apply theoretical concepts to interpret experimental data**.**	1	1	1	1	1	2	2	3	2	2	3	3	2	3	3	2	1
PH204.2: Molecular Spectra: To equip students with a strong foundation in molecular spectroscopy, enabling them to understand and analyze rotational spectra for different types of molecules. Students are expected to develop critical thinking, problem-solving skills.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	2	1
PH204.3: Oscillator: Students have a comprehensive understanding of the theoretical principles, mathematical models, and practical applications of molecular vibrations and spectroscopy in diatomic molecules.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
PH204.4. Spectroscopy: To provide students with a comprehensive understanding of various spectroscopic techniques and experimental methods, preparing them for applications in research, industry, and analytical chemistry.	2	1	2	2	2	1	2	2	3	2	1	2	3	2	2	2	2

PH204.5. Laser: Course aims to provide students with a comprehensive understanding of laser physics and its applications, preparing them for advanced studies in optics, photonics, and laser technology**.**	**2**	**2**	**2**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**	**3**

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	**COs No. & Titles**	**SOs No.**	**Classroom Instruction(CI)**	**Self - Learning(SL)**
PO: 1,2,3,4,5,6 7,8,9,10,11,12 PSO: 1,2, 3, 4, 5	**PH204.1:** Atomic Spectra: To provide students with a comprehensive understanding of atomic spectra and quantum mechanics, preparing them for advanced studies and applications in the field. Students should be able to apply theoretical concepts to interpret experimental data.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	Unit-1. Atomic Spectra 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8.1.9,1.10,1.11,1.12,1.13,1.14	i,ii,iii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH204.2:** Molecular Spectra: To equip students with a strong foundation in molecular spectroscopy, enabling them to understand and analyze rotational spectra for different types of molecules. Students are expected to develop critical thinking, problem-solving skills.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7	Unit-2 Molecular Spectra: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9	i,ii,iii
PO:1,2,3,4,5,6 7,8,9,10,11,12 PSO: 1,2, 3, 4, 5	**PH204.3:** Oscillator: Students have a comprehensive understanding of the theoretical principles, mathematical models, and practical applications of molecular vibrations and spectroscopy in diatomic molecules.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	Unit-3 : Oscillator: 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,	i,ii,iii

PO: 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH204.4.** Spectroscopy: To provide students with a comprehensive understanding of various spectroscopic techniques and experimental methods, preparing them for applications in research, industry, and analytical chemistry.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	Unit-4 : Spectroscopy: 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11,4.12,4.13	i,ii,iii
PO: 1,2,3,4,5,6 7,8,9,10,11,12 PSO: 1,2, 3, 4, 5	**PH204.5.** Laser: Course aims to provide students with a comprehensive understanding of laser physics and its applications, preparing them for advanced studies in optics, photonics, and laser technology.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.5	Unit 5: Laser: 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12,5.13,5.14, 5.15	i,ii,iii

Semester-II

Course Code: PH251

Course Title : **General Physics Lab-II**

Pre- requisite: Student should have basic knowledge of practical instruments in graduation.

Rationale: The students studying Physics should possess foundational understanding about historical background of graduation.

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

CO251.1. learn various Physics aspects by performing the experiments related to thermodynamics, dielectric and magnetic properties.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH251	**General Physics Lab-II**	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Lab work Assignment 5 number 7 marks each (LA)	Viva-Voice on Lab work 10 marks each (VV)	Lab Attendance (LA)	Total Marks (LA+VV+LA)		
PCC	PH251	**General Physics Lab-II**	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

CO251.1. learn various Physics aspects by performing the experiments related to thermodynamics, dielectric and magnetic properties.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	90
SW	15
SL	15
Total	120

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Self Learning (SL)**
SO1.1 Learn about thermodynamics and laws of thermodynamics. **SO1.2** Understand magnetic properties by using experiment **SO1.3** Study and determine the dielectric properties. **SO1.4** Determination of e/m of electron. **SO1.5** Learn about Error analysis.	**1.**To study of Hysteris loss and determine the B-H Curve. **2.**Determine Stefan constant. **3.**Verification of Newton's cooling law. **4.**Measurement of Band positions and determination of vibrational constants of N2 molecule **5.**To study dielectric properties of a liquid. **6.**To study dielectric properties of a Solid. 7.To study magnetic susceptibility.	1. Learn about basic instruments lick-vernier calipers, screw gage

	8. To study the ferroelectric transition in TGS crystal and measurement of Curie temperature. **9.** To determine magnetoresistance of a Bismuth crystal as a function of magnetic field. **10.** Determination of e/m of electron by normal Zeeman effect using Febry Perot Etalon.	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Ancient Binder Used for Constructions, Invention and properties of Portland, Cement strength development mechanism of Portland cement. Types of Cement produced in India.

b. Other Activities (Specify):

Note on Status of Indian cement industry in world and Major cement producing companies of India

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
CO251.1. learn various Physics aspects by performing the experiments related to thermodynamics, dielectric and magnetic properties.	**90**	15	15	120
Total Hours	**90**	**15**	**15**	**120**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	General Physics Lab-II	13	24	13	50
Total		13	24	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Experimental Physics	**Worsnop and Flint**	Little hampton Book Services Ltd, United Kingdom	9th Edition, 1951
2	Experiments in Modern Physics	**A. C. Melissinos, J. Napolitano**	Academic Press, Cambridge, Massachusetts	2nd Edition, 2003
5	Lab manuals provided by Department of Physics, AKS University, Satna (M. P.)			

Curriculum Development Team

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3. Dr Lovely Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
4. Mr. Saket Kumar , Assistant Professor , Department of Physics, AKS University Satna (M.P.)
5. Mr. Manish Agrawal, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
6. Miss Swati Kushwaha, Lab Faculty , Department of Physics, AKS University Satna (M.P.)

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH251

Course Title: General Physics Lab-II

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	**Problem analysis**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Modern tool usage**	**The engineer and society**	**Environment and sustainability:**	**Ethics**	**Individual and team work:**	**Communication:**	**Project management and finance:**	**Life-long learning**	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	**Apply knowledge of Physics in a different stream of science and to communicate effectively.**	**Ability to use the techniques, skills, and modern physical tools in real world application.**	**Engage in life-long learning and will have recognition.**
CO251.1. learn various Physics aspects by performing the experiments related to thermodynamics, dielectric and magnetic properties.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction(LI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO105.1. learn various Physics aspects by performing the experiments related to light, wave optics, interference, diffraction and polarization.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	15

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Semester-II

Course Code: PH252

Course Title : Electronics Lab-II

Pre- requisite: To study this course, a student must have had the Experimental knowledge of Physics in Graduation.

Rationale: The students studying this course would have practical (Experimental) Knowledge of Diodes, Gates and Transistors.

Course Outcomes:

PH252.1: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.

Scheme of Studies:

Board of Study	CourseCode	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH252	Electronics Lab-II	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) And others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional work (including assignments, seminars, mini-projects, etc.).),
SL: Self Learning,
C: Credits.

Note: **SW and** SL must be planned and performed under the continuous guidance and feedback of theteacher to ensure the outcome of Learning.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Assessment:

Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (RA)				End Semester Assessment	Total Marks
			Lab work Assignment 5 number 7 marks each (LA)	Viva-Voice on Lab work 10 marks each (VV)	Lab Attendance (LA)	Total Marks (LA+VV+LA)	(ESA)	(PRA+ ESA)
PCC	PH252	Electronic Devices	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction, including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH252.1: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	90
SW	15
SL	15
Total	120

Session Outcomes (SOs)	LaboratoryInstruction (LI)	Self-Learning (SL)
SO1 Students will learn all about Basic electronic devices and their working. **SO2** Students will learn to verify truth table for basic logic	1. To determine the characteristics curve (Input, Output and Transfer) and current gain in CE mode of PNP. 2. To determine the characteristics curve (Input, Output and Transfer) and current	1. Identify all the electronic devices you use in your daily life.

gates. **SO3** Students will be able to Understand the characteristic curve of electronic devices. **SO4** Students will be able to understand the Circuit diagram of all mentioned electronic devices. **SO5** Students will learn to calculate error and analysis.	gain in CE mode of NPN transistor. 3. To determine the basic parameters of Full wave, Half wave and Bridge Rectifiers. 4. To determine voltage regulation for L & π section filters. 5. To study characteristics of Zener diode and its use in voltage Regulation. 6. Study of a Regulated Power Supply using transistor. 7. Measurement of Hybrid parameters of transistor. 8. Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap. 9. Determination of Hall coefficient of a given semiconductor and estimation of charge carrier concentration. 10. Estimation of band energy gap of a semiconductor.	2. Identify the use of these electronic devices in your daily life electronic devices.

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**

i. Write a note on Electronic devices and make a list of devices (Having diodes and transistors) we are using in our daily life.

b. **Mini Project:**

(i) Prepare a chart of Diode and its types.

(ii) Prepare a chart of Transistor and its Characteristics curve.

c. **Other Activities:**

Try to do simple experiments using diode.

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Brief of Hours suggested for the Course Outcome.

Course Outcomes:	Lab Instruction (LI)	Sessional Work (SW)	Self-Learning (SL)	Total hours(LI+SW+SL)=
CO252.1: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	90	15	15	120

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO	Electronic devices(General)	30	10	10	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end-of-semester assessment for Mechanics and General Properties of Matter will be held with a writtenexamination of 50 marks.

Note. Detailed assessment rubrics need to be prepared by the course-wise teachers for the above tasks. Teachers can also design different tasks as per requirements for the end-semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Science Museum
7. Demonstration
8. ICT-Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) **Books** :

S.No.	Books Name	Author	Publisher	Edition &Year
1.	Practical Physics	S.L. GUPTA, V. KUMAR	Pragati Prakashan	2018
2.	Semi Conductor Devices- Physics and Technology	SM Sze	Wiley	1985
3.	Introduction to Semiconductor devices	M.S. Tyagi	John Wiley and Sons	1991
4.	Measurement, Instrumentation and Experimental Design in Physics and Engineering	M. Sayer and A. Mansingh	Prentice-hall of india private limited	2000
5.	Optical Electronics	Ajoy Ghatak and K. Thygarajan	Cambridge Univ. Press.	1989
6.	Lab Manuals provided by Dept. of Physics, AKS University, Satna.			

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH252

Course Title: Electronics Lab-II

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	**Problem analysis**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Modern tool usage**	**The engineer and society**	**Environment and sustainability:**	**Ethics**	**Individual and team work:**	**Communication:**	**Project management and finance:**	**Life-long learning**	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	**Apply knowledge of Physics in a different stream of science and to communicate effectively.**	**Ability to use the techniques, skills, and modern physical tools in real world application.**	**Engage in life-long learning and will have recognition.**
PH252.1The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.,	COs No.& Titles,	SOs No.	Laboratory Instruction(LI)	Classroom Instruction(CI),	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	PH252.1The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	SO1 SO2 SO3 SO4 SO5		Electronic Devices 1,2,3,4,5,6,7,8,9,10	1,2

Semester-III

Course Code:	**PH301**
Course Title :	**Electrodynamics and Plasma Physics**
Pre- requisite:	To understand of electrodynamics and plasma physics, a solid background in certain fundamental areas of physics and mathematics is essential. Here are the typical prerequisites for studying electrodynamics and plasma physics
Rationale:	The rationale for electrodynamics and plasma physics lies in their fundamental importance for understanding natural phenomena, technological applications, and potential future energy sources. Both fields contribute significantly to our knowledge of the physical universe and have practical implications in various scientific and engineering domains.

Course Outcomes:

PH301.1: Understanding Fundamental Electrostatic Concepts: Students will review and deepen their understanding of fundamental electrostatic concepts, including electric fields, Gauss's law, Laplace's and Poisson's equations, and methods of images.

PH301.2: Maxwell's Equations: Familiarity with Maxwell's equations, both in integral and differential forms, and the ability to apply them to solve problems in electrostatics and magnetostatics.

PH301.3: Relativistic Electrodynamics: Exploring the extension of classical electrodynamics to the relativistic regime, including the invariance of electric charge and the transformation properties of electric and magnetic fields under Lorentz transformations.

PH301.4: Covariance of Electrodynamics: Understanding the covariance of electrodynamics and deriving the Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field.

PH301.5: Magnetohydrodynamic Equations: Understanding the fundamental magnetohydrodynamic equations and their applications in describing plasma behavior.

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Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH301	Electrodynamics and Plasma Physics	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	PH301	Electrodynamics and Plasma Physics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH301.1: Understanding Fundamental Electrostatic Concepts: Students will review and deepen their understanding of fundamental electrostatic concepts, including electric fields, Gauss's law, Laplace's and Poisson's equations, and methods of images.

Approximate Hours	
Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	3
Total	17

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO1.1. Understanding the basics of electrostatics and magnetostatics. **SO1.2.**Familiarity with electric fields, Gauss's law, Laplace's and Poisson's equations, and the method of images. **SO1.3.**Knowledge of Biot-Savart's law and Ampere's law. **SO1.4** Understanding Maxwell's equations and their application in electrostatic and magnetostatic scenarios. **SO1.5.**Understanding scalar and vector potentials and their relationship to the electric and magnetic fields. **SO1.6.**Understanding the concept of gauge transformation and familiarity with the Coulomb gauge and Lorentz gauge. **SO1.7.**Ability to solve Maxwell's equations in conducting media.	**Unit 1: Electrostatics and Magnetostatics** **1.1.** Review of basics of electrostatics: electric field. **1.2.** Gauss's law. **1.3.** Laplace's and Poisson's equations **1.4.** Method of images and its application in electrostatics **1.5.** Introduction to magnetostatics: Biot-Savart law, **1.6.** Ampere's law **1.7.** Calculation of magnetic fields using Ampere's law **1.8.** Maxwell's equations: overview and significance **1.9.** Scalar and vector potentials in electromagnetism **1.10.** Gauge transformation **1.11.** Different gauge choices (Lorentz gauge, Coulomb gauge) **1.12.** Solution of Maxwell's equations in conducting media	i.Electric field ii.Electromagnetism ii.Conducting media

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Laplace's and Poisson's equations

ii. Different gauge choices (Lorentz gauge, Coulomb gauge)

(b) Other Activities (Specify):Seminar and group discussion related to subject

PH301.2: Maxwell's Equations: Familiarity with Maxwell's equations, both in integral and differential forms, and the ability to apply them to solve problems in electrostatics and magnetostatics.

Approximate Hours	
Item	AppX Hrs
Cl	13
LI	0
SW	2
SL	0
Total	15

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Understanding the radiation emitted by moving charges. **SO2.2.** Familiarity with retarded potentials and Lienard-Wiechert potentials. **SO2.3.** Understanding the electric and magnetic fields of charged particles in uniform motion, arbitrarily moving charged particles, and accelerated charged particles at low and high velocities. **SO2.4.** Understanding the angular distributions of power radiated and concepts such as Bremsstrahlung. **SO2.5.** Familiarity with the reaction force of radiation and the Abrahm-Lorentz method of self-force. **SO2.6.** Awareness of the challenges associated with the Abrahm-Lorentz model. **SO2.7.** Understanding the line-breadth and level-shift of an oscillator.	**Unit 2: Electrodynamics** **2.1.** Radiations by moving charges: acceleration radiation **2.2.** Deceleration radiation **2.3.** Retarded potentials **2.4.** Lienard-Wiechert potentials **2.5.** Electric and magnetic fields of charged particles in uniform motion **2.6.** Electric and magnetic fields of charged particles in non-uniform motion **2.7.** Fields of arbitrarily moving charged particles **2.8.** Fields of an accelerated charged particle at low velocity **2.9.** Fields of an accelerated charged particle at high velocity **2.10.** Angular distributions of power radiated **2.11.** Bremsstrahlung and its characteristics **2.12.** Reaction force of radiation **2.13.** The Abrahm-Lorentz method of self-force	i. Potentials ii. Charged particle iii. Uniform motion

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. The Abrahm-Lorentz method of self-force

ii. Electric and magnetic fields of charged particles in uniform motion

(b) Other Activities (Specify): Seminar and group discussion related to related subject.

PH301.3: Relativistic Electrodynamics: Exploring the extension of classical electrodynamics to the relativistic regime, including the invariance of electric charge and the transformation properties of electric and magnetic fields under Lorentz transformations.

Approximate Hours	
Item	AppX Hrs
Cl	11
LI	0
SW	2
SL	3
Total	16

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Reviewing four-vectors and Lorentz transformations in 4-dimensional spaces. **SO3.2.** Understanding the invariance of electric charge and relativistic transformation properties of electric and magnetic fields. **SO3.3.** Exploring the extension of classical electrodynamics to the relativistic regime, including the invariance of electric charge and the transformation properties of electric and magnetic fields under Lorentz transformations. **SO4.4.** Applying four-vectors and Lorentz transformations to describe Maxwell's equations in four-dimensional spacetime. **SO4.5.** Familiarity with the electromagnetic field tensor in 4-dimensional Maxwell equations. **SO4.6.** Understanding 4-vector current and potential and their invariance under Lorentz transformations.	**Unit 3: Maxwell's Equations** 3.1 Maxwell's Equations 3.2 Review of four-vector 3.3 Lorentz transformations in 4-dimensional spaces 3.4 Invariance of electric charge 3.5 Relativistic transformation properties of E fields 3.6 Relativistic transformation properties of H fields 3.7 Electromagnetic field tensor in 4-dimensional Maxwell equations 3.8 Four-vector current 3.9 Potential under Lorentz transformations 3.10 Invariance under Lorentz transformations 3.11 Applications of Maxwell's equations in different reference frames	**i.** Electric charge **ii.** Space time **iii.** Lorentz equation

SW-3 Suggested Sessional Work (SW):

b. Assignments:

i. Potential under Lorentz transformations

ii. Lorentz transformations in 4-dimensional spaces

c. **Other Activities (Specify):** Seminar and group discussion related to related subject

PH301.4: Covariance of Electrodynamics: Understanding the covariance of electrodynamics and deriving the Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field.

Approximate Hours	
Item	AppX Hrs
Cl	11
LI	0
SW	2
SL	3
Total	16

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO4.1. Understanding the covariance of electrodynamics and the Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field. **SO4.2.** Understanding the motion of charged particles in electromagnetic fields, including uniform and non-uniform E and B fields. **SO4.3.** Understanding the covariance of electrodynamics and deriving the Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field. **SO4.4.** Familiarity with particle drifts in non-uniform fields and static magnetic fields. **SO4.5.** Understanding adiabatic invariants and their relevance in electromagnetic fields. **SO4.6.** Analyzing the motion of charged particles in uniform and non-uniform electric and magnetic fields, including particle drifts and the concept of adiabatic invariants.	**Unit 4: Electromagnetic Fields** **4.1.** Covariance of electrodynamics: **4.2.** Lagrangian for a relativistic charged particle in an external EM field **4.3.** Hamiltonian for a relativistic charged particle in an external EM field **4.4.** Motion of charged particles in electromagnetic fields: **4.5.** Uniform E and B fields **4.6.** Non-uniform E and B fields **4.7.** Particle drifts in non-uniform fields **4.8.** Particle drifts in non-uniform implications **4.9.** Static magnetic fields and their properties **4.10.** Introduction to adiabatic invariants in electromagnetic fields **4.11.** Calculation and analysis of adiabatic invariants	**i.** Relativistic charge **ii.** Electromagnetic Charge **iii.** Invariance

SW-4 Suggested Sessional Work (SW):

a) Assignments:

(i) Lagrangian for a relativistic charged particle in an external EM field

(ii) Static magnetic fields and their properties

Other Activities (Specify):

Seminar and group discussion related to subject

PH301.5: Magnetohydrodynamic Equations: Understanding the fundamental magnetohydrodynamic equations and their applications in describing plasma behavior.

Approximate Hours	
Item	AppX Hrs
Cl	13
LI	0
SW	2
SL	3
Total	18

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1. Understanding magnetohydrodynamic (MHD) equations and their application in plasma physics. **SO5.2.** Familiarity with magnetic diffusion, viscosity, and pressure in plasma. **SO5.3.** Understanding MHD flow between boundaries with crossed electric and magnetic fields. **SO5.4.** Knowledge of the pinch effect and instability in a pinched plasma column. **SO5.5.** Understanding magnetohydrodynamic waves, including magneto-sonic and Alfvén waves. **SO6.6.** Familiarity with plasma oscillations, short wavelength limits for plasma oscillations, and Debye screening distance	**Unit 5: Plasma Physics** **5.1.** Introduction to magnetohydrodynamic (MHD) equations **5.2.** Magnetic diffusion, **5.3.** viscosity, and pressure in plasma **5.4.** Magnetohydrodynamic flow between boundaries with crossed electric fields **5.5.** Magnetohydrodynamic flow between boundaries with crossed fields **5.6.** Pinch effect **5.7.** Instability in a pinched plasma column **5.8.** Magnetohydrodynamic waves **5.9.** magnetoacoustic **5.10.** Alfvén waves **5.11.** Plasma oscillations and their characteristics **5.12.** Short-wavelength limit for plasma oscillations **5.13.** Debye screening distance	**i.** State of matter **ii.** Diffusion **iii.** Wave and oscillation

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Magnetohydrodynamic flow between boundaries with crossed electric fields
ii. Alfvén waves.

b. **Other Activities (Specify):** Seminar and group discussion related to subject

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW +Sl)
PH301.1: Understanding Fundamental Electrostatic Concepts: Students will review and deepen their understanding of fundamental electrostatic concepts, including electric fields, Gauss's law, Laplace's and Poisson's equations, and methods of images.	**12**	**2**	**3**	**17**
PH301.2:Maxwell's Equations: Familiarity with Maxwell's equations, both in integral and differential forms, and the ability to apply them to solve problems in electrostatics and magnetostatics.	**13**	**2**	**3**	**18**
PH301.3:Relativistic Electrodynamics: Exploring the extension of classical electrodynamics to the relativistic regime, including the invariance of electric charge and the transformation properties of electric and magnetic fields under Lorentz transformations.	**11**	**2**	**3**	**16**
PH301.4:Covariance of Electrodynamics: Understanding the covariance of electrodynamics and deriving the Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field.	**11**	**2**	**3**	**16**
PH301.5:Magnetohydrodyn Equations: Understanding the fundamental magnetohydrodynamic equations and their applications in describing plasma behavior.	**13**	**2**	**3**	**18**
Total Hours	**60**	**10**	**15**	**85**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Electrostatics and Magnetostatics	03	03	03	09
CO-2	Electrodynamics	04	06	02	12
CO-3	Maxwell's Equations	05	08	05	18
CO-4	Electromagnetic Fields	4	08	05	17
CO-5	Plasma Physics	06	04	06	16
Total		22	29	21	72

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Classical Electronics :	John David Jackson	Wiley	3rd Edition,2022
2	Measurement, Instrumentation and Experiment Design in Physics and Engineering	M. Sayer and A. Man Singh	Prentice-hall of india private limited, New Delhi.	2000
3	Fundamentals of plasma physics	J.A. Bittencourt	Springer	3rd ed.2004
4	Classical Electricity and Magnetism	K. H., Phillips	Dover Publications;	Second edition (12 July 2012)

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Cos, POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code : PH301

Course Title: Electrodynamics and Plasma Physics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH301.1: Understanding Fundamental Electrostatic Concepts: Students will review and deepen their understanding of fundamental electrostatic concepts, including electric fields, Gauss's law, Laplace's and Poisson's equations, and methods of images	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1
PH301.2: Maxwell's Equations: Familiarity with Maxwell's equations, both in integral and differential forms, and the ability to apply them to solve problems in electrostatics and magnetostatics	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	2	1
PH301.3: Relativistic Electrodynamics: Exploring the extension of classical electrodynamics to the relativistic regime, including the invariance of electric charge and the transformation properties of electric and magnetic fields under Lorentz transformations	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
PH301.4: Covariance of Electrodynamics: Understanding the covariance of electrodynamics and deriving the Lagrangian and Hamiltonian for a relativistic charged particle in an external	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2

electromagnetic field.																	
MPHY101.5: Magnetohydrodyn Equations: Understanding the fundamental magnetohydrodynamic equations and their applications in describing plasma behavior**.**	**-**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**	**3**

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	**COs No.& Titles**	**SOs No.**	**Classroom Instruction(CI)**	**Self- Learning (SL)**
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH301.1:**Understanding Fundamental Electrostatic Concepts: Students will review and deepen their understanding of fundamental electrostatic concepts, including electric fields, Gauss's law, Laplace's and Poisson's equations, and methods of images	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6	**Unit-1. Electrostatics** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.12	i,ii,iii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH301.2:Maxwell's Equations:** Familiarity with Maxwell's equations, both in integral and differential forms, and the ability to apply them to solve problems in electrostatics and magnetostatics	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7	**Unit-2 Electrodynamics** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10,2.11,2.12,2.13	i,ii,iii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH301.3:Relativistic Electrodynamics:** Exploring the extension of classical electrodynamics to the relativistic regime, including the invariance of electric charge and the transformation properties of electric and magnetic fields under Lorentz transformations	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**Unit-3 : Maxwell equations** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11	i,ii,iii

PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH301.4:Covariance of Electrodynamics:** Understanding the covariance of electrodynamics and deriving the Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6	**Unit-4 : Electromagnetic Fields** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11	i,ii,iii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**MPHY101.5:**Magnetohydrodyn Equations: Understanding the fundamental magnetohydrodynamic equations and their applications in describing plasma behavior**.**	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**Unit 5: Plasma Physics** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12,5.13	i,ii,iii

Semester-III

Course Code: PH302

Course Title : Quantum Mechanics-II

Pre- requisite: A thorough understanding of mechanics. Knowledge of partial differential equation and variable separable method. Commendable knowledge of integral and differential calculus.

Rationale: This course gives an insight of applying different approximation methods for stationary states and deals with alternative pictures of time evolution and relativistic quantum mechanics. It also helps the students to acquire basic knowledge of quantum field theory.

Course Outcomes:

PH302.1: Students will be able to apply different approximation methods for stationary states. Make extensive use of Schrodinger representation to learn about the newer concepts of quantization of energy.

PH302.2: To solve time independent perturbed systems using various methods. Use of different approximation methods to perturbed systems. To describe the time evolution of quantum systems and discuss matter radiation interaction.

PH302.3: To provide a formulation for quantum mechanical description of scattering phenomena and their applications.

PH302.4: To describe the relativistic quantum phenomena and account for electron spin.

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PH302.5: To understand and appreciate the commutative and non-commutative algebra in the special context of angular momentum in general. To understand the extensive use of abstract operator algebra to learn about angular momentum and its importance.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August, 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Quantum Mechanics-II	PH302	Quantum Mechanics-II	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	PH302	Quantum Mechanics-II	15	20	5	5	5	50	50	100

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Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH302.1: Students will be able to apply different approximation methods for stationary states. Make extensive use of Schrodinger representation to learn about the newer concepts of quantization of energy.

Approximate Hours

Item	Approx. Hrs
Cl	11
LI	0
SW	02
SL	01
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Develop an awareness of the broad applications of quantum mechanics. **SO1.2** Understand the structure of normal Helium atom and the principles that govern it. **SO1.3** Understand the Stark effect in hydrogen and its significance of WKB approximation method in quantum mechanics. **SO1.4** Understand the concept of variation method and connection formula. **SO1.5** Integrate the concepts to analyze potential barriers and apply them to the theory of alpha decay.	**Unit-1.0 Approximation Methods** 1.1 Introduction about Quantum Mechanics 1.2 Approximation method for bound states 1.3 Rayleigh-Schrodinger perturbation theory for non-degenerate and degenerate states 1.4 Application to perturbation of an oscillator 1.5 Normal Helium atom 1.6 Application to ground state of helium 1.7 First order Stark effect in Hydrogen 1.8 WKB Approximation methods 1.9 Variation Method 1.10 Connection formula 1.11 Ideas on potential barrier with applications to the theory of alpha-decay	Exploring different approximation methods based on quantum mechanics. Understanding the concepts of quantum mechanics and various theories associated with it.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Rayleigh-Schrodinger perturbation theory.
2. WKB approximation methods

PH302.2: To solve time independent perturbed systems using various methods. Use of different approximation methods to perturbed systems. To describe the time evolution of quantum systems and discuss matter radiation interaction.

Approximate Hours

Item	AppX Hrs
Cl	08
LI	0
SW	2
SL	2
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)

SO2.1 To understand how perturbation theory is extended to include time-dependent systems. **SO2.2** Understand the methods of variation of constants in the context to perturbation theory. Explore the application of perturbation theory with harmonic perturbations. **SO2.3** Learn the adiabatic approximation. Understand the Hamiltonian formulation for a charged particle in an external electromagnetic field. Analyze how an external electromagnetic field influences the behavior of a charged particle. **SO2.4** Understand the concepts of absorption and induced emission in the context of quantum transitions. Analyzing their contribution to the emission spectra of physical systems. **SO2.5** Explore the transition probability for electric dipole transitions and understand the physical significance of transition probabilities in electric dipole transitions. Physical interpretation of A and B coefficients in the context of absorption and emission processes.	Unit-2 Perturbation Theory 2.1 Time dependent Perturbation Theory 2.2 Methods of variation of constant and harmonic perturbation 2.3 Transition probability 2.4 Adiabatic and sudden approximation 2.5 Hamiltonian for a charged particle under the influence of external electromagnetic field 2.6 Absorption and induced emission. 2.7 Transition probability in electric dipole transition Physical 2.8 Einstein's A and B coefficients	A comprehensive understanding of absorption and emission mechanisms. Einstein's A & B coefficients

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1. Hamiltonian for a charged particle under the influence of electromagnetic field.
2. Relation between Einstein's A & B coefficients.

PH302.3: To provide a formulation for quantum mechanical description of scattering phenomena and their applications.

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 The theory of scattering and its interaction with (electrons and neutrons). **SO3.2** Understanding the probability of scattering events. **SO3.3** The theory of scattering by spherically symmetric potentials. **SO3.4** Concept of Born Approximation Method.	**Unit-3** : Scattering 3.1 Theory of Scattering 3.2 Scattering cross-section 3.3 Born Approximation and partial waves 3.4 Scattering by spherically symmetric potential 3.5 Identical particles with spin 3.6 Physical concepts and scattering amplitude 3.7 Symmetric and anti-symmetric wave functions 3.8 Pauli exclusion Principle 3.9 Pauli spin matrices	Understanding the quantum mechanical aspects of scattering.
SO3.5 Understanding Pauli exclusion Principle and Pauli spin matrices.		

SW-3 Suggested Sessional Work (SW):

a. Assignments:
1. Pauli exclusion Principle.
2. Born Approximation method.
3.

PH302.4: To describe the relativistic quantum phenomena and account for electron spin.
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Approximate Hours

Item	AppX Hrs
Cl	07
LI	0
SW	3
SL	2
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Downfall of Klein-Gordon equation **SO4.2** Exploring the framework of relativistic quantum mechanics. **SO4.3** Interpretation of probability and current density. **SO4.4** To understand the Klein-Gordon equation in an electromagnetic field. **SO4.5** Mathematical formulation in support of Klein-Gordon equation.	**Unit-4 : Quantum Equation-I** 4.1 Short comings of Klein-Gordon Equation 4.2 Introduction to relativistic quantum mechanics 4.3 Probability and current density 4.4 Klein-Gordon equation in the presence of electromagnetic field	Comprehensive understanding of electromagnetic field. Relativistic quantum mechanics.

SW-4 Suggested Sessional Work (SW):

a. Assignments:
1. Simple derivation of Klein-Gordon equation.
2. Probability and current density
3. Short comings of Klein-Gordon Equation

PH302.5: To understand and appreciate the commutative and non-commutative algebra in the special context of angular momentum in general. To understand the extensive use of abstract operator algebra to learn about angular momentum and its importance.

Item	AppX Hrs
Cl	07
LI	0
SW	2
SL	2
Total	11

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 To describe the time evolution of operators corresponding to physical observables. **SO5.2** Understanding of Dirac's equation for a free electron. **SO5.3** Exploring the Zitterbewegung concept. **SO5.4** Dirac's relativistic equation in electromagnetic field. **SO5.5** Concept of hyperfine splitting refers to the energy difference between atomic energy levels that arise from the interaction between the magnetic moment associated with the electron's spin and the nuclear magnetic moment.	**Unit 5: Quantum Equation-II** 5.1 Hydrogen atom 5.2 Equation of motion for operators, position momentum and angular momentum, spin of an electron. 5.3 Dirac's relativistic equation for a free electron 5.4 Zitterbewegung Dirac's relativistic equation in electromagnetic field 5.5 Negative energy states and their interpretation 5.6 Hyperfine splitting 5.7 Dirac's matrices	Understanding of atomic energy levels Hydrogen atom and its energy level splitting

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**

1. Theory of positron associated with negative energy states of electrons.
2. Position momentum and spin momentum.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH302.1: Students will be able to apply different approximation methods for stationary states. Make extensive use of Schrodinger representation to learn about the newer concepts of quantization of energy.	11	2	1	14
PH302.2: To solve time independent perturbed systems using various methods. Use of different approximation methods to perturbed systems. To describe the time evolution of quantum systems and discuss matter radiation interaction.	8	2	2	12
PH302.3: To provide a formulation for quantum mechanical description of scattering phenomena and their applications.	9	2	1	12
PH302.4: To describe the relativistic quantum phenomena and account for electron spin.	7	3	2	12
PH302.5: To understand and appreciate the commutative and non-commutative algebra in the special context of angular momentum in general. To understand the extensive use of abstract operator algebra to learn about angular momentum and its importance.	9	2	2	13
Total Hours	**44**	**11**	**8**	**63**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Approximation Methods	04	04	02	10
CO-2	Perturbation Theory	04	05	02	11
CO-3	Scattering	02	03	04	09
CO-4	Quantum equation-I	05	04	02	11
CO-5	Quantum equation-II	03	04	02	09
Total		18	20	12	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Quantum Mechanics	L.I. Schiff	McGraw Hill Education	2017
2	Quantum Physics	S. Gasiorowicz	Wiley	2003
3	Quantum Mechanics	B. Craseman and J.L. Powel	Courier Dover Publications	2015
4	Quantum Mechanics	A.P. Messiah	Dover Publications Inc.	2014
5	A Text book of Quantum Mechanics	P.M. Mathews & K. Venkatesan	McGraw Hill Education	2017
6	Modern Quantum Mechanics	J.J. Sakurai & Jim Napolitano	Cambridge University Press	1985
7	Quantum Mechanics Concepts and Applications	Nouredine Zettili	Wiley	2017

Curriculum Development Team

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COs POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code : PH302

Course Title: Quantum Mechanics-II

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustain ability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
CO1: Students will be able to apply different approximation methods for stationary states. Make extensive use of Schrodinger representation to learn about the newer concepts of quantization of energy.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	2
CO2: To solve time independent perturbed systems using various methods. Use of different approximation methods to perturbed systems. To describe the time evolution of quantum systems and discuss matter radiation interaction.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	2
CO3: To provide a formulation for quantum mechanical description of scattering phenomena and their applications.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	3
CO4: To describe the relativistic quantum phenomena and account for electron spin.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
CO5: To understand and appreciate the commutative and non-commutative algebra in the special context of angular momentum in general. To understand the extensive use of abstract operator algebra to learn about angular momentum and its importance.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO1:** Students will be able to apply different approximation methods for stationary states. Make extensive use of Schrodinger representation to learn about the newer concepts of quantization of energy.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	Unit-1.0 Historical progression and advancements in binding materials for construction 1.1,1.2,1.3,1.4,1.5,1.6,1.7	As mentionedin page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO2:** To solve time independent perturbed systems using various methods. Use of different approximation methods to perturbed systems. To describe the time evolution of quantum systems and discuss matter radiation interaction.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	Unit-2 Raw Materials and Fuel used for cement manufacture 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO3:** To provide a formulation for quantum mechanical description of scattering phenomena and their applications.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	Unit-3 : Types of cement manufactured in India 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO4:** To describe the relativistic quantum phenomena and account for electron spin.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	Unit-4 : Concise Explanation of the Portland Cement Production Process: 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	
PO 1,2,3,4,5,6 PSO 1,2, 3, 4, 5	**CO5:** To understand and appreciate the commutative and non-commutative algebra in the special context of angular momentum in general. To understand the extensive use of abstract operator algebra to learn about angular momentum and its importance.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	Unit 5: The Cement Sector in India and Regulatory Obligations. 5.1,5.2,5.3,5.4,5.5	

Semester-III

Course Code:	PH303
Course Title:	Digital Electronics & Microprocessor
Pre- requisite:	The broad education necessary to understand the different applications of mathematics to understand physics.
Rationale:	Now a day's application of digital circuits and microprocessors are extensively used in measurement and control applications in the field of electrical engineering and electrical power systems. So, the digital electronics and microprocessor have been introduced as a subject in electrical engineering curriculum. This course covers digital circuits logic gates Flip-flop, microprocessor 8085 architecture, its instruction set, programming and applications. After completing this subject, the student can write and execute programs for microprocessor-based applications.

Course Outcomes:

PH303.01: After studying this course, the student will be able to Observe logic circuits, assemble logic circuits and test the logic circuit

PH303.02: Identify the applications of junction devices, amplifiers and logic circuits.

PH303.03: Learn and to apply concepts learnt in analog and digital electronics in real life.

PH303.04: Describe architecture and operation of microprocessor 8085 and develop assembly language programs using instruction set of 8085.

PH303.05: Learn and to apply concepts learnt about Microprocessor & Peripheral Device.

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Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH303	Digital Electronics & Microprocessor	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e., Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PCC	PH303	Digital Electronics & Microprocessor	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH303.01: After studying this course, the student will be able to Observe logic circuits, assemble logic circuits and test the logic circuit

Approximate Hours

Item	AppX Hrs
Cl	08
LI	0
SW	0
SL	2
Total	10

SESSION OUTCOMES (SOs)	**CLASS ROOM INSTRUCTION (CI)**	**SELF LEARING**
SO 1.1 Definition of Amplitude modulation	Module 1.1: Introduction on Generation of AM waves	
SO 1.2 Demodulation of AM waves	1.2 Prepare the modulating signal that carries the information you want to transmit. This signal could be an audio signal, data, or any other form of information that needs to be transmitted.	
SO 1.3 DSBSC modulation	1.3: Mathematical explanation about DSBSC modulation	
SO 1.4 Generation of DSBSC waves	1.4: Use a mixer or a modulator circuit to combine the carrier signal and the modulating signal. In DSBSC modulation, the carrier amplitude is modulated by the modulating signal.	
SO 1.5 Coherent detection of DSBSC waves	1.5: Block Diagram Representation: Draw a block diagram illustrating the coherent detection process. It generally involves the following blocks: **Signal Source**: The DSBSC modulated signal. Local Oscillator (LO): Generates a reference carrier signal identical to the carrier signal used in modulation. **Multiplier/Mixer:** Multiplies the incoming DSBSC signal with the local oscillator signal. **Low-pass Filter (LPF):** Filters out the high-frequency components, leaving the original baseband signal. **Reconstructed Signal Output:** The demodulated baseband signal.	If possible, perform a demonstration or use simulation software to illustrate the coherent detection process. Show how changes in the local oscillator frequency or phase affect the recovered signal.
SO 1.6 SSB modulation	1.6: **Carrier Signal:** SSB starts with a carrier signal, which is a pure radio frequency signal. **Baseband Signal:** The audio signal (voice, data, etc.) that needs to be transmitted is called the baseband signal. **Mixing:** The baseband signal is modulated with the carrier signal using a mixer or a modulator. In SSB, the carrier signal is suppressed, and only one of the sidebands is	

	transmitted. **Sideband Suppression:** SSB removes one of the sidebands (either the upper or lower sideband) along with the carrier signal. This is done to reduce bandwidth usage since both sidebands carry similar information. **There are two types of SSB modulation:** **Upper Sideband (USB):** In USB, the carrier and the lower sideband are suppressed, and only the upper sideband is transmitted. The frequency range of the transmitted signal is above the carrier frequency. **Lower Sideband (LSB):** In LSB, the carrier and the upper sideband are suppressed, and only the lower sideband is transmitted. The frequency range of the transmitted signal is below the carrier frequency.	
SO 1.7 Vestigial sideband modulation	1.7: **AM Basis:** Start with the concept of AM modulation (carrier wave, modulating signal, resultant modulated signal). **Bandwidth Efficiency Need:** Explain the problem of excessive bandwidth use in standard AM due to transmitting both sidebands. **VSB Solution:** Introduce VSB as a solution that retains necessary information but reduces bandwidth by transmitting a full sideband and a partial vestige of the other sideband. **Signal Visualization:** Use diagrams or visual aids to illustrate how VSB looks compared to full AM modulation (with both sidebands). Applications: Discuss where VSB is used (e.g., television broadcasting) due to its bandwidth efficiency.	Mention potential advancements or improvements in FDM technology and its relevance in modern communication systems.
SO 1.8 Frequency division multiplexing (FDM)	1.8: Introduction to FDM: Definition: FDM is a method of transmitting multiple signals simultaneously over a shared medium by allocating unique frequency bands to each signal. Basic Concept: It involves dividing the available frequency spectrum into smaller frequency bands and assigning each signal its own band for transmission. How FDM Works: Frequency Spectrum Division: Explain the concept of the frequency spectrum and how it represents the range of frequencies used in communication. Signal Allocation: Describe how different signals are assigned specific frequency bands within the spectrum. Bandwidth Allocation: Discuss the importance of allocating sufficient bandwidth to each signal to ensure proper transmission. Components of FDM: Multiplexer (MUX): Explain the role of the multiplexer in combining multiple signals into a single composite signal for transmission. Transmission Medium: Discuss the medium (e.g., cables, optical fibers, airwaves) used to transmit the composite signal carrying all the individual signals. Demultiplexer (DEMUX): Describe the demultiplexer's function in separating the composite signal back into individual signals at the receiving end. Advantages of FDM: Efficient Use of Bandwidth: Discuss how FDM efficiently uses the available frequency spectrum by allowing multiple signals to coexist without interference. Simultaneous Transmission: Highlight the ability of FDM to transmit multiple signals concurrently, enabling simultaneous communication. Applications of FDM: Telecommunications: Explain how FDM is used in telephony, broadcasting, and data communications to transmit multiple signals over a single medium. Networking: Discuss FDM's role in certain networking technologies that utilize multiple frequencies for data transmission.	

SW-1 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  Power Point Presentation

PH303.02: Identify the applications of junction devices, amplifiers and logic circuits.

Approximate Hours

Item	AppX Hrs
Cl	7
LI	0
SW	2
SL	4
Total	13

SESSION OUTCOMES (SOs)	**CLASS ROOM INSTRUCTION (CI)**	**SELF LEARING**
SO 2.1 Boolean laws and Theorem	2.1: These laws and theorems are used to simplify Boolean expressions, design logic circuits, and perform logical operations in various fields such as computer science, digital electronics, and telecommunications.	1: Explain about Introduction to Logic Gates: Start by introducing basic logic gates (AND, OR, NOT, XOR, NAND, NOR, etc.) and their symbols. Explain how these gates take binary inputs (0s and 1s) and produce binary outputs based on predefined logical operations.
SO 2.2 Simple combinational circuits	2.2 Combinational circuits in digital electronics are circuits where the output is solely dependent on the current inputs. There is no memory element or feedback in these circuits, meaning the output is determined by the current state of inputs only. Here are explanations and examples of some simple combinational circuits: AND Gate, OR Gate, NOT Gate, XOR Gate (Exclusive OR) & NAND Gate (NOT-AND).	2 Adders: Half Adder: Begin with a half adder, which adds two single binary digits and produces the sum and carry outputs. Explain its truth table and logic diagram. Full Adder: Progress to a full adder, which adds two binary numbers along
SO 2.3 Karnaugh map pairs Quads and octets. Karnaugh simplications. Don't care conditions.	2.3: When teaching Karnaugh maps in a classroom setting, here's an instructional breakdown: Introduction to Boolean Algebra: Start by introducing the basic concepts of Boolean algebra, which includes logic gates, Boolean operators (AND, OR, NOT), truth tables, and Boolean expressions. Explanation of Karnaugh Maps:	

	Explain the purpose of Karnaugh maps: simplifying Boolean expressions to their minimal forms. Describe the structure of a K-map: rows and columns representing different input combinations and cells representing the output for each combination. Show the importance of adjacency in K-maps for grouping terms. Constructing Karnaugh Maps: Begin with simple truth tables and guide students on how to create K-maps from these tables. Demonstrate how to fill in 0s and 1s in the K-map based on the truth table values. Grouping and Simplification: Teach students how to group adjacent 1s (grouping should always be powers of 2: 1, 2, 4, 8, etc.). Explain the rules for grouping cells: groups should be rectangular and can wrap around edges. Emphasize the importance of maximizing the size of groups for better simplification. Finding Simplified Expressions: Show the process of finding simplified expressions using the grouped terms. Introduce the process of reading the simplified expression from the grouped cells in the K-map. Examples and Practice: Provide various examples of Boolean expressions and guide the students through the steps of creating K-maps, grouping terms, and simplifying the expressions. Encourage students to practice creating K-maps and simplifying expressions on their own or in groups. Advanced Topics (if applicable): If the class progresses well, introduce more complex expressions, including cases with don't care conditions in the truth tables. Explore higher variable count K-maps.	with a carry input and generates a sum and carry output. Explain how multiple full adders can be cascaded to add multi-bit numbers. Adder/Subtractor Circuits: Show how adders can be modified to perform subtraction by using 2's complement or by using additional control inputs. Subtractor: Half Subtractor: Introduce a half subtractor, which subtracts two single binary digits and produces the difference and borrow outputs. Full Subtractor: Move on to a full subtractor, capable of subtracting three binary digits: minuend, subtrahend, and borrow input, producing the difference and borrow outputs.
SO 2.4 The ASCII code. Excess III code. Gray code	2.4: Students might learn how to convert between these codes, understand their properties, and potentially apply them in designing digital circuits, error correction mechanisms, or understanding character encoding in computing systems.	
SO 2.5 Binary addition, Subtraction, unsigned binary numbers	2.5: When teaching binary addition and subtraction in a classroom, here's a structured approach you can follow: **Binary Addition:** Explain the binary number system: Only 0s and 1s are used. Show examples of addition, starting with simple cases like adding two binary digits (0 + 0, 0 + 1, 1 + 0, 1 + 1). Progress to addition of larger binary numbers, making sure to explain carrying (when the sum is greater than 1) and its similarity to carrying in the decimal system. Have students practice addition using various binary numbers until	3: Engaging students with interactive exercises, visual aids, and real-life examples (like converting binary numbers to decimal and vice versa) can make learning binary addition and

	they're comfortable. **Binary Subtraction:** Introduce the concept of binary subtraction by showing examples of subtracting smaller binary numbers (like 2 - 1, 3 - 2, etc.). Explain borrowing in binary (similar to borrowing in decimal) and how it works with only 0s and 1s. Move on to larger binary numbers, emphasizing borrowing when necessary. Provide exercises for students to practice subtraction in binary until they grasp the concept.	subtraction more interesting and understandable for them.
SO 2.6 Sign magnitude numbers. 2's compliment representation. 2's compliment arithmetic	2.6: It's important to understand the representations and operations, practice with different numbers and scenarios, and learn how to identify and handle special cases like overflow or underflow during arithmetic operations.	
SO 2.7 Arithmetic building blocks, The adder and subtractor & Logic Gates.	2.7 Arithmetic building blocks in digital electronics often involve the use of adders, subtractors, and logic gates to perform mathematical operations and logical functions.	**Real-world Examples:** Discuss how these concepts are utilized in modern computer architecture and how arithmetic operations are performed at the hardware level.

SW-2 Suggested Sessional Work (SW):

- **Assignments**
  - Provide various examples of Boolean expressions and guide the students through the steps of creating K-maps, grouping terms, and simplifying the expressions.
  - Encourage students to practice creating K-maps and simplifying expressions on their own or in groups.
- **Other Activity**
  - Power Point Presentation
  - Conduct quizzes or exercises to test students' understanding of K-maps.
  - Review the key concepts and address any remaining questions or confusion.

PH303.03: Learn and to apply concepts learnt in analog and digital electronics in real life.

Approximate Hours

Item	AppX Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO 3.1 Multiplexers & Demultiplexer	3.1 Begin by explaining the theory behind multiplexers and demultiplexers, their functions, basic operations, truth tables, and applications.	
SO 3.2 Decoder & Encoder	3.2 In a classroom setting, these terms might also be used more broadly to explain teaching and learning strategies. Here's an analogy: **Encoder:** In a classroom context, an encoder could be likened to the teaching methods and resources used by educators to transmit information to students. These methods could include lectures, readings, discussions, or multimedia materials. They take raw information (the curriculum) and encode it into a format that is more easily absorbed or understood by students. **Decoder:** Students, acting as decoders, take in this encoded information, process it, and generate their understanding or output, which could be in the form of homework, projects, exams, or presentations. The decoding process involves comprehending, internalizing, and applying the information received from the encoder (teacher) to produce the desired learning outcomes.	Use diagrams to illustrate the structure and functionality of MUX and DEMUX circuits. Show how the selection lines determine the input-output relationship.
SO 3.3 Parity generators-checkers	3.3 Here's a classroom instruction guide on how to explain parity generators and checkers: • Whiteboard or projector for diagrams • Logic gates diagram (AND, XOR, etc.) • Handouts or slides explaining the concepts • Examples and exercises for students	
SO 3.4 7400 Devices	3.4 If you're seeking classroom instructions or guidance on how to use 7400 series devices in educational settings or practical applications, here's a general outline you might find helpful: Introduction to 7400 Series Devices: Begin by explaining what 7400 series devices are, their purpose, and their significance in digital electronics. Discuss their various types, functionalities, and applications. Basic Concepts: Introduce fundamental concepts related to digital electronics, such as logic gates (AND, OR, NOT, etc.), truth tables, Boolean algebra, and binary arithmetic. Explain how these concepts are implemented using 7400 series ICs. Circuit Design: Teach students how to design simple logic circuits using 7400 series ICs. Start with basic circuits involving a single type of gate, then progress to more complex	

	circuits by combining multiple gates together. Practical Experiments: Provide hands-on experience by having students build circuits on breadboards using 7400 series ICs. This allows them to understand the physical connections and functioning of these devices. Troubleshooting and Debugging: Discuss common issues that may arise while working with these devices, and teach students how to troubleshoot and debug circuit problems effectively. Applications and Projects: Encourage students to explore practical applications of 7400 series devices. Assign projects that require designing and implementing logic circuits for specific tasks or problems. Simulation Software: Introduce simulation software tools that allow students to design and simulate digital circuits using 7400 series ICs. This can be useful for experimentation and learning without physical components. Safety Precautions: Emphasize the importance of handling electronic components safely. Teach proper handling techniques and precautions to avoid damaging the ICs or other equipment. Testing and Verification: Show students how to test their circuits to ensure they are functioning correctly. Teach them methods to verify the output against expected results. Discussion and Assessment: Conduct discussions, quizzes, or assessments to gauge students' understanding of 7400 series devices, their applications, and their ability to design and troubleshoot circuits using these components.	
SO 3.5 Flip-flops	3.5 Flip-flops, in the context of computer science or digital electronics, refer to bistable multivibrator circuits used to store binary information. These are essential components in sequential logic circuits and memory units. Here's an overview of flip-flops in a classroom instruction format: Introduction: Flip-flops are fundamental building blocks in digital electronics. They store one bit of data, which is either a 0 or a 1, and retain this information until updated by a clock signal.	

	Types of Flip-Flops: SR Flip-Flop (Set-Reset): This flip-flop has two inputs: Set (S) and Reset (R). It can hold one of two stable states (0 or 1), but it's essential to avoid inputs that cause both S and R to be high simultaneously, as it results in an undefined state. D Flip-Flop (Data): It has a single input (D) for data and a clock input. The stored output follows the input at the clock's rising or falling edge, allowing synchronization with the clock signal. JK Flip-Flop: This flip-flop has three inputs: J (set), K (reset), and a clock input. It has behavior similar to the SR flip-flop but includes additional functionality to prevent the undefined state. T Flip-Flop (Toggle): It has a single input (T) and a clock input. On the clock signal's rising or falling edge, the output toggles its state (0 to 1 or 1 to 0) based on the current state and the input. Operation: Flip-flops store data based on their inputs and the clock signal's timing. They have an internal state that changes based on the clock's rising or falling edge. The output remains constant until a clock transition occurs, updating the stored information. Clock signals synchronize the operations and prevent erratic behavior. Applications: Memory Units: Flip-flops are the basic storage elements in sequential circuits and memory units. Counters: They are used in constructing different types of counters to count events or clock pulses. Registers: Flip-flops are used in various types of registers, such as shift registers and parallel-load registers.	
SO 3.6 A/D and D/A converters	3.6 When teaching A/D and D/A converters in a classroom setting, instructors often follow these steps: Introduction to Concepts: Begin by explaining the fundamentals of analog and digital signals, highlighting the need for conversion between them. Working Principles: Explain the working principles of A/D and D/A converters, covering sampling, quantization,	

	encoding, decoding, and conversion techniques. Types of Converters: Discuss different types of A/D and D/A converters, their applications, advantages, and limitations. Mention successive approximation, delta-sigma, flash, and other types of converters. Real-life Examples: Use real-life examples or demonstrations to illustrate how these converters are used in various devices and systems, like digital audio systems, temperature sensors, or communication systems. Hands-on Exercises or Projects: Engage students with practical exercises or projects involving designing circuits using A/D and D/A converters. This hands-on experience reinforces theoretical knowledge. Challenges and Applications: Discuss challenges in converter design, such as accuracy, speed, and resolution. Explore applications in different fields like telecommunications, instrumentation, music production, and more. Recent Advances: Introduce students to recent advancements in converter technology and emerging trends in the field.	
SO 3.7 Semiconductor memory, (RAM, ROM & EPROM).	3.7 Simulation or Visual Representation: Use diagrams or online simulations to show the internal structure and functioning of RAM, ROM, and EPROM. Hands-on Experiment: If possible, demonstrate how an EPROM erasure happens using a UV light source (UV lamp) on a dummy EPROM chip (non-functional) to show the erasure process. Role Play or Storytelling: Create a storytelling session or role-play where RAM, ROM, and EPROM "characters" explain their roles and functions within a computer system. Comparison Exercise: Engage students in comparing the characteristics and uses of RAM, ROM, and EPROM, emphasizing their differences and similarities.	
SO 3.8 CMOS logic gates	3.8 Here's an overview of some common CMOS logic gates: CMOS Inverter: The basic CMOS logic gate is the inverter, which consists of a PMOS transistor and an NMOS transistor connected in series between the output and the power supplies. When the input is low, the PMOS transistor conducts, and the NMOS transistor is off, leading to a high output. Conversely, when the input is high, the NMOS transistor conducts, and the PMOS transistor is off, resulting in a low	

	output. CMOS AND Gate: A CMOS AND gate is constructed using multiple pairs of NMOS and PMOS transistors. When both inputs are high, the NMOS transistors conduct while the PMOS transistors are off, resulting in a low output. In all other cases, at least one PMOS transistor conducts, leading to a high output. CMOS OR Gate: The CMOS OR gate is constructed using parallel PMOS transistors and series NMOS transistors. When at least one input is high, the corresponding PMOS transistor conducts, causing the output to be low. Only when both inputs are low, both NMOS transistors conduct, resulting in a high output. CMOS NAND and NOR Gates: NAND and NOR gates can also be implemented using combinations of CMOS transistors. NAND gates are constructed similarly to AND gates but with an additional inverter stage at the output. NOR gates are constructed similarly to OR gates but with an inverter at the output.	

SW-3 Suggested Sessional Work (SW):

- Assignments
- Other Activity
  - Power Point Presentation
  - Practical demonstrations using simulation software or physical breadboard setups can further enhance the learning experience, allowing students to observe the behavior of CMOS gates in action. Additionally, discussing real-world applications of CMOS logic gates in various electronic devices can help students appreciate their significance in modern technology.

PH303.04: Describe architecture and operation of microprocessor 8085 and develop assembly language programs using instruction set of 8085.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	1
SL	2

Total	14

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO 4.1 8085 microprocessor	4.1 Teaching 8085 microprocessor architecture in a classroom setting can involve various methods and resources to ensure effective learning. Here's an organized plan for conducting a class on the 8085 microprocessor: Introduction and Overview: Start the session by introducing the concept of a microprocessor and its significance. Explain the role of the 8085 microprocessor in computing and its historical relevance. Discuss the basic architecture and components of the 8085 microprocessor. Instruction Set Architecture (ISA): Explain the instruction set architecture of the 8085 microprocessor. Categorize instructions: data transfer, arithmetic, logic, branching, etc. Provide examples and demonstrate how instructions are encoded. Registers and Memory: Discuss various registers (Accumulator, B, C, D, E, H, L, etc.) and their functions. Explain the concept of memory addressing modes (direct, indirect, immediate). Discuss the memory organization, addressing, and data transfer between registers and memory. Programming: Introduce assembly language programming for the 8085 microprocessor. Demonstrate simple programs using mnemonics and corresponding opcodes. Emphasize the importance of efficient programming practices. Timing and Control: Explain the timing diagram of the 8085 microprocessor. Discuss machine cycles, instruction cycles, and the concept of T-states. Describe how the control signals coordinate various operations. Interfacing and Peripherals: Discuss input/output interfacing with devices like LEDs, switches, etc. Explain how to interface memory and I/O devices with the 8085 microprocessor. Demonstrate programming for I/O operations.	
SO 4.2 Writing some programs in assembly language for 8085 microprocessor	4.2 Assembly language for the 8085 is based on mnemonics representing different instructions and requires a solid understanding of the processor's architecture and instruction set. Each instruction in the code above represents a particular operation (e.g., MVI for Move Immediate, LXI for Load Register Pair Immediate, MOV for Move, ADD for Add, STA for Store Accumulator).	
SO 4.3 Instruction set for 8085	4.3 he 8085 is an 8-bit microprocessor with a specific instruction set used in assembly language programming. Below, I'll provide a basic list of instructions categorized by their functionality: Data Transfer Instructions:	

	MOV - Move data from one register/memory to another register/memory. MVI - Move immediate data to a register. LDA - Load accumulator with data from memory. STA - Store accumulator data into memory. LHLD - Load H-L pair direct. SHLD - Store H-L pair direct. LDAX - Load accumulator indirect. Arithmetic Instructions: ADD - Add contents of a register/memory to the accumulator. ADI - Add immediate data to the accumulator. ADC - Add register/memory to accumulator with carry. SUB - Subtract contents of a register/memory from the accumulator. SUI - Subtract immediate data from the accumulator. SBB - Subtract register/memory from the accumulator with borrow. INR - Increment register/memory. DCR - Decrement register/memory. Logical Instructions: ANA - Perform bitwise AND operation between register/memory and accumulator. ANI - Perform bitwise AND operation between immediate data and accumulator. XRA - Perform bitwise XOR operation between register/memory and accumulator. XRI - Perform bitwise XOR operation between immediate data and accumulator. ORA - Perform bitwise OR operation between register/memory and accumulator. ORI - Perform bitwise OR operation between immediate data and accumulator. CMA - Complement accumulator. CMP - Compare register/memory with accumulator. Branching Instructions: JMP - Jump to the specified address unconditionally. JC - Jump if carry flag is set. JNC - Jump if carry flag is not set. JZ - Jump if zero flag is set. JNZ - Jump if zero flag is not set. JP - Jump if positive sign (MSB of accumulator) is set. JM - Jump if negative sign (MSB of accumulator) is set. CALL - Call a subroutine at the specified address. RET - Return from subroutine. RST - Restart the program execution from fixed memory locations. Control Instructions: HLT - Halt the processor. NOP - No operation.	
SO 4.4 Stack, I/O and machine control group	4.4 To explore the fundamentals of machine control groups and their role in computer architecture.	
SO 4.5 Memory read & write	4.5 about memory read and write in computer systems might involve a combination of lectures, demonstrations, and hands-on activities. Here's a basic outline you might consider: Introduction: Define Memory Read and Write: Explain the concepts of memory read and	

	write operations in computer systems. Introduce how data is stored and retrieved in memory. Purpose: Discuss why memory read and write operations are fundamental in computer architecture and how they facilitate data processing. Theory: Memory Basics: Provide an overview of different types of memory (RAM, ROM, cache) and their roles in storing data. Binary Representation: Explain how data is represented in binary form and how it's accessed during read and write operations. Memory Addresses: Introduce the concept of memory addresses and their significance in locating specific data. Memory Read Operation: Process Overview: Describe the steps involved in reading data from memory. Fetch-Decode-Execute: Explain the CPU's role in initiating memory read operations and retrieving data. Examples and Diagrams: Use diagrams or flowcharts to illustrate the sequence of events during a read operation. Memory Write Operation: Process Overview: Explain how data is written into memory. Write Cycles: Discuss the steps involved in storing data in memory locations. Memory Access Protocols: Introduce concepts like write-through, write-back, and their implications in memory write operations. Hands-on Activities/Demonstrations: Simulation or Emulation: Use software tools or online simulators to demonstrate memory read and write operations in action. Assembly Language Examples: Show simple code snippets in assembly language to demonstrate how read and write operations are performed at a low level. Real-world Examples: Practical Applications: Discuss real-world scenarios where understanding memory read and write operations is crucial (e.g., file storage, database management, etc.). Performance Optimization: Explain how optimizing memory read and write processes can enhance system performance. Recap and Assessment: Review: Summarize key points covered during the session. Quiz or Q&A: Engage students with a short quiz or question-and-answer session to reinforce understanding. Assignments/Projects: Provide assignments or projects that require students to write simple programs involving memory read and write operations.	
SO 4.6 Timing diagrams	4.6 In the context of 8085 microprocessor architecture, timing diagrams are graphical representations that show the timing relationships between various signals and operations within the microprocessor during instruction execution. These diagrams help in understanding the sequence of events that occur within the microprocessor's internal components during the fetch, decode, and execute phases of an instruction cycle.	
SO 4.7 Interrupts	4.7 In the context of the Intel 8085 microprocessor, interrupts play a crucial role in allowing the processor to handle external events or requests. Interrupts can temporarily suspend the main program execution and divert the processor's attention to another task.	
SO 4.8 Types of	4.8 Hardware Interrupts:	

Interrupts in 8085	TRAP: Non-maskable interrupt. Highest priority. RST 7.5, RST 6.5, RST 5.5, RST 4.5, RST 3.5, RST 2.5, RST 1.5: Maskable interrupts with different priorities. Software Interrupts: RST instructions: Similar to hardware interrupts but invoked by software instructions. SIM (Set Interrupt Mask): Used to disable or enable interrupts. RIM (Read Interrupt Mask): Used to read the status of interrupt lines.	
SO 4.9 Interrupt Process:	4.9 Interrupt Request (IRQ): External devices can request an interrupt. 2.Interrupt Acknowledge: The processor acknowledges the interrupt request by sending an acknowledgment signal. 3.Interrupt Service Routine (ISR): The processor jumps to the corresponding interrupt vector location (specific memory address) to execute the ISR. 4.Handling Interrupts: The ISR executes the required operations and typically ends with a return instruction (like RET or RETI) to return to the main program.	
SO 4.10 Interrupt Vector Table:	4.10 • The 8085 uses an interrupt vector table to determine the address to jump to when a particular interrupt occurs. • The starting address of this table is fixed in memory, and each interrupt has its specific vector address.	
SO 4.11 Maskable and Non-Maskable Interrupts:	4.11 • Maskable Interrupts: Can be disabled (masked) or enabled based on the SIM instruction. • Non-Maskable Interrupts: Cannot be disabled. They always get priority over maskable interrupts.	

SW-4 Suggested Sessional Work (SW):

- Assignments
- Other Activity

  Power Point Presentation

  Assessments could include quizzes, assignments, or a small project that requires implementation or simulation of these concepts.

PH303.05: Learn and to apply concepts learnt about Microprocessor & Peripheral Device

Item	AppX Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

SESSION OUTCOMES (SOs)	CLASS ROOM INSTRUCTION (CI)	SELF LEARING
SO 5.1 Programmable Interface devices	Module 5.1 Programmable interface devices can be utilized in classroom instruction across various subjects to enhance learning experiences. These devices enable students to interact with technology, understand programming concepts, and apply them to solve problems. Here are some ways programmable interface devices can be used in classroom instruction: Coding and Robotics: Devices like Arduino, Raspberry Pi, or micro:bit can introduce students to coding and robotics. They can learn programming languages like Python, Scratch, or C/C++ to control sensors, motors, lights, and other components, allowing them to build robots or interactive projects. STEM Projects: These devices enable hands-on STEM (Science, Technology, Engineering, and Mathematics) projects. Students can build scientific instruments, weather stations, automated plant watering systems, etc., fostering practical application of STEM concepts. Internet of Things (IoT): Teach students about IoT by using devices like Raspberry Pi to create connected devices. They can build smart home prototypes, monitor environmental data, or create devices that respond to real-time data. Interactive Art and Design: Programmable devices can be used in art and design classes to create interactive installations, kinetic	

	sculptures, or digital art projects, fostering creativity alongside technology. Physics and Electronics Experiments: Students can learn about circuits, sensors, and electronic components by building various projects. They can explore concepts like conductivity, resistance, and capacitance. Game Development: Engage students in creating their own games using programmable devices. This involves coding logic, game design principles, and graphics to develop interactive games. Collaborative Learning: Group projects involving programmable devices encourage teamwork, problem-solving, and communication skills as students work together to design, program, and debug their projects. Real-world Problem Solving: Encourage students to tackle real-world problems in their community using these devices. This can include designing solutions for energy conservation, waste management, or accessibility improvements. Computer Science Concepts: Use programmable devices to teach fundamental computer science concepts like loops, conditionals, variables, functions, and data structures in a practical, hands-on manner. Cross-curricular Integration: These devices can be integrated across subjects, such as using them in language classes to create interactive storytelling projects or in history classes to build simulations of historical events.	
SO 5.2 Internal Architecture and pin out diagrams of 8155 and 8255	5.2 The Intel 8155 and 8255 are both programmable I/O (Input/Output) devices commonly used in microprocessor-based systems. They are designed to provide parallel I/O interfacing with microprocessors. The 8155 is a bit more complex as it includes not only I/O ports but also an on-chip timer and 256 bytes of RAM.	
SO 5.3 Programmable interrupt controller Intel 8259	5.3 The Intel 8259 PIC is a critical component in managing interrupt requests in early computer systems. Understanding its configuration, modes of operation, and interrupt handling mechanisms is crucial for effectively managing system interrupts and ensuring proper functioning of devices connected to the CPU.	
SO 5.4 Direct memory access and 8257 DMA controller 8279 display/ key board controller	5.4 Discussing the architecture and working principles of the 8257 DMA controller, including its channels and modes of operation.	
SO 5.5 Interfacing with D/A and A/D	5.5 Interfacing with D/A (digital-to-analog) and A/D (analog-to-digital) converters is an essential aspect of working with digital and	Discuss real-world

converters	analog signals in various electronic applications. Here's a brief overview of how you might approach this topic in a classroom setting: Understanding D/A Converters: Begin by explaining the purpose of D/A converters, which convert digital signals into corresponding analog signals. Discuss the types of D/A converters: binary-weighted resistor, R-2R ladder, and sigma-delta converters, explaining their working principles and advantages/disadvantages. Demonstrate how to interface a microcontroller or digital system with a D/A converter to generate analog output signals. Understanding A/D Converters: Explain the function of A/D converters, which convert analog signals into digital values. Cover different types of A/D converters, such as successive approximation, integrating, and delta-sigma converters, highlighting their characteristics and applications. Discuss methods for interfacing analog sensors or signals with microcontrollers or digital systems using A/D converters to process the data.	applications where these converters play a crucial role, such as audio systems, instrumentation, communication systems, and industrial automation.
SO 5.6 Elementary method of digital to analog conversion	5.6 By demonstrating this basic DAC method practically, students can gain a better understanding of how digital signals can be converted into continuous analog signals, laying a foundation for further exploration in the field of analog and digital electronics.	
SO 5.7 Working of DAC 0808 and programme for interfacing with 8255 in 8085 based system.	5.7 it's important to go through the datasheets of the DAC0808, 8255, and 8085 microprocessors, understand their pin configurations, control signals, and timing requirements. Then, step-by-step, demonstrate how to set up the connections, initialize the ports, and transfer data between the devices using assembly language instructions. Testing and troubleshooting are essential parts of such a practical session to ensure correct interfacing and communication.	
SO 5.8 Internal block diagram of ADC 809 and working	5.8 The ADC0809 operates by taking an analog input signal, selecting its channel through the multiplexer, initiating the conversion with the start control, and then using the successive approximation algorithm with the help of a clock signal to produce the digital output.	
SO 5.9 Interfacing of IC 809 with 8085 based systems.	5.9 It's essential to provide hands-on demonstrations, diagrams, and explanations of the IC 809 interfacing process. You can break down the steps into manageable parts, explain the theory behind interfacing, demonstrate connections on a development board or simulation software, and show sample code snippets to communicate between the 8085 and IC 809.	

SW-5 Suggested Sessional Work (SW):

- Assignments
- Other Activity

  Power Point Presentation of Portland cement manufacture.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
PH303.01: After studying this course, the student will be able to Observe logic circuits, assemble logic circuits and test the logic circuit	8	1	1	10
PH303.02: Identify the applications of junction devices, amplifiers and logic circuits.	7	2	4	13
PH303.03: Learn and to apply concepts learnt in analog and digital electronics in real life.	8	1	1	10
PH303.04: Describe architecture and operation of microprocessor 8085 and develop assembly language programs using instruction set of 8085.	11	1	2	14
PH303.05: Learn and to apply concepts about Microprocessor & Peripheral Device.	8	1	1	10
Total Hours	42	06	09	57

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Acquire knowledge about various electronic components used in communication systems, such as amplifiers, oscillators, filters, and transmitters/receivers, and their functionalities in electronic communication.	03	01	01	05
CO-2	Students will comprehend the basic principles of digital systems, including binary number systems, Boolean algebra, and logic gates.	02	06	02	10
CO-3	These outcomes aim to ensure that students have a comprehensive understanding of digital electronics principles, enabling them to design, analyze, and troubleshoot digital circuits and systems effectively.	03	07	05	15
CO-4	A course on microprocessors typically aims to equip students with a range of skills and knowledge related to the design, functioning, and application of microprocessors.	-	10	05	15
CO-5	Acquire skills in designing both hardware and software components for effective device interfacing, including circuit design, sensor integration, and firmware development.	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

- Improved Lecture
- Tutorial
- Case Method
- Group Discussion
- Role Play
- Demonstration
- Brainstorming
- Quiz Coemption

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Microelectronic Circuits	S. Sedra and K. C. Smith	Oxford University Press	Revised edition 21 edition 2020
2	Op-Amps and Linear Integrated Circuits	R. A. Gaykwad	Prentice- Hall of India	2014
3	Digital Principles and Applications	D. P. Leach, A. P. Malvino and G. Saha	Tata McGraw Hill.	2001
4	Digital Design - Principles and Practices	J. F. Wakerly	Prentice Hall of India	2018
5	Lecture note provided by Department of Physics, AKS University, Satna (M. P.)			

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code : PH303

Course Title: Digital Electronics & Microprocessor

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	The ability to apply technical & engineering knowledge for production quality cement	Ability to understand the day to plant operational problems of cement manufacture	Ability to understand the latest cement manufacturing technology.	Ability to use the research based innovative knowledge for SDGs	Engage in life-long learning and will have recognition.
CO 1: Acquire knowledge about various electronic components used in communication systems, such as amplifiers, oscillators, filters, and transmitters/receivers, and their functionalities in electronic communication.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	2
CO 2: Students will comprehend the basic principles of digital systems, including binary number systems, Boolean algebra, and logic gates.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	2
CO 3: These outcomes aim to ensure that students have a comprehensive understanding of digital electronics principles, enabling them to design, analyze, and troubleshoot digital circuits and systems effectively.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	1
CO 4: A course on microprocessors typically aims to equip students with a range of skills and knowledge related to the design, functioning, and	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	3

application of microprocessors.																	
CO 5: Acquire skills in designing both hardware and software components for effective device interfacing, including circuit design, sensor integration, and firmware development.	**2**	**2**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**	**2**

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 1: Acquire knowledge about various electronic components used in communication systems, such as amplifiers, oscillators, filters, and transmitters/receivers, and their functionalities in electronic communication.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**Unit I (Communication Electronics)**	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 2 Students will comprehend the basic principles of digital systems, including binary number systems, Boolean algebra, and logic gates.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**Unit II (Basics of Digital Electronics)**	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 3: These outcomes aim to ensure that students have a comprehensive understanding of digital electronics principles, enabling them to design, analyze, and troubleshoot digital circuits and systems effectively.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**Unit – III (Digital Electronics)**	page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO 4: A course on microprocessors typically aims to equip students with a range of skills and knowledge related to the	SO4.1 SO4.2 SO4.3	**Unit IV (Microprocessor)**	

PSO 1,2, 3, 4, 5	design, functioning, and application of microprocessors.	SO4.4 SO4.5		
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 5: Acquire skills in designing both hardware and software components for effective device interfacing, including circuit design, sensor integration, and firmware development.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**Unit V (Programmable Interface devices)**	

Semester-III

Course Code: PH304

Course Title : **Nuclear and Particle Physics**

Pre- requisite: Student should have basic knowledge of basic properties of nuclei, nuclear reactions, general knowledge nuclear model and elementary knowledge of particles.

Rationale: The students studying Physics should possess foundational understanding about historical background of nuclear and particle physics.

Course Outcomes:

CO304.1. Understand the basic properties of nuclei and nuclear forces for studying nuclear structure.

CO304.2. Learn about nuclear models like- Liquid drop model and shell model to know nuclear structure.

CO304.3. Learn about nuclear decay and detection methods.

CO304.4. Learn about elementary particles and classify the particles and will be able to understand their properties.

CO304.5. Learn about cosmic rays and detection methods.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Elective (PEC)	PH304	**Nuclear and Particle Physics**	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PEC	PH304	**Nuclear and Particle Physics**	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

CO304.1. Understand the basic properties of nuclei and nuclear forces for studying nuclear structure.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Learn about Nuclear Interactions. **SO1.2** Understand theory of nuclear forces. **SO1.3** Learn about nuclear reaction. **SO1.4** Understand direct and compound nuclear reaction mechanisms. **SO1.5** Analysis of Breit-Wigner one–level formula.	**UNIT – I (Nuclear Interactions and Nuclear Reactions)** 1.1 Nuclear sizes and shapes, Experimental methods of determining nuclear radius 1.2Two-nucleon problem: Deuteron problem, Nucleon- nucleon interaction 1.3 Exchange forces and tensor forces 1.4 meson theory of nuclear forces 1.5 nucleon-nucleon scattering 1.6 Effective range theory, spin dependence of nuclear forces 1.7 charge independence and charge symmetry of nuclear forces 1.8Isospin formalism, Yukawa interaction 1.9 Direct and compound nuclear reaction mechanisms	1. Theory of Nuclear Interactions

	1.10 cross sections in terms of partial wave amplitudes 1.11 compound nucleus, scattering matrix, Reciprocity theorem 1.12 Breit- Wigner one–level formula, Resonance scattering.	

SW-1 Suggested Sessional Work (SW):

a) **Assignments:**
Explain Breit-Wigner one–level formula and Resonance scattering.

b) **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO304.2. Learn about nuclear models like- Liquid drop model and shell model to know nuclear structure.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Learn about different nuclear model. **SO2.2** Understand nuclear fission on the basis of nuclear model. **SO2.3** Aware about rotational and vibrational spectra. **SO2.4** Understand elementary idea of unified model **SO2.5** Analysis of various nuclear models.	**UNIT – II (Nuclear Models)** 2.1 Nuclear models 2.2 Liquid drop model, Semi empirical mass formula and isobaric stability 2.3 Bohr–wheeler theory of fission 2.4 Experimental evidence for shell effects-shell model, spin, orbit coupling, 2.5 magic numbers, Angular momenta and parities of nuclear ground states 2.6 Qualitative discussion and estimates of transition rates 2.7 magnetic moment and Schmidt lines 2.8 Collective model of Bohr and Mottelson (2) 2.9Rotational and vibrational spectra 2.10 elementary idea of unified model. (2)	1. Learn about various Nuclear Models

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**

Explain Liquid drop model with Bohr–wheeler theory of fission.

b. Other Activities (Specify):
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO304.3. Learn about nuclear decay and detection methods.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Deduce Fermi theory of beta decay **SO3.2** Detection and properties of neutrino Gamma decay. **SO3.3** Learn about nuclear detector and detection technique. **SO3.4** Understand alpha decay and detect it. **SO3.5** Understand and Analysis nuclear accelerator.	**UNIT – III (Nuclear Decay)** 3.1 Beta decay 3.2 Fermi theory of beta decay 3.3 Comparative half, lives, Parity violation 3.4 Two component theory of neutrino decay 3.5 Detection and properties of neutrino Gamma decay 3.6 Multipole transition in nuclei 3.7 Angular momentum and parity selection rules 3.8 Internal conversion, Nuclear isomerism 3.9 General ideas of nuclear radiation detectors 3.10 linear acceleration 3.11 Betatron 3.12 Proton- synchrotron, Electron synchrotron.	1. General ideas of nuclear radiation detectors

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Explain various nuclear detectors and give general ideas of nuclear radiation detectors.

b. Other Activities (Specify):
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO304.4. Learn about elementary particles and classify the particles and will be able to understand their properties.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Learn about elementary particles **SO4.2** Understand category of various elementary particles. **SO4.3** Learn elementary ideas of invariance. **SO4.4** Understand particle symmetry and conservation laws. **SO4.5** Analysis of quark model.	**UNIT – IV (Elementary particle physics)** 4.1 Types of interaction between elementary particles 4.2 Hadrons and leptons 4.3 Symmetry and conservation laws 4.4 Elementary ideas of CP invariance 4.5 Elementary ideas of CPT invariance 4.6 Classification of hadrons 4.7 lie algebra and SU(2) 4.8 SU (3) multiplets 4.9 Quark model 4.10 Gell Mann-Okubo mass formula for octet 4.11 decuplet hadrons 4.12 Charm, bottom and top quarks.	1. Interaction between elementary particles

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**

Describe hadrons and classify it.

b. **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

CO304.5. Learn about cosmic rays and detection methods.

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Learn about Cosmic rays nature, composition, charge behavior. **SO5.2** Understand origin of cosmic rays. **SO5.3** Able to understand properties of cosmic rays. **SO5.4** Understand relation with classical mechanics. **SO5.5** Observe penetration of cosmic rays on atmosphere.	**UNIT – V (Cosmic Rays)** 5.1 Cosmic rays, nature, composition, charge and energy (2) 5.2 spectrum of primary cosmic rays 5.3 production and propagation of secondary cosmic rays 5.4 Soft, penetrating and nucleonic components 5.5 Origin of cosmic rays 5.6 Rossi curve (2) 5.7 Bhabha–Heitler theory of cascade showers (2) 5.8 Covariant Lagrangian (2)	. General theory of Cosmic Rays

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
   Explain Origin of cosmic rays, Rossi curve and Bhabha–Heitler theory of cascade showers.

b. **Other Activities (Specify):**
   Present any one topic of this unit by power point presentation in front of departmental student and faculty.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
CO304.1. Understand the basic properties of nuclei and nuclear forces for studying nuclear structure.	**12**	1	1	14
CO304.2. Learn about nuclear models like- Liquid drop model and shell model to know nuclear structure.	12	1	1	14
CO304.3. Learn about nuclear decay and detection methods.	12	1	1	14
CO304.4. Learn about elementary particles and classify the particles and will be able to understand their properties.	12	1	1	14
CO304.5. Learn about cosmic rays and detection methods.	12	1	1	**14**
Total Hours	**60**	**5**	**5**	**70**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Nuclear Interactions and Nuclear Reactions**	03	03	04	10
CO-2	**Nuclear Models**	03	04	03	10
CO-3	**Nuclear Decay**	03	03	04	10
CO-4	**Elementary particle physics**	03	03	04	10
CO-5	**Cosmic Rays**	03	03	04	10
Total		15	16	19	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Introductory Nuclear Physics,	Kenneth S. Kiane	Wiley New York	1988
2	Introduction to Nuclear Physics	H.A. Enge	Addison- Wesley	1975
3	Nuclear Physics	I. Kaplan	2 Ed. Narosa	1989
4	Atomic Nucleus	R.D.Evans	McGraw Hill, New York	1955
5	Lecture note provided by Department of Physics, AKS University, Satna (M. P.)			

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2. Dr C. P. Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
3. Dr Lovely Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
4. Mr. Saket Kumar , Assistant Professor , Department of Physics, AKS University Satna (M.P.)
5. Mr. Manish Agrawal, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
6. Miss Swati Kushwaha, Lab Faculty , Department of Physics, AKS University Satna (M.P.)

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH304

Course Title: Nuclear and Particle Physics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
CO304.1. Understand the basic properties of nuclei and nuclear forces for studying nuclear structure.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1
CO304.2. Learn about nuclear models like-Liquid drop model and shell model to know nuclear structure.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	1
CO304.3. Learn about nuclear decay and detection methods.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
CO304.4. Learn about elementary particles and classify the particles and will be able to understand their properties.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
CO304.5. Learn about cosmic rays and detection methods.	2	1	2	1	1	3	3	3	1	1	2	2	3	3	1	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 PSO 1,2, 3, 4, 5	**CO304.1.** Understand the basic properties of nuclei and nuclear forces for studying nuclear structure.	SO1.1 SO1.4 SO1.5	**UNIT – I (Nuclear Interactions and Nuclear Reactions)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11	As mentioned in page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO304.2.** Learn about nuclear models like-Liquid drop model and shell model to know nuclear structure.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**UNIT – II (Nuclear Models)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO304.3.** Learn about nuclear decay and detection methods.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**UNIT – III (Nuclear Decay)** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO304.4.** Learn about elementary particles and classify the particles and will be able to understand their properties.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**UNIT – IV (Elementary particle physics)** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO304.5.** Learn about cosmic rays and detection methods.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**UNIT – V (Cosmic Rays)** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	

Semester-III

Course Code: **PH305**

Course Title : **Digital signal processing**

Pre- requisite: Student should have basic knowledge of Electrical signals, systems, Basic Electrical Laws, Z- Transform, Fourier transform and basic mathematical operations.

Rationale: This course is designed to provide the knowledge to student's about Digital signal Processing besides the basic topics. It includes advanced topics of signals processing and its parameters, This course would help students to understand more advanced concepts of modern communication system

Course Outcomes:

PH305.1: Understanding of Discrete time signals and systems. Significance of sampling and reconstruction.

PH305.2: Applications of Z-transform in Digital signals and systems.

PH305.3: Identify the properties and characteristics of discrete Fourier Transform along with their Mathematical representation and analysis.

PH305.4: Understanding the basic concepts designing of different types of filters.

PH305.5: Analyzing the Applications of Digital Signal Processing

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Elective (PEC)	**PH305**	Digital Signal Processing	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						**End Semester Assessment**	**Total Marks**
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ESA)
PEC	PH305	Digital Signal Processing	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH305.1: Understanding of Discrete time signals and systems. Significance of sampling and reconstruction.

Approximate Hours

Item	Approx Hrs
Cl	08
LI	0
SW	1
SL	1
Total	10

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Understand the concept of discrete time signals and systems **SO1.2** Understand the different methods of representation of discrete time signals and systems **SO1.3** Significance of sampling and reconstruction of signals and systems **SO1.4** Importance and explanation of alising method sampling theorem and Nyquist rate.	**Unit-1: Discrete-time signals and systems** 1.1 Definition of discrete time signals and systems 1.2 Sequences representation of discrete time signals and systems 1.3 Representation of signals on orthogonal basis. 1.4 Representation of discrete systems using difference equations 1.5 Numerical of difference equations 1.6 Sampling and reconstruction of signals and systems 1.7 Explanation of alising 1.8 Sampling theorem and Nyquist rate.	1. Basics of signal and systems 2. Difference between Analog signals and discrete time signals 3. Differential equations

SW-1 Suggested Sessional Work (SW):

a. Assignments:

Numerical Problems of sampling theorem and Nyquist rate

PH305.2: Applications of Z-transform in Digital signals and systems.

Approximate Hours

Item	Approx Hrs
Cl	10
LI	0
SW	1
SL	1
Total	12

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Understanding of Z- transform **SO2.2** Solve different signals and systems using Z transform **SO2.3** To understand the significance of Region of convergence. **SO2.4** Basic knowledge of inverse Z-Transform.	**Unit-2 Z-Transform** 2.1 Introduction to Z-transform. 2.2 Region of Convergence 2.3 Analysis of linear shift invariant systems using Z-Transform 2.4 Numerical of Z-transform 2.5 Different properties of Z-Transform for Causal signals 2.6 Numerical on properties of Z-Transform 2.7 Interpretation of stability in z-domain 2.8 Inverse z-transforms. 2.9 Properties of Inverse Z-Transform 2.10 Numerical of Inverse Z-Transform	1. Basics of Z-Transform 2. Properties of signals and systems

SW-2 Suggested Sessional Work (SW):

a. **Assignments:**
   i. Numerical Problems on Z-Transform.
   ii. Numerical Problems based on Inverse Z-Transform.

PH305.3: Identify the properties and characteristics of discrete Fourier Transform along with their Mathematical representation and analysis.

Approximate Hours

Item	Approx Hrs
Cl	8
LI	0
SW	1
SL	1
Total	10

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 To Understand the concept of Discrete time Fourier Transform **SO3.2** Significance of properties of discrete Fourier transform **SO3.3** To Understand the concept of fast Fourier Transform	**Unit-3 : Discrete Fourier Transform** 3.1 Introduction to Discrete Fourier Transform 3.2 Properties of discrete Fourier transform 3.3 Numericals 3.4 Convolution of signals 3.5 Fast Fourier Transform Algorithm 3.6 Parseval's Identity 3.7 Implementation of Discrete Time systems 3.8 Numericals	1. Basics of Fourier transform. 2. Discrete time signals

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**
   - **i.** Numerical Problems based on Discrete Fourier transform.
   - **ii.** Numerical Problems of Fast Fourier Transform.

PH305.4: Understanding the basic concepts designing of different types of filters.

Approximate Hours

Item	Approx Hrs
Cl	11
LI	0
SW	1
SL	1
Total	13

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1 Understanding the basic concepts of digital filters **SO4.2** Significance of design of digital filters and its types **SO4.3** to illustrate the different methods involve in designing	**Unit-4 : Design of Digital filters** 4.1 Introduction to digital filters and its significance in digital signal processing. 4.2 Window method for filter designing 4.3 Park-McClellan's method for	i. Filters and types of filters ii. Difference between analog and digital filters

of digital filters	filter designing 4.4 Introduction to Design of IIR Digital Filters 4.5 Butterworth method 4.6 Chebyshev method 4.7 Elliptic Approximations 4.8 Low-pass,band pass,band stop and high pass filters 4.9 Effect of finite register length in FIR filter design. 4.10 Parametric and non-parametric spectral estimation. 4.11 Introduction to multi-rate signal processing	

SW-4 **Suggested Sessional Work (SW):**

a. Assignments:

i. Explanation of designing of FIR and IIR filters

ii. Numerical problems based on window method.

b. Mini Project:

i. Draw a chart of Different types of filters.

PH305.5: Analyzing the Applications of Digital Signal Processing.

Approximate Hours

Item	Approx Hrs
Cl	8
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1 To understand the correlation functions **SO5.2** To understand the significance of power spectra **SO5.3** Importance of linear mean square estimation.	**Unit 5: Applications of Digital Signal Processing** 5.1 Correlation Functions 5.2 Examples of correlation functions. 5.3 Power Spectra 5.4 Stationary Processes 5.5 Optimal filtering using ARMA Model 5.6 Linear Mean-Square	1. Remember the properties of filters 2. Types of correlation function.

	Estimation 5.7 Examples of Linear mean square Estimation 5.8 Wiener Filter.	

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Numerical Problem based on correlation function

ii. Numerical Problem based on linear mean square Estimation.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
PH305.1: Understanding of Discrete time signals and systems. Significance of sampling and reconstruction.	8	1	1	10
PH305.2: Applications of Z-transform in Digital signals and systems.	10	1	1	12
PH305.3: Identify the properties and characteristics of discrete Fourier Transform along with their Mathematical representation and analysis.	8	1	1	10
PH305.4: Understanding the basic concepts designing of different types of filters.	11	1	1	13
PH305.5: Analyzing the Applications of Digital Signal Processing	8	1	1	10
Total Hours	45	5	5	55

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Discrete-time signals and systems	02	03	05	10
CO-2	Z-transform	02	04	04	10
CO-3	Discrete Fourier Transform	02	02	06	10

CO-4	Design of Digital filters	03	07	05	15
CO-5	Applications of Digital Signal Processing	01	02	02	05
Total		10	18	22	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Process calculation will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Group Discussion
4. Practical Design Demonstration
5. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
6. Brainstorming

Suggested Learning Resources:

(a) **Books** :

S. No.	Title	Author	Publisher	Edition & Year
1	Digital Signal Processing: A computer based approach	S. K. Mitra	McGraw Hill	2011
2	Discrete Time Signal Processing‖	A.V. Oppenheim and R. W. Schafer,	Prentice Hall	1989
3	Digital Signal Processing: Principles, Algorithms and Applications	J. G. Proakis and D.G. Manolakis	Prentice Hall	1997
4	Theory and Application of Digital Signal Processing	L. R. Rabiner and B. Gold	Prentice Hall,	1992.
5	Introduction to digital Signal Processing‖,	J. R. Johnson	Prentice Hall,	1992.
6.	Digital Signal Processing‖,	D. J. DeFatta, J. G. Lucas and W. S. Hodgkiss	John Wiley & Sons,	1988.
7	Lecture note provided by Dept. of Electrical Engineering, AKS University, Satna.			

Curriculum Development Team

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2. Dr. C. P. Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
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4. Mr. Saket Kumar , Assistant Professor , Department of Physics, AKS University Satna (M.P.)
5. Mr. Manish Agrawal, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
6. Miss Swati Kushwaha, Lab Faculty , Department of Physics, AKS University Satna (M.P.)

****

COs,POs and PSOs Mapping

Course Title: M.Sc. (Physics)
Course Code: PH305
Course Title: DIGITAL SIGNAL PROCESSING

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem Solving	Design Skills	Laboratory Skills	Team work	Communication Skills	Ethical and Professional Behavior	Lifelong Learning	Global and Societal Impact	Project Management	Adaptability	Professional Development	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
CO1: Understanding of Discrete time signals and systems. Significance of sampling and reconstruction.	3	3	2	2	2	1	1	2	2	1	2	2	2	3	2	2	1
CO 2: Applications of Z-transform in Digital signals and systems.	3	3	3	3	2	2	1	3	2	2	2	3	3	2	3	2	2

CO3: Identify the properties and characteristics of discrete Fourier Transform along with their Mathematical representation and analysis	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**
CO 4: Understanding the basic concepts designing of different types of filters.	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**
CO 5: Analyzing the Applications of Digital Signal Processing	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self-Learning (SL)

PO:1,2,3,4,5,6,7,8 ,9,10,11,12 PSO 1,2, 3, 4, 5	CO1: Understanding of Discrete time signals and systems. Significance of sampling and reconstruction.	SO1.1 SO1.2 SO1.3 SO1.4	**UNIT-1: Discrete-time signals and systems** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8	
PO:1,2,3,4,5,6,7,8 ,9,10,11,12 PSO 1,2, 3, 4, 5	CO 2: Applications of Z-transform in Digital signals and systems.	SO2.1 SO2.2 SO2.3 SO2.4	**UNIT-2**: **Z-Transform** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10	
PO:1,2,3,4,5,6,7,8 ,9,10,11,12 PSO 1,2, 3, 4, 5	CO3: Identify the properties and characteristics of discrete Fourier Transform along with their Mathematical representation and analysis	SO3.1 SO3.2 SO3.3	**Unit-3: Discrete Fourier Transform** 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8	As mentionedin page number 3 to 7
PO:1,2,3,4,5,6,7,8 ,9,10,11,12 PSO 1,2, 3, 4, 5	CO 4: Understanding the basic concepts designing of different types of filters.	SO4.1 SO4.2 SO4.3	**UNIT-4: Design of Digital filters** 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8, 4.9,4.10,4.11	
PO:1,2,3,4,5,6,7,8 ,9,10,11,12 PSO 1,2, 3, 4, 5	CO 5: Analyzing the Applications of Digital Signal Processing	SO5.1 SO5.2 SO5.3	**UNIT-5: Applications of Digital Signal Processing** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8	

Semester-III

Course Code:	PH351
Course Title :	**General Physics Lab-III**
Pre- requisite:	Student should have basic knowledge of practical instruments in graduation.
Rationale:	The students studying Physics should possess foundational understanding about historical background of graduation.

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

PH351.1. learn various Physics aspects by performing the experiments related to nuclear physics and decay detection methods.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH351	**General Physics Lab-III**	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Lab work Assignment 5 number 7 marks each (LA)	Viva-Voice on Lab work 10 marks each (VV)	Lab Attendance (LA)	Total Marks (LA+VV+LA)		
PCC	PH351	General Physics Lab-III	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH351.1. learn various Physics aspects by performing the experiments related to nuclear physics and decay detection methods.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	90
SW	15
SL	15
Total	120

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Self Learning (SL)**
SO1.1 Learn about scattering methods **SO1.2** Understand Geiger muller counter by using experiment **SO1.3** Study and determine operating voltage and dead time. **SO1.4** study production techniques of nuclear reactors. **SO1.5** Learn about Error analysis.	1. To determine the operating voltage, slope k of the plateau and dead time of a G.M. Counter. 2. Features analysis using G.M. Counter. 3. Study of Rutherford scattering with the help model. 4. To determine half-life of a radio isotope using GM counter. 5. To study characteristics of a GM counter and to study statistical nature of radioactive decay. 6. Decoding and display of the outputs from the IC 7490. 7. To study the Compton scattering using gamma	Learn about basics of detection methods

	rays of suitable energy. 8. To study production techniques of nuclear reactors. 9. To study of production methods of nuclear power energy.	

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**
Study production methods of nuclear power energy in India.

b. Other Activities (Specify):
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH351.1. learn various Physics aspects by performing the experiments related to nuclear physics and decay detection methods.	**90**	15	15	120
Total Hours	**90**	**15**	**15**	**120**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	General Physics Lab-III	13	24	13	50
Total		13	24	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Experimental Physics	**Worsnop and Flint**	Little hampton Book Services Ltd, United Kingdom	9th Edition, 1951
2	Experiments in Modern Physics	**A. C. Melissinos, J. Napolitano**	Academic Press, Cambridge, Massachusetts	2nd Edition, 2003
5	Lab manuals provided by Department of Physics, AKS University, Satna (M. P.)			

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH351

Course Title: General Physics Lab-III

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH351.1. learn various Physics aspects by performing the experiments related to nuclear physics and decay detection methods.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction(LI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH351.1. learn various Physics aspects by performing the experiments related to nuclear physics and decay detection methods.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	15

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Semester-III

Course Code: PH352

Course Title : Electronics Lab-III

Pre- requisite: To study this course, a student must have had the Experimental knowledge of Physics in Graduation.

Rationale: The students studying this course would have practical (Experimental) Knowledge of Diodes, Gates and Transistors.

Course Outcomes:

PH352.1: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Progra mCore (PCC)	PH352	Electronics Lab-III	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) And others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop,field or other locations using different instructional strategies)
SW: Sessional work (including assignments, seminars, mini-projects, etc.).),
SL: Self Learning,
C: Credits.

Note: **SW and** SL must be planned and performed under the continuous guidance and feedback of the teacher to ensure the outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (RA)				**End Semester Assessment (ESA)**	**Total Marks** (PRA+ ESA)
			Lab work Assignment 5 number 7 marks each (LA)	Viva-Voice on Lab work 10 marks each (VV)	Lab Attendance (LA)	Total Marks (LA+VV+LA)		
PCC	PH352	Electronics Lab-III	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction, including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH352.1: The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	90
SW	15
SL	15
Total	120

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Self-Learning (SL)**
SO1 Students will learn all	1. Astable, Monostable and Bistable	1. Identify

about Basic electronic devices and their working. **SO2** Students will learn to verify truth table for basic logic gates. **SO3** Students will be able to Understand the characteristic curve of electronic devices. **SO4** Students will be able to understand the Circuit diagram of all mentioned electronic devices. **SO5** Students will learn to calculate error and analysis.	Multivibrator. 2. To assemble Logic gates using discrete components and to verify truth table. 3. Study of logic circuits TTL, NAND, NOR and XOR gates. 4. To study of R-S Flip-Flop and verify its truth table. 5. To study of J-K Flip-Flop and race around condition followed by verifying its truth table. 6. Addition, Subtraction and Binary to BCD conversion. 7. Experiments on MUX and DEMUX. 8. To study of encoder and Decoder 9. To study of shift register and counter. 10. Arithmetic operations using microprocessors 8085/8086. 11. D/A converter interfacing and frequency/temperature measurement with microprocessor 8085 / 8086. 12. A/D converter interfacing and AC/DC voltage/current measurement using microprocessor 8085/8086. 13. Motor Speed control, Temperature control using 8085/8086.	all the electronic devices you use in your daily life. 2. Identify the use of these electronic devices in your daily life electronic devices.

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**
   i. Write a note on Electronic devices and make a list of devices (Having diodes and transistors) we are using in our daily life.

b. **Mini Project:**
   (i) Prepare a chart of Diode and its types.
   (ii) Prepare a chart of Transistor and its Characteristics curve.

c. **Other Activities:**
   Try to do simple experiments using diode.

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Brief of Hours suggested for the Course Outcome.

Course Outcomes:	Lab Instruction (Ll)	Sessional Work (SW)	Self-Learning (SL)	Total hours(LI+SW+SL)=

CO252.1:The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	90	15	15	120

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO	Electronic devices(General)	30	10	10	50

Legend: R: Remember, U: Understand, A: Apply

The end-of-semester assessment for Mechanics and General Properties of Matter will be held with a writtenexamination of 50 marks.

Note. Detailed assessment rubrics need to be prepared by the course-wise teachers for the above tasks. Teachers can also design different tasks as per requirements for the end-semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to Science Museum
7. Demonstration
8. ICT-Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) **Books** :

S.No.	Books Name	Author	Publisher	Edition & Year
1.	Practical Physics	S.L. GUPTA, V. KUMAR	Pragati Prakashan	2018
2.	Semi Conductor Devices- Physics and Technology	SM Sze	Wiley	1985
3.	Introduction to Semiconductor devices	M.S. Tyagi	John Wiley and Sons	1991
4.	Measurement, Instrumentation and Experimental Design in Physics and Engineering	M. Sayer and A. Mansingh	Prentice-hall of india private limited	2000
5.	Optical Electronics	Ajoy Ghatak and K. Thygarajan	Cambridge Univ. Press.	1989
6.	Lab Manuals provided by Dept. of Physics, AKS University, Satna.			

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2. Dr C. P. Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
3. Dr Lovely Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH352

Course Title: Electronics Lab-III

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH352.1The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.,	COs No.& Titles,	SOs No.	Laboratory Instruction (LI)	Self Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4	PH352.1The course would empower the students to develop an idea about Electronic Devices, Experimental knowledge, working and characteristics curve of electronic apparatus.	SO1 SO2 SO3 SO4 SO5	Electronic Devices 1,2,3,4,5,6,7,8,9,10	1,2

Semester-IV

Course Code: PH401

Course Title : Physics of Nanomaterials

Pre- requisite: To introduce knowledge on basics of nanoscience and the fundamental concepts behind size reduction in various physical properties. More specifically, the student will be able to understand the different properties of materials being used in various length scales.

Rationale:

- The objective of this course is to provide the knowledge on the Physics of nanostructure materials, materials growth aspects important for size control and size selection and application of nanoscale materials.
- The course lays foundation for advanced courses in engineering aspects of materials and their applications.

Course Outcomes:

PH401.1 Correlate properties of nanostructures with their size, shape and surface characteristics.

PH401.2 Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity and mechanical properties.

PH401.3 Understand the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.

PH401.4 Describe several synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nonporous materials, and nanostructured bulk materials, and also could describe how different lithography methods can be used for making nanostructures.

PH401.5 To comprehend basic knowledge on the characterization of nanomaterials by different methods. Understand some specific materials like graphene and carbon nanotubes for various applications.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Elective (PEC)	PH401	Physics of Nanomaterials	4	0	0	0	4	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ESA)
PEC	PH401	Physics of Nanomaterials	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH401.1: Correlate properties of nanostructures with their size, shape and surface characteristics.

Approximate Hours

Item	Approx. Hrs
Cl	09
LI	0
SW	03
SL	01
Total	13

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Study of electronic band structures in materials. The density of states describes the distribution of energy levels available to electrons in a material. **SO1.2** Emphasize the importance of the density of states in determining various electronic properties, such as conductivity, mobility, and optical characteristics. Emphasize the importance of the density of states in determining various electronic properties, such as conductivity, mobility, and optical characteristics. **SO1.3** Solve the time-independent Schrödinger equation for a particle in an infinitely deep square well. Discuss the quantization of energy levels and the formation of discrete energy states. **SO1.4** Understanding the quantization of energy levels in quantum dots due to confinement in all dimensions. how the size of quantum dots affects their electronic and optical properties. **SO1.5** Elaborating different nanostructured materials like nanotubes, nanowires, nanosheets, nanofilms.	**Unit-1 Concept of Quantum Confinement** 1.1 Density of states in bands 1.2 Variation of density of states with energy (2) 1.3 Electron confinement in infinitely deep square well 1.4 Confinement in two and three dimension 1.5 Idea of quantum well 1.6 Quantum wire and quantum dots 1.7 Classification of nanostructured materials (2)	Basics of Quantum mechanics and different energy levels

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Concept of density of states.
2. Classification of nano structured materials.
3. Concept of quantum well.

PH401.2: Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity and mechanical properties.

Approximate Hours

Item	AppX Hrs
Cl	10
LI	0

SW	2
SL	1
Total	13

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 To understand density of states (DOS) in quantum wells as the distribution of energy states per unit energy range and quantum wells differs from that in bulk materials due to the confinement. **SO2.2** Understand the the energy levels and density of states to the formation of energy bands in quantum wells. Illustrate how the band structure evolves with changes in well dimensions. **SO2.3** Learn the how the discrete energy levels within the well form subbands due to quantum confinement. Understand the concepts of absorption and induced emission in the context of quantum transitions. **SO2.4** Define superlattices as periodic structures composed of alternating layers of different materials. Types of superlattices as binary superlattices, ternary superlattices, and graded superlattices. **SO2.5** Provide an overview of the importance of fabrication techniques in creating well-defined MQW and SL structures.how the choice of fabrication method influences the properties and performance of the resulting structures.	**Unit-2 Quantum wells and Superlattices** 2.1 Energy levels and density of states in quantum wells 2.2 Band structure in quantum well 2.3 Coupling between the wells 2.4 Multiple quantum well structure, Absorption and induced emission. 2.5 Superlattice dispersion relation 2.6 Density of states 2.7Band structure in superlattice 2.8 Types of superlattices 2.9 Techniques of Fabrication of MQW 2.10 SL structures (MBE, MOCVD, LPE etc)	Understanding of band structure and lattice structure.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1. Band structure in superlattice and their types.
2. Various fabrication techniques of multiple quantum well (MQW).

PH401.3 Understand the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.

Item	AppX Hrs
Cl	09
LI	0
SW	3
SL	1
Total	13

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Synthesis of nanoparticles with an understanding of bottom-up approaches including various synthesis process. Exploring the role of precursors, reactants, and reaction conditions in chemical synthesis. **SO3.2** Understanding the another synthesis technique: top down technique **SO3.3** Physical properties of nanoparticles and the influence of impurities, composition, surface characteristics with an understanding of how these factors affect the behavior and applications of nanomaterials. **SO3.4** Relevance of thermodynamics in the context of nanoparticles and their application to nanoscale materials. **SO3. 5** An overview of XRD as a technique for analyzing the crystal structure of materials. Introduce the Bragg equation and the principles of X-ray diffraction.	**Unit-3: Nanoparticles** 3.1 Synthesis of nanoparticles 3.2 Bottom up technique 3.3 Cluster beam evaporation 3.4 Ion beam deposition 3.5 Chemical bath deposition with capping techniques 3.6 Top down technique: Ball milling technique. 3.7 Physical properties of nanoparticles 3.8 Impurities and composition surfaceness, structure 3.9 Thermodynamic properties 3.10 Determination of particle size by width of XRD peaks.	Knowledge of nano dimensional scale.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1. Bottom-up and top-down techiques.
2. Synthesization techniques for the fabrication of nanoparticles.
3. Characterization method (XRD) of nanoparticles.

PH401.4: Describe several synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nonporous materials and nanostructured bulk materials and also able to describe how different lithography methods can be used for making nanostructures.

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Approximate Hours

Item	Approx. Hrs
Cl	07
LI	0
SW	5
SL	1
Total	13

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO4.1 Defining fullerenes as a class of carbon allotropes consisting of unique structural characteristics of fullerenes. Various methods used for the synthesis of fullerenes. **SO4.2** Exploring the framework of structural characteristics of carbon nanotubes. **SO4.3**Synthesization techniques for carbon nanotubes such as arc discharge, chemical vapor deposition (CVD) and laser ablation. **SO4.4** Understanding of the synthesis methods, structural characteristics and characterization techniques associated with these unique carbon allotropes. **SO4.5** Applications of carbon nanotubes in energy storage devices; supercapacitors and batteries, resistive random-access memory (RRAM) and non-volatile memory.	**Unit-4: Carbon Nanotubes** 4.1 Special carbon solids; fullerenes and tubules 4.2 Formation and characterization of fullerenes and tubules. (2) 4.3 Single wall and multi-wall carbon nanotubues.(2) 4.4 Electronic properties of nanotubes. 4.5 Carbon nanotube based electronic devices.	Structure of carbon atom

SW-4 Suggested Sessional Work (SW):

a. Assignments:

1. Concept of carbon nanotubes (single and multiwalled).
2. Synthesization techniques of carbon nanotubes.

3. Characterization techniques of carbon nanotubes.

4. Electronic properties of carbon nanotubes.

5. Applications of nanomaterials.

PH401.5: To comprehend basic knowledge on the characterization of nanomaterials by different methods. Understand some specific materials like graphene and carbon nanotubes for various applications.

Item	Approx. Hrs
Cl	08
LI	0
SW	2
SL	1
Total	11

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO5.1 Familiarizing various characterization techniques (electrical, optical, structural, magnetic) for the understanding of unique properties of nanomaterials. **SO5.2** Understanding of how light interacts with matter including absorption, fluorescence and phosphorescence and inelastic scattering of photons. **SO5.3** Exploring the concept of heat flow in materials as a function of temperature, phase transitions, crystallization, melting and reactions in materials and also viscoelastic behavior, modulus, damping, and glass transition in materials. **SO5.4** Understanding the basic principles of how X-rays interact with crystal lattices to produce diffraction patterns. Also charge transport mechanisms in nanoparticles including hopping, tunneling, and ballistic transport. **SO5.5** Exploring the wideapplications of nanomaterials include optic, electro-optic, medicine, biotechnology and energy applications.	**Unit 5: Characteristics of nanomaterials** 5.1 Special experimental techniques for characterization of nanostructured materials. 5.2 Optical properties (Absorption spectra, luminescence, Raman scattering) 5.3 Thermal and Mechanical characterizations (DSC and DMA), spectral response. 5.4 Determination of particle size by shift in photoluminescence peaks 5.5 Determination of particle size by shift in XRD peaks. 5.6 Electrical properties of nanoparticles. 5.7 Nanostructured magnetic materials, stability of nanocrystals. 5.8 Applications of nanostructured materials.	Synthesis of nanomaterials with various techniques involved.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

1. Different characterization techniques for nanomaterials.
2. Applications of nanomaterials.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH302.1: Correlate properties of nanostructures with their size, shape and surface characteristics.	09	03	1	13
PH401.2: Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity and mechanical properties.	10	02	1	13
PH401.3: Understand the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.	09	03	1	13
PH401.4: Describe several synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nonporous materials, and nanostructured bulk materials, and also could describe how different lithography methods can be used for making nanostructures.	07	05	1	13
PH401.5 To comprehend basic knowledge on the characterization of nanomaterials by different methods. Understand some specific materials like graphene and carbon nanotubes for various applications.	08	02	1	11
Total Hours	**41**	**15**	**5**	**63**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Concept of Quantum Confinement	04	04	02	10
CO-2	Quantum wells and Superlattices	04	05	02	11
CO-3	Nanoparticles	02	03	04	09
CO-4	Carbon Nanotubes	05	04	02	11
CO-5	Characteristics of nanomaterials	03	04	02	09
Total		18	20	12	50

Legend: R: Remember, U: Understand, A: Apply

Note: Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

Text and Reference Books:

1. Introduction to Nanotechnology: Poole and Owners
2. Quantum Dots : Jacak, Hawrylak and Wojs
3. Handbook of Nanostructured Materials and Nanotechnology : Nalva (editor)
4. Nano Technology/ Principles and Practices: S.K. Kulkarni
5. Carbon Nanotubes: Silvana Fiorito
6. Nanotechlongy: Richard Booker and Earl Boysen
7. Nanotechnology Molecularly designed material by Gan-Moog, Chow ,
8. Kenneth. E Gonsalves, AmericanChemical Society.
9. Quantum dot heterostructure by D. Bimerg, M. Grundmann and N.N.Ledentsov John Wiley and sons 1998.
11. Nanotechnology: Molecular Speculations on global abundance by B.C.Gran dall MIT Press 1996.
12. Physics of low dimensional semiconductors by John W. Davies, Cambridge Univ. Press 1999.
13. Physics of semiconductor nanostructures by K.R. Jain Narosa 1999
14. Nano-fabrication and bio-systems: Integrating materials science engineering Science and biology by Harvey C. Hoch, Harold G. Craighead and Lynn Jelinski, Cambridge Univ. Press- 1996.
15. Nano particles and nano structured films: Preparation, characterization and application, Ed. J. H. Fendler, Jhon Wiley and sons 1998.
16. Wave mechanics applied to semiconductor heterostructures by Gerald Bastard.

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code : PH401

Course Title: Physics of Nanomaterials

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
CO1 Correlate properties of nanostructures with their size, shape and surface characteristics.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	2
CO2 Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity and mechanical properties.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	2
CO3 Understand the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	1
CO4 Describe several synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nonporous materials, and nanostructured bulk materials, and also could describe how different lithography methods can be	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	3

used for making nanostructures.																	
CO5 To comprehend basic knowledge on the characterization of nanomaterials by different methods. Understand some specific materials like graphene and carbon nanotubes for various applications.	**-**	**-**	**-**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**	**2**

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO1:** Correlate properties of nanostructures with their size, shape and surface characteristics.	SO1.1 SO1.2(2) SO1.3 SO1.4 SO1.5 SO1.6 SO1.7(2)	Unit-1 **Concept of Quantum Confinement** Historical progression and advancements in binding materials for construction 1.1,1.2,1.3,1.4,1.5,1.6,1.7	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO2:** Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity and mechanical properties	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8 SO2.9 SO2.10	Unit-2 **Quantum wells and Superlattices**Raw Materials and Fuel used for cement manufacture 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10	As mentioned in

				page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO3:** Understand the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale. .	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6 SO3.7 SO3.8 SO3.9 SO3.10	Unit-3 : **Nanoparticles** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**CO4:** Describe several synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nonporous materials, and nanostructured bulk materials, and also could describe how different lithography methods can be used for making nanostructures. .	SO4.1 SO4.2(2) SO4.3(2) SO4.4 SO4.5	Unit-4 : **Carbon Nanotubes** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	
PO 1,2,3,4,5,6	**CO5:** TTo comprehend basic knowledge on the characterization of nanomaterials by different methods. Understand some specific materials like graphene and carbon nanotubes for various applications.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.7 SO5.8	Unit 5: **Characteristics of nanomaterials** . 5.1,5.2,5.3,5.4,5.5	

Semester-IV

Course Code:	**PH402**
Course Title :	**Solar Cell and other Renewable Energy Devices**
Pre- requisite:	To understand the technical feasibility of deploying specific renewable energy technologies. Consider factors such as the suitability of solar cells, wind turbines, or other devices based on the site conditions and energy requirements.
Rationale:	solar cells and other renewable energy devices revolves around mitigating environmental impact, ensuring long-term energy sustainability, fostering economic development, and addressing global challenges related to climate change and resource scarcity.

Course Outcomes

PH402.1 Develop a strong foundation in the physics and material properties relevant to photovoltaic energy conversion. They will be equipped with the knowledge to analyze and understand the operation of photovoltaic devices.

PH402.2 Develop a comprehensive understanding of different types of solar cells, their operating principles, and the underlying concepts of semiconductor physics. They will be able to analyze the performance and efficiency of solar cells, understand the principles of advanced solar cell technologies.

PH402.3 Gain a comprehensive understanding of hydrogen energy, its production through solar methods, and the storage processes and materials involved. They will be equipped with the knowledge to analyze the environmental and energy considerations associated with hydrogen, understand the physics and material characteristics.

PH402.4 Demonstrate a comprehensive understanding of safety factors associated with hydrogen production, storage, and utilization. Understand the use of hydrogen for electricity generation and assess its benefits for power production and Explain elementary concepts of proton-conducting batteries and compare them to other energy storage technologies.

PH402.5. Demonstrate a thorough understanding of the elements and principles of solar thermal energy, wind energy, and ocean thermal energy conversion. Apply their knowledge to design and analyze practical applications of solar thermal energy, including solar cookers, water heaters, and air dryers.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc.I[st](Physics) Program

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Open Elective (OEC)	PH402	Solar Cell and other Renewable Energy Devices	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
OEC	PH402	Solar Cell and other Renewable Energy Devices	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH402.1 Students will develop a strong foundation in the physics and material properties relevant to photovoltaic energy conversion. They will be equipped with the knowledge to analyze and understand the operation of photovoltaic devices.

Approximate Hours	
Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

ession Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1. Demonstrate a comprehensive understanding of the fundamental principles underlying photovoltaic energy conversion. **SO1.2.** Apply knowledge of conversion physics and material properties to assess and design efficient photovoltaic systems. **SO1.3.** Evaluate the optical properties of solids and their importance in the context of solar energy conversion. **SO1.4.** Differentiate between direct and indirect transition semiconductors and analyze their characteristics. **SO1.5.** Establish the interrelationship between absorption coefficients and band gap in semiconductors. **SO1.6.** Assess the impact of carrier recombination on solar cell performance and propose strategies to mitigate its effects. **SO1.7.** Demonstrate practical skills in the analysis and design of solar energy conversion devices. **SO1.8.** Apply theoretical concepts to real-world scenarios in the field of solar energy technology	**Unit 1: Solar Energy** **1.1.** Fundamentals of photovoltaic energy conversion **1.2.** Conversion physics **1.3.** Material properties **1.4.** Relevant to photovoltaic energy conversion **1.5.** Optical properties of solids **1.6.** Importance in solar energy conversion **1.7.** Direct and indirect transition semiconductors **1.8.** Direct and indirect transition semiconductors characteristics **1.9.** Interrelationship between absorption coefficients **1.10.** Band gap in semiconductors **1.11.** Recombination of carriers in photovoltaic materials **1.12.** Impact of carrier recombination on solar cell performance	**i.** Photovoltaic effect **ii.** Conversion of energy **iii.** carrier recombination

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Importance in solar energy conversion

ii. Fundamentals of photovoltaic energy conversion

b. Other Activities (Specify): Seminar and group discussion related to subject

4PHY101.2 Develop a comprehensive understanding of different types of solar cells, their operating principles, and the underlying concepts of semiconductor physics. They will be able to analyze the performance and efficiency of solar cells, understand the principles of advanced solar cell technologies.

Approximate Hours	
Item	AppX Hrs
Cl	13
LI	0
SW	2
SL	3
Total	18

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1. Demonstrate a comprehensive understanding of different types of solar cells and their working principles. **SO2.1.** Apply the principles of p-n junctions to analyze the operation of solar cells. **SO2.3.** Use the transport equation to model charge carrier movement within solar cells. **SO2.4.** Analyze and calculate key parameters such as current density, open-circuit voltage, and short-circuit current in solar cells. **SO2.5.** Describe the characteristics of single crystal silicon and amorphous silicon solar cells. **SO2.6.** Understand the basics of advanced solar cell technologies, including tandem cells and solid-liquid junction cells. **SO2.7.** Explain the principles behind photoelectrochemical solar cells and their potential applications. **SO2.8.** Apply theoretical knowledge to evaluate and design solar cell systems for specific applications	**Unit 2: Solar Cells** **2.1.** Introduction to solar cells **2.2.** Different types of solar cells **2.3.** Principles of p-n junction solar cells **2.4.** Transport equation in solar cells **2.5.** Current density in solar cells **2.6.** Open circuit voltage in solar cells **2.7.** Short circuit current in solar cells **2.8.** Brief descriptions of single crystal silicon **2.9.** Amorphous silicon solar cells **2.10.** Elementary ideas of advanced solar cells **2.11.** Tandem solar cells, **2.12.** Solid-liquid junction solar cells) **2.13.** Principles of photoelectrochemical solar cells	**i.** Basic of cell **ii.** Photo electric effect **iii.** Amorphous materials

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Principles and working of p-n junction solar cells
ii. Principles and working Tandem solar cells,

(b) Other Activities (Specify): Seminar and group discussion related to subject

PH402.3 Gain a comprehensive understanding of hydrogen energy, its production through solar methods, and the storage processes and materials involved. They will be equipped with the knowledge to analyze the environmental and energy considerations associated with hydrogen, understand the physics and material characteristics.

Approximate Hours	
Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	3
Total	17

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1. Understand the global relevance and environmental impact of hydrogen energy in the context of depleting fossil fuels. **SO3.2.** Comprehend the various methods for hydrogen production, with a focus on solar-driven processes. **SO3.3.** Apply the principles of physics and material science to analyze and design systems for the production of solar hydrogen. **SO3.4.** Evaluate different storage methods for hydrogen, considering their advantages and limitations. **SO3.5.** Understand the special features of solid-state hydrogen storage materials and their potential applications. **SO3.6.** Analyze the structural and electronic characteristics of hydrogen storage materials for effective storage solutions.	**Unit 3: Eco-friendly Energy (Hydrogen Energy)** **1.1.** Relevance of hydrogen energy in depletion of fossil fuels **1.2.** Environmental considerations of hydrogen energy **1.3.** Hydrogen production methods **1.4.** Solar hydrogen through photoelectrolysis processes **1.5.** Photocatalytic processes **1.6.** Physics for the production of solar hydrogen **1.7.** Material characteristics for the production of solar hydrogen **1.8.** Storage of hydrogen: overview of various storage processes **1.9.** Special features of solid-state hydrogen storage materials **1.10.** Structural characteristics of hydrogen storage materials **1.11.** electronic characteristics of hydrogen storage materials **1.12.** Introduction to new storage modes for hydrogen	**i.** fossil fuels **ii.** solar hydrogen **ii.** storage materials

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Principle of Photocatalytic processes

ii. Structural and electronic characteristics of hydrogen storage materials

Other Activities (Specify): Seminar and group discussion related to subject

PH402.4 Demonstrate a comprehensive understanding of safety factors associated with hydrogen production, storage, and utilization. Understand the use of hydrogen for electricity generation and assess its benefits for power production and Explain elementary concepts of proton-conducting batteries and compare them to other energy storage technologies

Approximate Hours	
Item	AppX Hrs
Cl	11
LI	0
SW	2
SL	0
Total	13

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO4.1 Demonstrate a comprehensive understanding of hydrogen energy and its potential applications. **SO4.2**Analyze and apply safety considerations in the production, storage, and use of hydrogen in various contexts. **SO4.3**Evaluate the utilization of hydrogen as a fuel source in different industries. **SO4.4**Understand the role of hydrogen in vehicular transport, including hydrogen fuel cell vehicles. **SO4.5**Explore and assess diverse applications of hydrogen energy, including electricity generation and transportation. **SO4.6.**Comprehend the principles and functioning of fuel cells and proton-conducting batteries. **SO4.7.**Gain elementary knowledge of other hydrogen-based devices such as air conditioners and hydride batteries.	**Unit 4: Applications of Hydrogen Energy** **4.1.** Hydrogen Energy **4.2.** Safety considerations in the use of hydrogen **4.3.** Utilization of hydrogen as fuel **4.4.** Hydrogen in vehicular transport **4.5.** Applications of Hydrogen energy **4.6.** Hydrogen for electricity generation **4.7.** fuel cells **4.8.** Proton-conducting batteries **4.9.** Elementary concepts of other hydrogen-based devices **4.10.** Air conditioners **4.11.** Hydride batteries	**i.**Batteries **ii.**Electricity generation **iii.**Fuel

SW-4 Suggested Sessional Work (SW):

a) Assignments:

(i) Applications of Hydrogen energy

(ii) Elementary concepts of other hydrogen-based devices

Other Activities (Specify): Seminar and group discussion related to subject

PH402.5. Demonstrate a thorough understanding of the elements and principles of solar thermal energy, wind energy, and ocean thermal energy conversion. Apply their knowledge to design and analyze practical applications of solar thermal energy, including solar cookers, water heaters, and air dryers.

Approximate Hours	
Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	3
Total	17

Session Outcomes (SOs)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Demonstrate a comprehensive understanding of clean energy and its significance in addressing environmental challenges. **SO5.2.** Differentiate between renewable and non-renewable energy sources and analyze their environmental impacts. **SO5.3.** Understand the principles and applications of solar thermal energy, wind energy, and ocean thermal energy conversion. **SO5.4.** Analyze the design and functionality of solar cookers, water heaters, and air dryers. **SO5.5.** Explore specific examples of solar thermal energy applications in different sectors. **SO5.6.** Classify and describe various wind machines used for energy generation.	**Unit 5: Clean Energy** **5.1.** Introduction of Clean Energy **5.2.** Renewable energies **5.3.** Non-Renewable energies **5.4.** solar thermal energy, **5.5.** wind energy, **5.6.** Ocean thermal energy conversion **5.7.** Solar cookers, **5.8.** Water heaters, **5.9.** Air dryers **5.10.** Examples of solar thermal energy applications **5.11.** Classification and description of wind machines **5.12.** Performance analysis of wind machines (solidity factor, energy in the wind)	**i.** Energies **ii.** Thermal energy **iii.** Wind machines

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
    i. Renewable energies and Non-Renewable energies
    ii. Solar cookers.

b. **Other Activities (Specify):**

Seminar and group discussion related to subject

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH402.1: Understanding Fundamental Electrostatic Concepts: Students will review and deepen their understanding of fundamental electrostatic concepts, including electric fields, Gauss's law, Laplace's and Poisson's equations, and methods of images.	12	2	3	17
PH402.2: Maxwell's Equations: Familiarity with Maxwell's equations, both in integral and differential forms, and the ability to apply them to solve problems in electrostatics and magnetostatics.	13	2	3	18
PH402.3: Relativistic Electrodynamics: Exploring the extension of classical electrodynamics to the relativistic regime, including the invariance of electric charge and the transformation properties of electric and magnetic fields under Lorentz transformations.	12	2	3	17
PH402.4: Covariance of Electrodynamics: Understanding the covariance of electrodynamics and deriving the Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field.	11	2	3	16
PH402.5: Magnetohydrodynamic Equations: Understanding the fundamental magnetohydrodynamic equations and their applications in describing plasma behavior.	12	2	3	17
Total Hours	60	10	15	85

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Unit-1:** Solar Energy	03	10	01	14
CO-2	**Unit 2:** Solar cell	02	10	02	14
CO-3	**Unit 3:** Eco-friendly energy	03	10	05	18
CO-4	**Unit 4:** Applications of hydrogen energy	3	10	05	18
CO-5	**Unit 5:** Clean energy	03	10	05	18
Total		14	60	18	92

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Fundamentals of Solar Cells Photovoltatic Solar Energy:	Fahrenbruch & Bube		
2	Photoelectrochemical Solar Cells	Chandra		
3	Solar energy Thermal Processs	Dluffie and Backman.	Wiley & Sons. New York	
4	Solar Energy	Jui Sheng Haieh,Prentic Hall,	New Jersey	
5	Solar Energy	S.P, Tata McGraw Hill,	New Delhi	
6	Hydrogen as an Energy Carrier Technologies System Economy	Winter & Nitch (Eds.)		

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code : PH402

Course Title: Solar Cell and other Renewable Energy Devices

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engin e ering knowle dge	Pro b lem anal ysis	Desig n/dev elop ment of soluti ons	Cond uct invest igatio ns of compl ex probl ems	Mode rn tool usage	The engi neer and soci ety	Enviro n ment and sustain ability:	Ethics	Indiv i dual and team work :	Com munic ation:	Project manage ment and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicat e effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engag e in life-long learnin g and will have recogn ition.
PH402.1 Develop a strong foundation in the physics and material properties relevant to photovoltaic energy conversion. They will be equipped with the knowledge to analyze and understand the operation of photovoltaic devices.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	2
PH402.2 Develop a comprehensive understanding of different types of solar cells, their operating principles, and the underlying concepts of semiconductor physics. They will be able to analyze the performance and efficiency of solar cells, understand the principles of advanced solar cell technologies.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	2
PH402.3 Gain a comprehensive understanding of hydrogen energy, its production through solar methods, and the storage processes and materials involved. They will be equipped with the knowledge to analyze the environmental and energy considerations associated with hydrogen, understand the physics and material characteristics.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
PH402.4 Demonstrate a comprehensive understanding of safety factors associated with hydrogen production, storage, and utilization. Understand the use of hydrogen for electricity generation and assess its benefits	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	3

for power production and Explain elementary concepts of proton-conducting batteries and compare them to other energy storage technologies.																	
PH402.5. Demonstrate a thorough understanding of the elements and principles of solar thermal energy, wind energy, and ocean thermal energy conversion. Apply their knowledge to design and analyze practical applications of solar thermal energy, including solar cookers, water heaters, and air dryers.	**1**	**2**	**2**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**	**3**

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self-Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH402.1** Develop a strong foundation in the physics and material properties relevant to photovoltaic energy conversion. They will be equipped with the knowledge to analyze and understand the operation of photovoltaic devices.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5 SO1.6 SO1.7 SO1.8	**Unit-1.**Solar Energy 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11,1.12	i ii ii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH402.2** Develop a comprehensive understanding of different types of solar cells, their operating principles, and the underlying concepts of semiconductor physics. They will be able to analyze the performance and efficiency of solar cells, understand the principles of advanced solar cell technologies.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5 SO2.6 SO2.7 SO2.8	**Unit-2** :Solar cell 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10,2.11,2.12, 2.13	i ii ii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH402.3** Gain a comprehensive understanding of hydrogen energy, its production through solar methods, and the storage processes and materials involved. They will be equipped with the knowledge to analyze the environmental and energy considerations associated with hydrogen, understand the physics and material characteristics.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5 SO3.6	**Unit-3 :** Eco-friendly energy 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12	i ii ii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH402.4** Demonstrate a comprehensive understanding of safety factors associated with hydrogen production, storage, and utilization. Understand the use of hydrogen for electricity generation and assess its benefits for power production and Explain elementary concepts of proton-conducting batteries and compare them to other energy storage technologies.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5 SO4.6 SO4.7	**Unit-4 :** Applications of hydrogen energy 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10,4.11,4.12,	i ii ii
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH402.5.** Demonstrate a thorough understanding of the elements and principles of solar thermal energy, wind energy, and ocean thermal energy conversion. Apply their knowledge to design and analyze practical applications of solar thermal energy, including solar cookers, water heaters, and air dryers. .	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5 SO5.6	**Unit 5:** Clean energy 5.1,5.2,5.3,5.4,5.5	i ii ii

Semester-IV

Course Code:	PH403
Course Title :	**Computational and Experimental Techniques and Data Analysis**
Pre- requisite:	Student should have basic knowledge of basic properties of nuclei, nuclear reactions, general knowledge nuclear model and elementary knowledge of particles.
Rationale:	The students studying Physics should possess foundational understanding about historical background of Computational and Experimental Techniques and Data Analysis.

Course Outcomes:

PH403.1 : Computations techniques to solve various differential equations

PH403.2 : The solutions of linear and non-linear equations along with solutions of differential equations.

PH403.3 : Monte Carlo methods and its application to problems of physicalworld.

PH403.4 : To understand computer application to problems in condensed matter physics.

PH403.5 : Learn about experimental techniques and data analysis used in physics.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Elective (PEC)	PH403	**Computational and Experimental Techniques and Data Analysis**	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PEC	PH403	Computational and Experimental Techniques and Data Analysis	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH403.1: Computations techniques to solve various differential equations

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 learn computations techniques to solve various numerical integration **SO1.2** learn computer programming to solve various numerical integration **SO1.3** Able to create hypothetical data sets for Physical Systems. **SO1.4** Aware of various Numerical methods. **SO1.5** understand error analysis by various numerical integration	**Unit I (Numerical Integration)** 1.1 Newton-cotes formulae (2) 1.2 Trapezoidal rule 1.3 Simpson's 1/3 rule 1.4 error estimates in trapezoidal rule (2) 1.5 Simpson 1/3 rule using Richardson deferred limit approach 1.6 Gauss-Legender quadrature method (2) 1.7 Monte Carlo method for single integral 1.8 Monte Carlo method for double integral 1.9 Monte Carlo method for triple integral	Learn about Numerical Integration

SW-1 Suggested Sessional Work (SW):

a. **Assignments:**

Explain Gauss-Legender quadrature method

b. **Other Activities (Specify):**

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH403.2: The solutions of linear and non-linear equations along with solutions of differential equations.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Aware of various numerical differential methods. **SO2.2U**nderstand error by various numerical differential methods. **SO2.3** Learn computational techniques to solve differential methods. **SO2.4** Use of differential methods. **SO2.5** Able to create hypothetical data sets for physical systems.	**Unit-II (Differentiation equ and its solution)** 2.1 Numerical Differentiation 2.2 Taylor Series method 2.3 Generalized numerical differentiation 2.4 Truncation errors 2.5 Numerical Solution of First Order Differential Eqns 2.6 First order Taylor Series method 2.7 Euler's method 2.8 Runge Kutta methods 2.9 Predictor corrector method 2.10 Elementary ideas of solutions of partial differential eqns 2.11 Numerical Solutions of Second Order Differential Eqns 2.12 Initial and boundary value problems: shooting methods.	1. Learn about Numerical Differentiation

SW-2 Suggested Sessional Work (SW):

a. Assignments:

Explain Numerical Solutions of Second Order Differential Equation.

b. Other Activities (Specify):
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH403.3: Monte Carlo methods and its application to problems of physicalworld.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO3.1 Learn molecular simulations and optimization techniques. **SO3.2** Familiar with random sampling of large data sets. **SO3.3** Able to create hypothetical data sets for Physical Systems. **SO3.4** Aware of various simulation methods. **SO3.5** Understands error analysis by various simulation methods.	**UNIT – III Introduction to Computer Simulation** 3.1 Molecular Dynamics 3.2 Molecular Dynamic Simulation Gas with random collisions (2) 3.3 N body gas, 3.4 Monte Carlo simulations (2) 3.5 The 2-D Ising model 3.6 The 2-D Ising model for interacting spins 3.7 Specific heat 3.8 Average energy 3.9 Magnetization 3.10 Susceptibility	1. Introduction to Computer Simulation

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**

Explain Monte Carlo simulations with example.

b. **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH403.4: To understand computer application to problems in condensed matter physics.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Aware of problems in condensed matter physics. **SO4.2 U**nderstand simulation of phonon. **SO4.3** Learn simulation techniques to solve problems in condense matter physics. **SO4.4** Use differential methods of free electron theory. **SO4.5** Able to theory of symmetry and phonon propagation.	**UNIT – IV (Computer Application to problems in Condensed Matter Physics)** 4.1 Simulation of phonon dispersion curves (2) 4.2 density of states 4.3 The reciprocal lattice (2) 4.4 Harrison construction(2D) (3) 4.5 One dimensional phonon propagation (2) 4.6 Two dimensional Lattice vibrations 4.7 Two dimensional nearly free electrons	1. Learn simulation techniques to solve problems in condense matter physics

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**

Explain Harrison construction.

b. Other Activities (Specify):
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH403.5: Learn about experimental techniques and data analysis used in physics.

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Learn about various types of transducer. **SO5.2** Familiar with measurement and control Signal conditioning and recovery. **SO5.3** Able to create hypothetical data sets for Physical Systems. **SO5.4** Aware with Data interpretation and analysis. **SO5.5** Understands error analysis by linear and curve fitting.	**Unit-V (Experimental Techniques and Data analysis)** 5.1 Transducers 5.2 Temperature 5.3 pressure/vacuum 5.4 magnetic field, vibration, optical and particle detectors 5.5 Measurement and control: Signal conditioning & recovery, impedance matching 5.6 Shielding and grounding 5.7 Data interpretation and analysis 5.8 Precision and accuracy, error analysis, propagation of errors 5.9 least squares fitting, 5.10 linear and non-linear curve fitting 5.11Chi-square test 5.12 Linear regression; Polynomial regression; Exponential and Geometric regression	. General theory of Experimental Techniques and Data analysis

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Explain Linear regression; Polynomial regression; Exponential and Geometric regression.

b. **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH403.1: Computations techniques to solve various differential equations	**12**	1	1	14
PH403.2: The solutions of linear and non-linear equations along with solutions of differential equations.	12	1	1	14
PH403.3: Monte Carlo methods and its application to problems of physicalworld.	12	1	1	14
PH403.4: To understand computer application to problems in condensed matter physics.	12	1	1	14
PH403.5: Learn about experimental techniques and data analysis used in physics.	12	1	1	**14**
Total Hours	**60**	**5**	**5**	**70**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Numerical Integration**	03	04	03	05
CO-2	**Differentiation equ and its solution**	04	03	03	10
CO-3	**Introduction to Computer Simulation**	04	03	03	15
CO-4	**Computer Application to problems in Condensed Matter Physics**	03	04	03	15
CO-5	**Experimental Techniques and Data analysis**	03	04	03	05
Total		17	18	15	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Introductory methods of Numerical Analysis	S. S. Sastry	PHI	5th & 2012
2	Computer Oriented Numerical Methods	V. Rajaraman	PHI	4th & 2019
3	Numerical methods for Mathematics, Science and Engineering	John H. Mathew	Pearson Education (US)	2nd & 1992
5	Lecture note provided by Department of Physics, AKS University, Satna (M. P.)			

Curriculum Development Team

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH403

Course Title: Computational and Experimental Techniques and Data Analysis

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH403.1: Computations techniques to solve various differential equations	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1
PH403.2: The solutions of linear and non-linear equations along with solutions of differential equations.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	1
PH403.3: Monte Carlo methods and its application to problems of physicalworld.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
PH403.4: To understand computer application to problems in condensed matter physics.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
PH403.5: Learn about experimental techniques and data analysis used in physics.	2	1	2	1	1	3	3	3	1	1	2	2	3	3	1	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning (SL)
PO 1,2,3,4,5,6, 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH403.1:** Computations techniques to solve various differential equations	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**Unit I (Numerical Integration)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9	As mentioned in page number 2 to 6
PO 1,2,3,4,5,6, 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH403.2:** The solutions of linear and non-linear equations along with solutions of differential equations.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**Unit-II (Differentiation equ and its solution)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10, 2.11, 2.12	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH403.3:** Monte Carlo methods and its application to problems of physicalworld.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**UNIT – III Introduction to Computer Simulation** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH403.4:** To understand computer application to problems in condensed matter physics.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**UNIT – IV (Computer Application to problems in Condensed Matter Physics)** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	**PH403.5:** Learn about experimental techniques and data analysis used in physics.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**UNIT – V (Experimental Techniques and Data analysis)** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	

Semester-IV

Course Code: PH404

Course Title : **Physics of Solar Energy**

Pre- requisite: There is no prerequisite or co- requisite for this course. But students are expected to know basic semiconductor physics.

Rationale: The students studying Physics should possess foundational understanding about historical background of solar energy.

Course Outcomes:

PH404.1. The available solar energy and the current solar energy conversion and utilization processes, solar spectrum.

PH404.2. The factors that influence the use of solar radiation as an energy source.

PH404.3. The various active and passive technologies that are available for collecting solar energy; have the ability to apply design principles to selection of an appropriate solar energy installation to meet requirements.

PH404.4. How solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated.

PH404.5. To examine the potential & drawbacks of currently manufactured technologies, as well as pre-commercial technologies. How to enhance solar cell performance and reduce cost, and the major hurdles-technological and economic, towards widespread adoption.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Open Electives (OEC)	PH404	**Physics of Solar Energy**	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
OEC	PH404	**Solar Energy**	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH404.1. The available solar energy and the current solar energy conversion and utilization processes, solar spectrum.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)

SO1.1 To understand the radiation. **SO1.2** To learn about the absorption of solar radiation in the atmosphere. **SO1.3** To understand the global and diffused radiation, seasonal and daily variation. **SO1.4** To learn about sun tracking systems. **SO1.5** To learn about solar energy collector efficiency and its dependence on various parameters.	**UNIT – I (Solar Radiation)** 1.1 origin 1.2 solar constant 1.3 spectral distribution of solar radiation 1.4 absorption of solar radiation in the atmosphere 1.5 global and diffused radiation 1.6 seasonal and daily variation of solar radiation 1.7 measurement of solar radiation 1.8 sun tracking systems 1.9 photo thermal conversion 1.10 solar energy collectors 1.11 collector efficiency and its dependence on various parameters (2)	1. Study about Radiation

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Explain solar radiation and origin of radiation.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH404.2. The factors that influence the use of solar radiation as an energy source.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 To understand the solar energy. **SO2.2** To learn about storage of solar energy. **SO2.3** To learn about solar water heater and solar cooker. **SO2.4** To learn about solar fuels **SO2.5** Understand the principle of solar green houses.	**UNIT – II (Solar energy)** 2.1 storage of solar energy 2.2 solar pond 2.3 solar water heater 2.4 solardistillation 2.5 solar cooker 2.6 solar green houses 2.7 solar dryers 2.8 absorption air conditioning 2.9 solar fuels 2.10 electrolysis of water 2.11 photoelectrochemical splitting of water (2)	1. Learn about solar energy

SW-2 Suggested Sessional Work (SW):

a) **Assignments:**
   i. Explain solar cooker with principle, construction and working.
   ii. Discuss about solar dryers.

b) Other Activities (Specify):
   Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH404.3. The various active and passive technologies that are available for collecting solar energy; have the ability to apply design principles to selection of an appropriate solar energy installation to meet requirements.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 To learn about Photo voltaic effect. **SO3.2** To understand semiconductor properties**.** **SO3.3** To learn about p-n junction its characteristics. **SO3.4** To understand thermal equilibrium condition**.** **SO3.5** To understand Silicon based solar cells: single crystal, polycrystalline and amorphous silicon solar cells.	**UNIT – III (Fundamentals of solar cells)** 3.1 Photo voltaic effect 3.2 semiconductor properties 3.3 energylevels 3.4 basic equations 3.5 p-n junction its characteristics 3.6 fabrication steps 3.7 thermal equilibrium condition 3.8 depletion capacitance 3.9 junction breakdown 3.10 heterojunction 3.11 Silicon based solar cells: single crystal, polycrystalline and amorphous silicon solar cells (2)	1. fundamental of solar cells.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Explain p-n junction and its characteristics.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH404.4. How solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 To understand Solar cell device structures. **SO4.2** Learn about Solar cell device construction. **SO4.3** Learn about surface structures for maximum light absorption. **SO4.4** Elementary treatment of current voltage characteristics in dark and light. **SO4.5** Understanding about charge carrier generation recombination and other losses.	**UNIT – IV (Device physics-I)** 4.1 Solar cell device structures 4.2 construction 4.3 output power, efficiency, fill factor and optimization for maximum power(4) 4.4 surface structures for maximum light absorption 4.5 current voltage characteristics in dark and light 4.6 operating temperature vs conversion efficiency 4.7 charge carrier generation 4.8 recombination and other losses(2)	1. Learn about solar devices.

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
   i. Write Solar cell device structures.
   ii. Describe briefly operating temperature vs conversion efficiency.

b) **Other Activities (Specify):**
   Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH404.5. To examine the potential & drawbacks of currently manufactured technologies, as well as pre-commercial technologies. How to enhance solar cell performance and reduce cost, and the major hurdles-technological and economic, towards widespread adoption.

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 To understand Cadmiumtelluride solar cells. **SO5.2** Learn about copper indium gallium selenide solar cells. **SO5.3** Learn about organic solar cells. **SO5.4** Learn about perovskite solar cells. **SO5.5** To understand advanced concepts in photovoltaic research.	**UNIT – V (Device physics-II**) 5.1 Cadmiumtelluride solar cells 5.2 copper indium gallium selenide solar cells 5.3 organic solar cells 5.4 perovskite solar cells 5.5 Advanced concepts in photovoltaic research	1. Learn about solar devices.

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Explain Covariant four- dimensional formulation.

b. **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH404.1. The available solar energy and the current solar energy conversion and utilization processes, solar spectrum.	**12**	1	1	14

PH404.2. The factors that influence the use of solar radiation as an energy source.	12	1	1	14
PH404.3. The various active and passive technologies that are available for collecting solar energy; have the ability to apply design principles to selection of an appropriate solar energy installation to meet requirements.	12	1	1	14
PH404.4. How solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated.	12	1	1	14
PH404.5. To examine the potential & drawbacks of currently manufactured technologies, as well as pre-commercial technologies. How to enhance solar cell performance and reduce cost, and the major hurdles-technological and economic, towards widespread adoption.	12	1	1	**14**
Total Hours	**60**	**5**	**5**	**70**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Solar Radiation**	03	04	03	10
CO-2	**Solar energy**	03	04	03	10
CO-3	**Fundamentals of solar cells**	03	04	03	10
CO-4	**Device physics-I**	03	04	03	10
CO-5	**Device physics-II**	03	04	03	10
Total		15	20	15	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Solar energy fundamentals and applications	H P Garg, J Prakash	Tata McGraw Hill publishing Co.Ltd	2006
2	Principles of Solar Engineering	D. Yogi Goswami, Frank Kreith, Jan F. Kreider	Taylor and Francis	2000
3	Semiconductor Devices, Basic Principles	Jasprit Singh	Wiley	2001
4	Solar Cell Device Physics	Stephen J.Fonash	2nd edition, Academic Press	2003
5	Lecture note provided by Department of Physics, AKS University, Satna (M. P.)			

Curriculum Development Team

1. Dr O. P. Tripathi , Head, Department of Physics, AKS University Satna (M.P.)
2. Dr C. P. Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
3. Dr Lovely Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
4. Mr. Saket Kumar , Assistant Professor , Department of Physics, AKS University Satna (M.P.)
5. Mr. Manish Agrawal, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
6. Miss Swati Kushwaha, Lab Faculty , Department of Physics, AKS University Satna (M.P.)

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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH404

Course Title: Physics of Solar Energy

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH404.1. The available solar energy and the current solar energy conversion and utilization processes, solar spectrum.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1
PH404.2. The factors that influence the use of solar radiation as an energy source.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	1
PH404.3. The various active and passive technologies that are available for collecting solar energy; have the ability to apply design principles	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2

to selection of an appropriate solar energy installation to meet requirements.																	
PH404.4. How solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated.	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	2
PH404.5. To examine the potential & drawbacks of currently manufactured technologies, as well as pre-commercial technologies. How to enhance solar cell performance and reduce cost, and the major hurdles-technological and economic, towards widespread adoption.	**2**	**1**	**2**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**1**	**3**	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning (SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH404.1. The available solar energy and the current solar energy conversion and utilization processes, solar spectrum.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**UNIT – I (Solar Radiation)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11	As mentioned in page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH404.2. The factors that influence the use of solar radiation as an energy source.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**UNIT – II (Solar Energy)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10, 2.11	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH404.3. The various active and passive technologies that are available for collecting solar energy; have the ability to apply design principles to selection of an appropriate solar energy installation to meet requirements.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**UNIT – III (Fundamentals of solar cells)** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH404.4. How solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**UNIT – IV (Device physics-I)** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH404.5. To examine the potential & drawbacks of currently manufactured technologies, as well as pre-commercial technologies. How to enhance solar cell performance and reduce cost, and the major hurdles-technological and economic, towards widespread adoption.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**UNIT – V (Device physics-II)** 5.1, 5.2, 5.3, 5.4, 5.5	

Semester-IV

Course Code: PH405

Course Title : **Astronomy and Space physics**

Pre- requisite: To study this course, the student must had Physics as a subject in Diploma..

Rationale: The students studying Physics should possess foundational understanding about historical background of astronomy and space physics.

Course Outcomes:

PH405.1. Student will be able to know the basic concepts of astronomy and space physics.

PH405.2. Student will be able to know about physical processes optical telescope, in stars and ' evolution of stars.

PH405.3. Student would be able to know about stellar distances and other.

PH405.4. Student would be able to differentiate between various coordinate systems and know about Binary stars and their motions.

PH405.5. Student would be able to know about the characteristics of Sun.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Elective (PEC)	PH405	Astronomy and Space physics	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA + ESA)
PEC	PH405	Astronomy and Space physics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH405.1. Student will be able to know the basic concepts of astronomy and space physics.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 To understand the Astronomical Coordinates. **SO1.2** To learn about the Horizon, Equatorial, Ecliptic and galactic system of coordinates. **SO1.3** To understand the Apparent and Mean solar time and their relations. **SO1.4** To learn about Calendar, Julian date and heliocentric correction. **SO1.5** To learn about H-R Diagram.	**UNIT – I (Observational Data)** 1.1 Astronomical Coordinates- Celestial Sphere 1.2 Horizon, Equatorial, Ecliptic and galactic system of coordinates 1.3 Conversion from one coordinate system to another 1.4 Aspects of sky from different places on the earth 1.5 Twilight, Seasons, Sidereal 1.6 Apparent and Mean solar time and their relations 1.7 Calendar. Julian date and heliocentric correction 1.8 Determination of Mass, luminosity, radius, temperature and distance of a star 1.9 H-R Diagram 1.10 Empirical mass-luminosity relation	1. Aspects of sky from different places on the earth

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Explain solar radiation and origin of radiation.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH405.2. Student will be able to know about physical optical telescope, processes in stars and ' evolution of stars.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 To understand the solar energy. **SO2.2** To learn about storage of solar energy. **SO2.3** To learn about solar water heater and solar cooker. **SO2.4** To learn about solar fuels **SO2.5** Understand the principle of solar green houses.	**UNIT – II (Telescopes)** 2.1 Basic Optics 2.2 Optical Telescopes 2.3 Radio Telescopes 2.4 Infrared Astronomy 2.5 Ultraviolet Astronomy 2.6 X-ray Astronomy 2.7 Gamma-Ray Astronomy 2.8 All-Sky Surveys 2.9 Virtual Observatories	1. Learn about Optics 2. Basic knowledge of optical instruments

SW-2 Suggested Sessional Work (SW):

a) Assignments:

i. Explain Optical Telescopes with principle, construction and working.
ii. Discuss about X-ray Astronomy.

b) Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH405.3. Student would be able to know about stellar distances and other.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 To learn about stellar motions. **SO3.2** To understand secular and moving cluster parallaxes. **SO3.3** To learn about atmospheric extinction. **SO3.4** To understand Black-body approximation to the continuous radiation and temperatures of stars. **SO3.5** To understand variable stars as distance indicators.	**UNIT – III (Stellar Distances and Magnitudes)** 3.1 Distances of stars from the trigonometric 3.2 secular andmoving cluster parallaxes 3.3 Stellar motions 3.4 Magnitude scale and magnitude systems 3.5 Atmospheric extinction 3.6 Absolute magnitudes and distance modulus 3.7 Colour index 3.8 Black-body approximation to the continuous radiation and temperatures of stars 3.9 Variable stars as distance indicators	1. Fundamental of Magnitude scale and magnitude systems for stellar motions.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Explain Variable stars as distance indicators.

b. Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH405.4. Student would be able to differentiate between various coordinate systems and know about Binary stars and their motions.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0

SW	1
SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 To understand Visual, spectroscopic and eclipsing binaries. **SO4.2** Learn about importance of binary stars as source of basic astrophysical data. **SO4.3** Learn about classification and properties of various types of intrinsic and eruptive variable stars**.** **SO4.4** Astrophysical importance of the study of variable stars. **SO4.5** Understanding about novae and supernovae.	**UNIT – IV (Binaries and Variable Stars)** 4.1 Visual, spectroscopic and eclipsing binaries 4.2 Importance ofbinary stars as source of basic astrophysical data 4.3 Classification and properties of various types of intrinsic and eruptive variable stars 4.4 Astrophysical importance of the study of variable stars. 4.5 Novae 4.6 Supernovae	1. Learn about Supernovae. 2. Basics of stars and solar system

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Give classification and properties of varioustypes of intrinsic and eruptive variable stars.

b) Other Activities (Specify):

Present any one topic of this unit by power point presentation in front of departmental student and faculty.

PH405.5. Student would be able to know about the characteristics of Sun.

Item	AppX Hrs
Cl	12
LI	0
SW	1

SL	1
Total	14

Session Outcomes (SOs)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 To understand Physical Characteristic of Sun. **SO5.2** Learn about solar magnetic fields. **SO5.3** Learn about organic sun-spots. **SO5.4** Learn about solar atmosphere-chromospheres and corona. **SO5.5** To understand advanced concepts of Solar activity.	**UNIT – V (The Sun)** 5.1 Physical Characteristic of Sun 5.2 Basic data, solar rotation 5.3 solar magnetic fields 5.4 Photosphere- granulation 5.5 sun-spots 5.6 Babcock model of sunspot formation 5.7 solar atmosphere- chromospheres and corona 5.8 Solar activity 5.9 flares 5.10 prominences 5.11 Solar wind and activity cycle 5.12 Helioseismology	1. Learn about Solar wind and activity cycle. 2. About interplanetary parameters

SW-5 Suggested Sessional Work (SW):

a. **Assignments:**
Explain Solar activity.

b. **Other Activities (Specify):**
Present any one topic of this unit by power point presentation in front of departmental student and faculty.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)

PH405.1. Student will be able to know the basic concepts of astronomy and space physics.	**12**	1	1	14
PH405.2. Student will be able to know about physical processes optical telescope, in stars and ' evolution of stars.	12	1	1	14
PH405.3. Student would be able to know about stellar distances and other.	12	1	1	14
PH405.4. Student would be able to differentiate between various coordinate systems and know about Binary stars and their motions.	12	1	1	14
PH405.5. Student would be able to know about the characteristics of Sun.	12	1	1	**14**
Total Hours	**60**	**5**	**5**	**70**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Observational Data**	03	04	03	10
CO-2	**Telescopes**	03	04	03	10
CO-3	**Stellar Distances and Magnitudes**	03	04	03	10
CO-4	**Binaries and Variable Stars**	03	04	03	10
CO-5	**The Sun**	03	04	03	10
Total		15	20	15	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	Text book of Spherical Astronomy	**W.M.Smart**	Cambridge University Press	6th edition,1977
2	Astronomy, The evolving Universe	**M. Zeilik**	Cambridge University Press	1st Edition,2002
3	Solar Astrophysics	**P.V. Foukal**	Wiley-VCH, United States	1st Edition, 2004
4	Introduction to Astronomy and Cosmology	**I. Morrison**	Wiley, United States	1st Edition,2008
5	Lecture note provided by Department of Physics, AKS University, Satna (M. P.)			

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4. Mr. Saket Kumar , Assistant Professor , Department of Physics, AKS University Satna (M.P.)
5. Mr. Manish Agrawal, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH405

Course Title: Astronomy and Space physics

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	Problem analysis	Design/development of solutions	Cond uct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
PH405.1. Student will be able to know the basic concepts of astronomy and space physics.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1
PH405.2. Student will be able to know about physical processes optical telescope, in stars and ' evolution of stars.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1	1
PH405.3. Student would be able to know about stellar distances and other.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2	2
PH405.4. Student would be able to differentiate between various coordinate systems and know about Binary stars and their motions.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2	2
PH405.5. Student would be able to know about the characteristics of Sun.	2	1	2	1	1	3	3	3	1	1	2	2	3	3	1	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH405.1. Student will be able to know the basic concepts of astronomy and space physics.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	**UNIT – I (Observational Data)** 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10	As mentioned in page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH405.2. Student will be able to know about physical processes optical telescope, in stars and evolution of stars.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	**UNIT – II (Telescopes)** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH405.3. Student would be able to know about stellar distances and other.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	**UNIT – III (Stellar Distances and Magnitudes)** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH405.4. Student would be able to differentiate between various coordinate systems and know about Binary stars and their motions.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	**UNIT – IV (Binaries and Variable Stars**) 4.1, 4.2, 4.3, 4.4, 4.5, 4.6	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH405.5. Student would be able to know about the characteristics of Sun.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	**UNIT – V (The Sun**) 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12	

Semester-IV

Course Code:	PH451
Course Title :	**General Energy and Computational Lab**
Pre- requisite:	Student should have basic knowledge of practical instruments in graduation.
Rationale:	The students studying Physics should possess foundational understanding about historical background of graduation.

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

PH451.1. learn various Physics aspects by performing the experiments related to nano material synthesis and computational techniques.

A K S University

Faculty of Basic Science

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	PH451	**General Energy and Computational Lab**	0	6	1	1	8	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical Lab

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Lab work Assignment 5 number 7 marks each (LA)	Viva-Voice on Lab work 10 marks each (VV)	Lab Attendance (LA)	Total Marks (LA+VV+LA)		
PCC	PH451	General Energy and Computational Lab	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH451.1. learn various Physics aspects by performing the experiments related to nano material synthesis and computational techniques.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	90
SW	15
SL	15
Total	120

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Self Learning (SL)**
SO1.1 Learn about nanomaterial, nanofibre and nanotube. **SO1.2** Understand computational techniques. **SO1.3** Understand synthesis of nanocomoposite. **SO1.4** Design and fabrication of solar panels. **SO1.5** Learn about Error analysis.	1. To study of Cabon Nanotubes by Spray Pysolysis method and its verification through x-ray diffraction. 2. To study the I-V characteristics of the supplied solar cell and find its spectral response. 3. Analysis of H-atom spectra in minerals. 4. To study of Neutron activation analysis. 5. Synthesis of Polymer electrolytes by using solution cast method. 6. Study of preparation techniques for oxides nanomaterials. 7. Synthesis of Nanocomposite Polymer electrolytes with the help of sol-gel method. 8. Study of synthesis of nanofibers using gel-spinning and electrospinning	1. Learn about basic computer and nano material

	techniques. 9. To determine the current density, open circuit voltage, power density for hydrogen batteries (proton conducting). 10. To study design and fabrication of solar panels. 11. To study of charging-discharging behavior of electrochemical devices. 12. To study production techniques of fuel cell. 13. To study production methods of wind energy devices. 14. Numerical solution of ordinary differential equation with the help of PC. 15. Numerical Solution of second order ordinary differential equations by using PC. 16. Numerical solution of simultaneous linear algebraic equations 17. To study of least square fitting with simple example. 18. Numerical solutions of equations (single veriable).	

SW-1 Suggested Sessional Work (SW):

Assignments:
Study of charging-discharging behavior of electrochemical devices

Other Activities (Specify):

Perform experimental verification to other student and show it.

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH451.1. learn various Physics aspects by performing the experiments related to nano material synthesis and computational techniques.	**90**	15	15	120
Total Hours	**90**	**15**	**15**	**120**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	**Unit Titles**	**Marks Distribution**			**Total Marks**
		R	**U**	**A**	
CO-1	**General Energy and Computational Lab**	13	24	13	50
Total		13	24	13	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Experimental Physics	**Worsnop and Flint**	Little hampton Book Services Ltd, United Kingdom	9th Edition, 1951
2	Experiments in Modern Physics	**A. C. Melissinos, J. Napolitano**	Academic Press, Cambridge, Massachusetts	2nd Edition, 2003
3	Lab manuals provided by Department of Physics, AKS University, Satna (M. P.)			

Curriculum Development Team

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2. Dr C. P. Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
3. Dr Lovely Singh, Assistant Professor , Department of Physics, AKS University Satna (M.P.)
4. Mr. Saket Kumar , Assistant Professor , Department of Physics, AKS University Satna (M.P.)
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Cos,POs and PSOs Mapping

Course Title: M.Sc. (Physics)

Course Code: PH451
Course Title: General Energy and Computational Lab

Course Outcomes	Program Outcomes												Program Specific Outcome				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	Engineering knowledge	**Problem analysis**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Modern tool usage**	**The engineer and society**	**Environment and sustainability:**	**Ethics**	**Individual and team work:**	**Communication:**	**Project management and finance:**	**Life-long learning**	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	**Apply knowledge of Physics in a different stream of science and to communicate effectively.**	**Ability to use the techniques, skills, and modern physical tools in real world application.**	**Engage in life-long learning and will have recognition.**
PH451.1. learn various Physics aspects by performing the experiments related to nano material synthesis and computational techniques.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1	1

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction(LI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH451.1. learn various Physics aspects by performing the experiments related to nano material synthesis and computational techniques.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18	1

Semester-IV

Course Code:	PH452
Course Title :	**Research Project Work**
Pre- requisite:	Student should have basic knowledge of practical instruments in graduation.
Rationale:	The students studying Physics should possess foundational understanding about historical background of graduation and post graduation.

Course Outcomes:
After completion of this project, students will be able to:

PH452.1. learn various Physics aspects by performing the experiments related to nano material synthesis, space physics, general physics and other areas of physics.

A K S University

Faculty of Basic SCience

Department of Physics

Curriculum of M.Sc. (Physics) Program

(Revised as on 01 August 2023)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Research Project	PH452	**Research Project Work**	0	10	1	1	12	10

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
Research Project	PH 452	Research Project Work	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PH452.1. learn various Physics aspects by performing the experiments related to nano material synthesis, space physics, general physics and other areas of physics.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	150
SW	15
SL	15
Total	180

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Self Learning (SL)**
SO1.1 Basic of literature review SO1.2 Techniques used for performing research SO1.3 Analyze the results and tabulate them in a proper manner SO1.4 How to write and dissertation, making presentation and viva etc. **SO1.5** Learn about Error analysis.	Any research project title related to physics. **1.** Define a literature review related to project title. **2.** Identify sources of information. **3.** Conducting the literature review with working title of project. **4.** Using bibliographic management software. **5.** Managing the project process. 6. Writing the project.	1. Learn about basic computer and physics and mathematics 2. Software (s) to be used, laboratory planning, data survey etc for the proposed research work.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Ancient Binder Used for Constructions, Invention and properties of Portland, Cement strength development mechanism of Portland cement. Types of Cement produced in India.

b. Other Activities (Specify):

Note on Status of Indian cement industry in world and Major cement producing companies of India

Brief of Hours suggested for the Course Outcome

Course Outcomes	**Laboratory Instruction (LI)**	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PH452.1. learn various Physics aspects by performing the experiments related to nano material synthesis, space physics, general physics and other areas of physics.	**150**	15	15	180
Total Hours	**150**	**15**	**15**	**180**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**Research Project Work**	10	20	20	50
Total		10	20	20	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Experimental Physics	**Worsnop and Flint**	Little hampton Book Services Ltd, United Kingdom	9th Edition, 1951
2	Experiments in Modern Physics	**A. C. Melissinos, J. Napolitano**	Academic Press, Cambridge, Massachusetts	2nd Edition, 2003
3	A Text Book of Practical Physics	I. Prakash & Ramakrishna	Kitab Mahal	11th Edition, 2011
4	Practical Physics	G. L. Squires	Cambridge University Press	4th Edition, 2015
5	Lab manuals provided by Department of Physics, AKS University, Satna (M. P.)			

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Course Code: PH452
Course Title: Research Project Work

Course Outcomes	Program Outcomes												Program Specific Outcome				
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	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	Identify, formulate, and solve Physics problems.	Design and conduct experiments, as well as to analyse and interpret data.	Apply knowledge of Physics in a different stream of science and to communicate effectively.	Ability to use the techniques, skills, and modern physical tools in real world application.	Engage in life-long learning and will have recognition.
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PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	PH452.1. learn various Physics aspects by performing the experiments related to nano material synthesis, space physics, general physics and other areas of physics.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1, 2, 3, 4, 5, 6	1, 2