SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcome based Curriculum Framework

(LOCF)

For

M.Sc. I Physics

Postgraduate Programme

From

Academic year

2023-24

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation,
- Inculcate values.
- Provide them opportunities for all round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament, and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Physics

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Deepak More	Chairman	K J Somaiya College of Science and Commerce
Subject Expert nominated by Vice-Chancellor			
1	Dr. Anita Kanwar	Principal	VES College, Chembur
Subject experts			
1	Dr. Nigvendra Sharma	Head of the Department	Maharashtra College of Arts, Science &Commerce
2	Dr Dinesh Kala	Head of the Department	G N Khalsa College of Arts, Science & Commerce
3	Dr. Paresh Joshi	Academic Program coordinator JSO	HBCSE,Mumbai
Representative from Industry/corporate sector/allied area			
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Meritorious Alumnus			
1	Mr. Vikrant Jadhav	Founder Member	Panacea Intech PVT LTD
Experts other than parent university			
1	Dr. Raghunath Chelakkot	Associate Professor	Department of Physics, IITB, Mumbai
2	Dr. R. R. Deshmukh	Professor	Department of Physics, ICT, Mumbai

3	Dr. Pruthul Desai	Principal	P T Sarvajanik College, Surat
Student Representative			
1	Mr Mahindra Santra	Student	M.Sc-II
Faculty of the specialisation			
1	Dr. Geeta Nair	Associate Professor	K J Somaiya College of Science and Commerce
2	Mr. A M Shaker	Associate Professor	K J Somaiya College of Science and Commerce
3	Dr. Jitendra Pendharkar	Associate Professor	K J Somaiya College of Science and Commerce
4	Dr. Smita Survase	Associate Professor	K J Somaiya College of Science and Commerce
5	Mr. Anshul Gupta	Assistant Professor	K J Somaiya College of Science and Commerce
6	Mr. Deepak Jalla	Assistant Professor	K J Somaiya College of Science and Commerce
7	Mr. Amit More	Assistant Professor	K J Somaiya College of Science and Commerce
8	Dr. Pallavi Raote	Assistant Professor	K J Somaiya College of Science and Commerce
9	Mr. Ketankumar Gayakwad	Assistant Professor	K J Somaiya College of Science and Commerce
10	Dr. Rucha Naik	Assistant Professor	K J Somaiya College of Science and Commerce
11	Dr. Shruti Barve	Assistant Professor	K J Somaiya College of Science and Commerce

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K J Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment, and develop beyond curriculum, is offered at our college.

An Autonomous college carries a prestigious image for the students and the teachers, and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of several workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This has ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning, and flip- class learning practiced by a committed fleet of faculty and supported by several hands have been our unique outstanding propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment, and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu

Principal

Acknowledgement

Syllabus Revision is an essential part of academic sustenance. This year, with the implementation of NEP 2020, we now have the added responsibility of delivering a curriculum that focuses on both- a sound knowledge base along with higher order skills that will support all round development and vocation of the learner. At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also deeply obliged to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am indebted to my young and vibrant colleagues in the Department of Physics for their sincere and painstaking efforts during the compilation of the restructured syllabus as per NEP 2020 guidelines.

Dr. Deepak More

Chairperson

Board of Studies in Physics

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Preamble

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. We endeavour to mould young minds to participate, contribute and add value to every milestone in their path towards academic excellence. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum manifold.

The LOCF will assist teachers to envisage the outcome expected from the learners at the end of the programme. It will help them to strategize their teaching effectively. At the same time, this document will guide the students through the new curriculum and help them acquire all the skills and knowledge sets required for their personal and academic growth. Higher education qualifications such as the master's degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible, and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme, establishing multidisciplinary education and research universities, pooled credit banks and creating a National research Foundation to promote and support research activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender, or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to developing an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

1. Introduction

Physics is a science that deals with the nature and effects of matter, energy and their interactions. It's amazing how much physics is used in our daily lives. Without a doubt, physics has benefited the social and economic spheres with a plethora of innovative discoveries. Above all, the application of basic physics principles has greatly aided in the growth of technology. You can pursue a Master's in Physics program if you have taken undergraduate physics courses and want to improve your understanding and career in the discipline.

MSc in Physics is a postgraduate course that concentrates on conceptual and practical aspects of Physics. The course duration is 2-years, and students who have successfully completed this course can find employment in diverse industries in the public or private sector. Usually, the curriculum of an MSc Physics course entails a thorough study of the field of Physics. Students who wish to dig deeper into the enigmatic theories of Physics should apply for the MSc Physics course. Students accepted into this programme will learn about fundamental principles and concepts in physics, such as classical and quantum theories, electronics, optics, and so on.

The M.Sc. Physics programme is developed by keeping in mind the interest of learners to explore and achieve in depth knowledge and skills in the field of Physics. The flexible framework helps to maintain the ethos of Physics degree programmes through periodic programme review within a broad framework of agreed/expected post graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The M.Sc. programme is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process, and quality assessment of student's learning levels. Updating teaching, learning pedagogy and outcome-based education form the pillars of the programme.

This curriculum framework is developed on the principles of student centric learning pedagogy. The platform intends to empower graduates with the skills required for pursuing wildlife-related careers, higher education in Physics and its allied subjects.

Various graduate attributes are emphasised in this framework such as critical thinking, basic psychology, scientific reasoning, moral ethical reasoning, etc. While designing this framework, an important aspect considered was the measurable teaching-learning outcome to ensure employability of the graduates. Implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, NPTEL, SWAYAM and other e-learning platforms are suggested through this framework. The framework also focuses on issues relevant to India and of the rest of the world.

Every course is designed in such a way that students get decent exposure to each topic by keeping an equilibrium between these topics and thus creating interest to pursue further education in the field of Physics. It covers the fundamental concepts of Physics to establish a strong foundation of the subject and helps students to explore the subject more.

The practical sessions are designed to help the students gain necessary skills in programming and experimental techniques. Students are also encouraged to improve their scientific writing skills through various assignments. The research-based project work and On-the Job training in the curriculum instills team building attitude within students and ensures the building of a strong industry interface. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation. The Research project or Dissertation helps the students greatly to improve their understanding of the subject and apply their knowledge to the field.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching, and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever-changing needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for M.Sc. Physics will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of M.Sc. Physics

The M.Sc. Physics programme is of two years duration. Each year is divided into two semesters. The post graduate program in Physics is designed to include core topics like classical and quantum mechanics. Mathematical Methods, Condensed Matter Physics, Electrodynamics, Atomic and Molecular Physics along with applied branches such as microprocessor and microcontroller programming, scilab, and python. The Physics programme thus strikes a perfect balance between fundamental and advanced concepts.

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. Wherever possible RBPT approach will be adopted to make the process of learning more learner centric. ICT-based teaching-learning tools will be incorporated through which even the mundane aspects could be made more interesting and relevant.

2.2 Programme Education Objectives (PEOs)

The overall aims of Master's degree program in Physics are to:

1. Familiarize with the basic rules and ideas of physics as well as how they are used in various contexts.
2. Develop teaching and research skills.
3. Gain the ability to organize, carry out, and report on theoretical and/or experimental physics challenges in the future using a productive scientific method.
4. Comprehend scientific data and develop scientific temper.
5. Develop communication skill and teamwork through internship and On Job Training.
6. Accumulate knowledge by continuous activity centred learning and leverage the past knowledge to solve the problems in the future.

3. Postgraduate Attributes in Physics

Attributes expected from the graduates of M.Sc. Physics Programme are:

PGA 1: Capable of demonstrating good knowledge and understanding of major concepts, theoretical principles and experimental findings in Physics and its different subfields.

PGA 2: Ability to transmit complex technical information relating all areas in Physics in a clear and concise manner.

PGA 3: Ability to employ critical thinking and efficient problem-solving skills in all the basic areas of Physics.

PGA 4: Capability for asking relevant/appropriate questions relating to the issues and problems in the field of Physics, and planning, executing and reporting the results of a theoretical or experimental investigation.

PGA 5: Capable of working effectively in diverse teams in both classroom, laboratory, Physics workshop and in industry and field-based situations.

PGA 6: Enthusiasm for working individually and in diverse teams through interdisciplinary projects.

PGA 7: Capable of identifying/mobilizing appropriate resources required for a project and manage a project.

PGA 8: Capable of using computers for simulation studies in Physics and computation and appropriate software for numerical and statistical analysis of data.

PGA 9: Capable of demonstrating ability to think and analyze rationally with modern and scientific outlook and identify ethical issues.

PGA 10: Able to develop a national as well as international perspective for their career in the chosen field of the academic activities.

4. Qualification descriptors

Upon successful completion of the programme, students receive a master's degree in physics. M.Sc. Physics graduates of this department acquire knowledge pertaining to various core and applied branches under Physics along with the development of Practical skills in their specialisation. The postgraduates are expected to demonstrate the extensive knowledge of various concepts in Physics and their applications. The postgraduates are thus able to contribute to research and development, Academia, Government, and public sectors. This programme will establish a solid foundation for the student to pursue further studies in Physics such as Doctoral work or field-based research in the subject.

The list below provides a synoptic overview of possible career paths provided by post graduate training in Physics:

1. Academics
2. Research
3. Defence
4. Information Technology
5. Space Research Centers
6. Health Physics
7. Forensic science department
8. Oil and gas sectors
9. Packaging industry
10. Geophysics and meteorology
11. Energy sector
12. Telecommunications
13. Environmental monitoring and analysis
14. Sound Engineering

Job Roles for M.Sc. Physics graduate:

After graduation one can seek a professional career as:

1. Research Assistants
2. Academician
3. Radiologist
4. Laboratory Technician
5. System Analyst
6. Data Analyst
7. Accelerator operator
8. Laser Engineer
9. Web developer
10. Astronomer
11. Meteorologist
12. Aerospace systems engineer

Higher Education options for M.Sc. Physics postgraduate:

1. PhD in their respective specializations
2. BEd

5. Programme Specific Outcomes (PSOs)

After the successful completion of modules in different courses of M.Sc. Physics, the learner will be able to:

PSO I. Comprehend algebraic concepts and advanced mathematical tools involved in the interpretation of various physical properties of materials.

PSO II. Appreciate the principles of Electrodynamics and their applications in daily life.

PSO III. Develop essential logical and analytical skills to approach a problem both quantitatively and qualitatively.

PSO IV. Gain knowledge and the skills to measure some of the properties of solid materials and understand the underlying principles governing the dynamics of rigid bodies.

PSO V. Acquire scientific temper leading to critical thinking and research motivation in Physics and its allied areas.

PSO VI. Design and develop coding to provide solutions for real life problems.

5.1 Course Mapping

Semester	PSO / Course	I	II	III	IV	V	VI
I	MJ I	√		√		√	
	MJ II	√		√		√	
	MJ III	√		√		√	
	MJ IV			√	√	√	
	DSE1			√		√	√
	DSE2			√		√	√
	DSE3	√		√	√	√	
	RM	√		√		√	
II	MJ I			√	√	√	
	MJ II		√	√	√	√	
	MJ III	√		√		√	
	MJ IV	√		√		√	
	DSE1			√		√	√
	DSE2			√		√	√
	DSE3	√		√	√	√	
	OJT	√		√		√	√
III	MJ I	√		√	√	√	
	MJ II	√		√		√	
	MJ III	√		√		√	√
	MJ IV	√		√		√	
	DSE1			√		√	√
	DSE2			√		√	√
	DSE3			√		√	√

IV	MJ I	√		√	√	√	
	MJ II	√		√		√	
	MJ III	√		√		√	√
	MJ IV	√		√		√	
	Internship	√		√		√	

6. Structure of M.Sc. Physics programme

The programme consists of two years (two semesters per year). The syllabus is drafted such that all significant theoretical subjects are covered in the initial three semesters with an emphasis on on-the-job training and research project/ internship/ apprenticeship work in industry or certified laboratories.

Sem	Major	DSE	RM/OJT/ RIA	Total
1	14	4	RM 4	22
2	14	4	OJT 4	22
3	16	6	----	22
4	8	----	14	22

- In semester I, the learner will have four major core courses on General Physics, one discipline specific elective and one common minor course on Research Methodology.
- In Semester II, the learner will have four major core courses on Advanced Physics, one discipline specific elective and will have to engage in an on-the-job training for 21 days.
- In Semester III the subject specialisation begins, the learner has four courses in core physics and two discipline specific elective courses.
- In Semester IV the learner has four courses in core physics and will have to complete one long Research Project and submit a dissertation at the end of the semester.
- Dissertation should be appreciable, original and of good quality. Assessment of dissertation will be based on an open viva for defence.

1. **Major Core Courses (MJ):**

a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that subject or discipline.

b) There are sixteen Major Core courses (MJ), four each, in semesters I II, III and IV

c) Each Major Core Courses is compulsory.

d) Each Major Core Course consists of 2 credits for theory and 1.5 credits for practical in semester I and II and 2 credits for theory and 2 credits for practical in semester III and IV.

e) The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum to adhere to common minimum standards with other universities/institutions.

2. **Discipline Specific Elective (DSE):**

a) A course is chosen by the candidate from the same stream as an elective out of the three courses offered. Elective course helps the student to gain a broader understanding of the specialization in the major discipline.

b) There is one DSE course each in semester I, II and two in semester III. The credits assigned are 2 credits for theory ie. 30 hours; 2 lectures of 1 hr each per week and 2 credits for practical of four hours per week in semester 1 and 2. In semester 3, there are 2 credits for theory per course and 1 credit each for the practical.

3. **Research Methodology (RM)**
   a) This is a mandatory course to all post graduate students.
   b) Students are required to achieve understanding of the various nuances of research, how to formulate a research problem, plan the work and execute it effectively. Scientific writing and other skills relevant to research are taught here.
   c) This course carries 4 credits (60 - hours in class teaching)

4. **On Job Training (OJT)**
   a) On Job training or Internships are introduced as per the guidelines of the National Education Policy (NEP) 2020, which emphasizes the importance of research and internships in undergraduate education. The internships will be mandatory for students in three-year and four-year degree programs, with a duration of 60 to 120 hours.
   b) This seeks to equip students with the ability to gain relevant soft skills such as teamwork, problem-solving, work ethics, adaptability, communication, and time management.
   c) This training carries 4 credits. 1 credit corresponds to 30 hours of engagement.

5. **Internship (INT):**

a) One of the fundamental principles guiding the development of our education system as per NEP 2020 is the fostering of 'outstanding research as a corequisite for outstanding education and development'. with this perspective Research project / Dissertation is a mandatory component of the master's program

b) Here the learner is assigned a research problem related to their field of specialization either within the department or at a premier institute of the country. The learner must complete their research and present their dissertation at the end of the period.

c) Internship is introduced in semester IV of M.Sc course, having 14 credits. 1 credit of internship corresponds to 30 hours of engagement in a semester.

6.1 Course Content

Sr. No	Semester	Course number	Course Code	Course title
1	I	MJ I	23PSIPHMJIMTM	Mathematical Methods
2		MJ II	23PSIPHMJ2CLMI	Classical Mechanics-I
3		MJ III	23PSIPHMJ3QMI	Quantum Mechanics-I
4		MJ IV	23PSIPHMJ4CMP	Condensed Matter Physics
5		MJ P	23PSIPHMJP1 23PSIPHMJP2	Practicals based on each Major Course- [MJ 1+MJ II=P1, MJ III+MJ IV=P2]
6		DSE1	23PSIPHDSEMIP	8086 Microprocessors
7		DSE2	23PSIPHDSESCL	Scilab
8		DSE3	23PSIPHDSEMS1	Material Science-I
9		DSEP	23PSIPHDSEMIPP 23PSIPHDSESCLP	Practical based on the DSE

			23PS1PHDSEMS1LP	course
10		RM	24PS1PHRMG	Research Publication and Ethics
11	II	MJ I	23PS2PHMJ1AEL	Applied Electronics
12		MJ II	23PS2PHMJ2CED	Classical Electrodynamics
13		MJ III	23PS2PHMJ3QM2	Quantum Mechanics-II
14		MJ IV	23PS2PHMJ4AMP	Atomic and Molecular Physics
15		MJ P	23PS2PHMJP1 23PS2PHMJP2	Practicals based on each Major Course- [MJ I+MJ II=P1, MJ III+MJ IV=P2]
16		DSE I	23PS2PHDSEMIC	8051 Microcontroller
17		DSE 2	23PS2PHDSEPYP	Python Programming
18		DSE 3	23PS2PHDSEMS2	Material Science -II
19		DSE P	23PS2PHDSEMICP 23PS2PHDSEPYPP 23PS2PHDSEMS2P	Practicals based on each DSE course
20		OJT	23PS2PHOJT	On Job Training
21	III	MJ I	24PS3PHMJ1STM1	Statistical Mechanics I
22		MJ II	24PS3PHMJ2NPH1	Nuclear Physics-1

23		MJ III	24PS3PHMJ3EXP1	Experimental Physics I
24		MJ IV	24PS3PHMJ4CLM2	Classical Mechanics II
25		MJ P	24PS3PHMJP1 24PS3PHMJP2	Practicals based on each Major Course- [MJ I+MJ II=P1, MJ III+MJ IV=P2]
26		DSE 1	24PS3PHDSEPIC	PIC Microcontroller
27		DSE 2	24PS3PHDSECPP	C++ programming
28		DSE 3	24PS3PHDSEAPR	32- bit ARM Processor
29		DSE P	24PS3PHDSEPICP 24PS3PHDSECPPP 24PS3PHDSEAPRP	Practicals based on the DSE course
30	IV	MJ I	24PS4PHMJ1STM2	Statistical Mechanics 2
31		MJ II	24PS4PHMJ2NPH2	Nuclear Physics II
32		MJ III	24PS4PHMJ3EXP2	Experimental Physics II
33		MJ IV	24PS4PHMJ4AMM	Advanced Mathematical Methods
34		RP/INT/A	24PS4PHRIA	Research Project/Internship/ Apprenticeship

6.2 Credit distribution for M.Sc. Physics

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	MJ I	Mathematical Methods	2	1.5	3.5
	MJ II	Classical Mechanics-I	2	1.5	3.5
	MJ III	Quantum Mechanics-I	2	1.5	3.5
	MJ IV	Condensed Matter Physics	2	1.5	3.5
	DSE	Student will choose any one DSE	2	2	4
	RM	Research Publication and Ethics	4	-	4
	Total				**22**
II	MJ I	Applied Electronics	2	1.5	3.5
	MJ II	Classical Electrodynamics	2	1.5	3.5
	MJ III	Quantum Mechanics-II	2	1.5	3.5
	MJ IV	Atomic and Molecular Physics	2	1.5	3.5
	DSE	Student will choose one DSE	2	2	4
	OJT	On Job Training	4	-	4

	Total				**22**
III	MJ I	Statistical Mechanics I	2	2	4
	MJ II	Nuclear Physics I	2	2	4
	MJ III	Experimental Physics I	2	2	4
	MJ IV	Classical Mechanics II	2	2	4
	DSEI	Student will choose one DSE	2	1	3
	DSEII	Student will choose one DSE	2	1	3
	Total				**22**
IV	MJ I	Statistical Mechanics II	2	-	2
	MJ II	Nuclear Physics II	2	-	2
	MJ III	Experimental Physics II	2	-	2
	MJ IV	Advanced Mathematical Methods	2	-	2
	RIA	Research Project/ Internship/ Apprenticeship	14	-	14
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	DSE [Any one per semester]	RM/OJT/ Internship CC
I	1] Mathematical Methods 2] Classical Mechanics-I 3]Quantum Mechanics-I 4] Condensed Matter Physics	1]8086 Microprocessors 2]Scilab 3]Material Science-I	Research Publication and Ethics
II	1] Applied Electronics 2] Electrodynamics 3]Quantum Mechanics-II 4] Atomic and Molecular Physics	1]8051 Microcontroller 2]Python Programming 3]Material Science-II	OJT
III	1] Statistical Mechanics I 2] Nuclear Physics 3] Experimental Physics I 4] Classical Mechanics II	1] PIC Microcontroller 2] C++ programming 3] 32- bit ARM Processor	-
IV	1] Statistical Mechanics II 2] Nuclear Physics II 3] Experimental Physics II 4] Advanced Mathematical Methods		Research Internship

6.4 Course Learning Objectives

The two-year postgraduate Physics programme is designed to familiarize students with in-depth knowledge of Physics. The objective of structured syllabus in Physics is to make the concepts and basics of Physics clear and interesting to students and to ensure the development of vertical growth in the subject. The idea behind this is to enable students to develop analytical skills and critical thinking.

It is our attempt that students achieve this objective through systematic reading and class lectures and through feedback on their written work-assignments, project/research papers, presentations, discussions, debates, etc. our intention is to enable students to formulate cogent arguments, presenting the necessary evidence to establish these, based on a training in Physics.

7. Detailed M.Sc. Physics Syllabus

M.Sc. Syllabus with effect from the Academic year 2023-2024

Syllabus - M.Sc I Physics

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures per module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER I									
Core Course Theory									
I	Mathematical Methods	23PSIPHMJ 1MTM	2	30	2	15	20	30	50
II	Classical Mechanics -I	23PSIPHMJ 2CLMI	2	30	2	15	20	30	50
III	Quantum Mechanics-I	23PSIPHMJ 3QMI	2	30	2	15	20	30	50
IV	Condensed Matter Physics	23PSIPHMJ 4CMP	2	30	2	15	20	30	50
Core Course Practical									
I	Practical I	23PSIPHMJ P1	3	90			25	50	75
II	Practical II	23PSIPHMJ P2	3	90			25	50	75
Discipline Specific Elective (Select any one)									
I	8086 Microprocessors	23PSIPHDS EMIP	2	30	2	15	20	30	50
II	Scilab	23PSIPHDS ESCL	2	30	2	15	20	30	50
III	Material Science-I	23PSIPHDS	2	30	2	15	20	30	50

		EMS1							
Discipline Specific Elective Practicals									
I	Practicals based on Discipline Specific Course	23PS1PHDS EMIPP	2	60			20	30	50
II		23PS1PHDS ESCLP	2	60			20	30	50
III		23PS1PHDS EMSIP	2	60			20	30	50
OJT/Research Projects/Internship									
I	Research Publication and Ethics	24PS1PHR MG	4	60	4	15	100	------	100
SEMESTER II									
Core Course Theory									
I	Applied Electronics	23PS2PHMJ 1AEL	2	30	2	15	20	30	50
II	Classical Electrodynamics	23PS2PHMJ 2CED	2	30	2	15	20	30	50
III	Quantum Mechanics-II	23PS2PHMJ 3QM2	2	30	2	15	20	30	50
IV	Atomic & molecular Physics	23PS2PHMJ 4AMP	2	30	2	15	20	30	50
Core Course Practical									
I	Practical I	24PS2PHM JP1	3	90			25	50	75
II	Practical II	24PS2PHM JP2	3	90			25	50	75

Discipline Specific Elective (Select any one)									
I	8051 Microcontroller	23PS2PHDSEMIC	2	30	2	15	20	30	50
II	Python Programming	23PS2PHDSEPYP	2	30	2	15	20	30	50
III	Material Science-II	23PS2PHDSEMS2	2	30	2	15	20	30	50
Discipline Specific Elective Practicals									
I	Practicals based on discipline specific course	23PS2PHDSEMICP	2	60			20	30	50
II		23PS2PHDSEPYPP	2	60			20	30	50
III		23PS2PHDSEMS2P	2	60			20	30	50
OJT/Research Projects/Internship									
I	OJT	24PS1PHOJT	4	120			100		100

MSc PHYSICS SEMESTER I

Core Course- I
COURSE TITLE: Mathematical Methods
COURSE CODE: 23PS1PHMJ1MTM
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Describe applications of Complex variable 2. Apply Complex integrals 3. Discuss Special functions 4. Explain Tensor analysis.		
Module I	Complex Variables and Integrals	[15L]
Learning Objectives The module is intended to - 1. Establish the mathematical background to understand core areas of physics. 2. Create a solid foundation for theoretical and experimental research in Physics.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Analyze complex variables and their applications. 2. Calculate complex integral.		
1.1	Complex Variables, Cauchy-Riemann Equations, Analytic functions, Harmonic functions,	4L

1.2	Elementary functions: Exponential and Trigonometric, Taylor and Laurent series, Solution of differential equation using power series Frobenius method, Residues, Residue theorem, Principal part of the functions, Residues at poles, zeroes and poles of order m	6L
1.3	Contour Integrals, Evaluation of improper real integrals, improper integral involving Sines and Cosines, Definite integrals involving sine and cosine functions.	5L
Module 2	**Special Functions and Tensor Analysis**	**[15L]**
Learning Objectives The module is intended to - 1. Understand the concept of Special functions 2. Understand Tensor Analysis		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Evaluate Special Functions. 2. Perform Tensor Analysis		
2.1	Legendre functions: Legendre polynomials, Rodrigue's formula; generating function and recursion relations; Orthogonality and normalization; associated Legendre function, special harmonics. Bessel functions: Bessel functions of the first kind, recursion relations and orthogonality. Hermite functions: Hermite polynomials, generating function, recursion relations;	7L

	Orthogonality.	
2.2	Laguerre functions: Laguerre & associated Lauguerre polynomials, recursion relations, Orthogonality. Tensor Analysis: Introduction to Tensor Analysis, Addition and Subtraction of Tensors, summation convention, Contraction, Direct Product, Levi-Civita Symbol.	8L

References:

- Mathematical Physics, H.K.Dass, S.Chand and Company Ltd.,2010.
- Mathematical Methods for Physicists, G. Arfken: Mathematical Methods for Physicists, Academic Press Academic Press.
- Schaum's Outline of Complex Variables, 2nd edition
- Mathematical Methods for Physicists (4th edition):
- George Arfken& Hans J. Weber, Academic Press, San Diego (1995).
- Mathematical Methods in Physical Sciences (2nd edition): Mary L. Boas, John Wiley & Sons, New York (1983).
- Mathematical Physics: P. K. Chattopadhyay, Wiley Eastern Ltd., New Delhi (1990).
- Introduction to Mathematical Physics: Charlie Harper, Prentice Hall of India Pvt. Ltd., New Delhi (1995).
- Mathematical Methods for Physicists (4th edition): George Arfken& Hans J. Weber, Academic Press, San Diego (1995).
- Mathematical Methods in Physical Sciences (2nd edition): Mary L. Boas, John Wiley & Sons, New York (1983)
- Matrices and Tensors in Physics (3rd edition): A.W.Joshi, New Age International (P) Ltd. Publishers, New Delhi (2000).

Question paper Template
MSc PHYSICS SEMESTER I
Core Course- I
COURSE TITLE: Mathematical Methods
COURSE CODE: 23PS1PHMJ1MTM
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	-	10	10	5	-	25
II	-	-	10	10	5	-	25
Total marks per question	-	-	20	20	10	-	50
% Weightage	-	-	40	40	20	-	100

MSc PHYSICS SEMESTER I
Core Course- II
COURSE TITLE: Classical Mechanics -I
COURSE CODE: 23PS1PHMJ2CLM1
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Establish new mechanics to overcome the difficulties in applying Newtonian Mechanics. 2. Introduce the concept of Lagrangian and Hamiltonian mechanics. 3. Learn to compare coordinate transformation amongst all the above mechanics.		
Module I	Lagrangian Dynamics & Calculus of Variations	[15L]
Learning Objectives The module is intended to - 1. Introduce the concepts of Hamiltonian and Lagrangian mechanics 2. Familiarize learner with the calculus of variations.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Apply the calculus of variations to Physics problems, Apply Lagrangian dynamics to Physics problems 2. Establish connection between ignorable coordinates and laws of conservations.		
1.1	Hamilton's principle, Calculus of variations, Derivation of	6L

	Lagrange's equations from Hamilton's principle	
1.2	Lagrange Multipliers and constraint extremization Problems, Extension of Hamilton's principle to nonholonomic systems	5L
1.3	Advantages of a variational principle formulation, Cyclic coordinates and conservation theorems.	4L
Module 2	**Hamiltonian Dynamics and Canonical Transformations**	**[15L]**
Learning Objectives The module is intended to - 1. Introduce and apply Hamilitonian equations of motion. 2. Introduce the concept of canonical transformations		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Apply canonical transforms to simplify Physics problems 2. Use canonical invariants to determine if a coordinate transformation is canonical		
2.1	Derivation of Hamilton's equations from a variational principle.	3L
2.2	Canonical Transformations, Examples of canonical transformations, The symplectic approach to canonical transformations, Poisson brackets and other canonical invariants	7L
2.3	Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket	5L

	formulation, The angular momentum Poisson bracket relations.	

References:

- Classical Mechanics, H. Goldstein, Poole and Safko, 3rd Edition, Narosa Publication (2001)
- N. C. Rana and P. S. Joag., Classical Mechanics, Tata McGraw Hill Publication.
- S. N. Biswas, Classical Mechanics, Allied Publishers (Calcutta).
- V. B. Bhatia, Classical Mechanics, Narosa Publishing (1997).
- Landau and Lifshitz, Butterworth, Heinemann, Mechanics.
- R. V. Kamat, The Action Principle in Physics, New Age Intl. (1995).
- E. A. Deslougue, Classical Mechanics, Vol I and II, John Wiley (1982).

Question paper Template
MSc PHYSICS SEMESTER I
Core Course- II
COURSE TITLE: Classical Mechanics -I
COURSE CODE: 23PS1PHMJ2CLM1
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	-	10	15	-	-	25
II	-	-	13	12	-	-	25
Total marks per question	-	-	23	27	-	-	50
% Weightage	-	-	46	54	-	-	100

MSc PHYSICS SEMESTER I
Core Course- III
COURSE TITLE: Quantum Mechanics -1
COURSE CODE: 23PS1PHMJ3QM1
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Discuss basic principles of quantum mechanics and applications. 2. Apply commutation relations in uncertainty principles 3. Describe the basic applications of quantum mechanics. 4. Apply Schrodinger equation in one dimensional potential barrier.		
Module I	Introduction to Quantum Mechanics	[15L]
Learning Objectives The module is intended to - 1. Explain the basic principles of quantum mechanics and solution to initial value problem 2. Describe the commutation relationship and its application in uncertainty principle.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Understand basic principles of quantum mechanics and applications. 2. Apply commutation relations in uncertainty principles.		
1.1	Postulates of QM: Observables and operators; measurements; the state function and expectation values; the time-	8L

	dependent Schrodinger equation; time development of state functions; solution to the initial value problem. Problem solving	
1.2	Superposition and Commutation: The superposition principle; Commutator relations; their connection to the uncertainty principle; degeneracy; complete sets of commuting observables. Time development of state functions and expectation values. Problem solving	7L
References: • Richard Liboff, Introductory Quantum Mechanics, 4thed., 2003. (RL) • DJ Griffiths, Introduction to Quantum Mechanics, 3rd Edition 2018. (DG) • Nouredine Zettili, Quantum Mechanics- Concepts and Applications, 2nd edition, 2009, Wiley (NZ)		
Module 2	Matrix Formalism	[15L]
Learning Objectives The module is intended to - 1. Develop matrix formulation for Quantum Mechanics. 2. Explain concept of tunneling in potential barrier.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Understand the basic principles of quantum mechanics. 2. Apply Schrodinger equation in one dimensional potential barrier.		
2.1	Dirac notation; Hilbert space; Dirac Notation, Operators:	10L

	Uncertainty relations between operators, Hermitian operators and their properties. Matrix mechanics: Basis and representations; matrix properties; unitary transformations. Symmetries and conservation laws. Poisson's bracket and commutators	
2.2	Particle in a box, Harmonic oscillator, Unbound states, Rectangular potential barrier-tunnelling	5L

References:

- Richard Liboff, Introductory Quantum Mechanics, 4thed., 2003. (RL)
- DJ Griffiths, Introduction to Quantum Mechanics, 3rd Edition 2018. (DG)
- Nouredine Zettili, Quantum Mechanics- Concepts and Applications, 2nd edition, 2009, Wiley (NZ)

Additional References:

- W Greiner, Quantum Mechanics: An Introduction, 4th. ed., 2004.
- R Shankar, Principles of Quantum Mechanics, 2nd ed., 1994.
- SN Biswas, Quantum Mechanics, 1998.
- A Ghatak & S Lokanathan, Quantum Mechanics: Theory &Applications. 5th ed., 2004.

Question paper Template
MSc PHYSICS SEMESTER I
Core Course- III
COURSE TITLE: Quantum Mechanics -I
COURSE CODE: 23PS1PHMJ3QM1
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	3	7	10	5	-	-	25
II	3	10	8	4	-	-	25
Total marks per question	6	17	18	9	-	-	50
% Weightage	12	34	36	18	-	-	100

MSc PHYSICS SEMESTER I
Core Course- IV
COURSE TITLE: Condensed Matter physics
COURSE CODE: 23PS1PHMJ4CMP
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Understand fabrication techniques for p-n junctions and various concepts related to semiconductor devices. 2. Explain the crystal structure and several ways of analyzing it and develop theories 3. Describe various kinds of magnetism in materials.		
Module I	Semiconductor Devices	[15L]
Learning Objectives The module is intended to - 1. Explain the techniques used for fabrication of p-n junction and its characteristics. 2. Explain the metal semiconductor contacts and various properties related to it.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Describe various p-n junction fabrication methods. 2. Derive the IV and CV characteristics of a diode. 3. Explain metal semiconductor contacts and various concepts related to it.		

1.1	p-n junction: Fabrication of p-n junction by diffusion and ion-implantation; Abrupt and linearly graded junctions; Thermal equilibrium conditions; Depletion regions; Depletion capacitance, Capacitance – voltage (C-V) characteristics, Evaluation of impurity distribution, Ideal and Practical Current- voltage (I-V) characteristics; Tunneling and avalanche reverse junction break down mechanisms; Minority carrier storage, diffusion capacitance. Carrier lifetime measurement by reverse recovery of junction diode. Tunnel diode.	8L
1.2	Metal – Semiconductor Contacts: Schottky barrier – Energy band relation, Capacitance-voltage (C-V) characteristics, Current-voltage (I-V) characteristics; Ideality factor, Barrier height and carrier concentration measurements; Ohmic contacts functions and expectation values.	7L

References:

- S.M. Sze; Semiconductor Devices: Physics and Technology, 2nd edition, John Wiley, New York, 2002.
- B.G. Streetman and S. Banerjee; Solid State Electronic Devices, 5th edition, Prentice Hall of India, NJ, 2000.
- W.R. Runyan, Semiconductor Measurements and Instrumentation, McGraw Hill,Tokyo, 1975.
- Adir Bar-Lev: Semiconductors and Electronic devices, 2nd edition, Prentice Hall, Englewood Cliffs, N.J., 1984.

Module 2	Crystal Physics and Magnetism	[15L]
Learning Objectives The module is intended to - 1. Explain concepts of reciprocal lattices and structure factors. 2. Describe the theory of magnetism.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Explain reciprocal lattice and scattering from surfaces. 2. Understand the theory of magnetism and equations related to it.		
2.1	Reciprocal Lattice and Brillouin Zones. Reciprocal Lattice to sc, bcc, fcc, Scattered wave amplitude, Fourier analysis of the basis; Structure Factor of lattices (sc, bcc, fcc); Atomic Form Factor; Temperature dependence of reflection lines. Elastic scattering from Surfaces; Elastic scattering from amorphous solids.	10L
2.2	Langevin's diamagnetic equation, diamagnetic response, Quantum mechanical formulation, core diamagnetism. Langevin's Theory of Para magnetism, Rare Earth Ions, Hund's Rule.	5L
References: • Charles Kittel "Introduction to Solid State Physics," 7th edition John Wiley & Sons. • J.Richard Christman "Fundamentals of Solid State Physics" John Wiley & sons		

- M.A.Wahab "Solid State Physics –Structure and properties of Materials" Narosa Publications 1999.
- M. Ali Omar "Elementary Solid State Physics" Addison Wesley (LPE)

Question paper Template
MSc PHYSICS SEMESTER I
Core Course- IV
COURSE TITLE: Condensed Matter physics
COURSE CODE: 23PS1PHMJ4CMP
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	10	10	-	-	-	25
II	5	15	5	-	-	-	25
Total marks per question	10	25	15	-	-	-	50
% Weightage	20	50	30	-	-	-	100

MSc PHYSICS SEMESTER I
Practical Major Course- I
COURSE CODE: 23PS1PHMJP1
[CREDITS - 03]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Make layout and adjustments of the equipment. 2. Record observations and plot graphs. 3. Estimate possible errors in the observation of results. 4. Design simple experiments
1. Analysis of sodium spectrum 2. h/e by vacuum photocell 3. Absorption spectrum of specific liquids 4. Coupled Oscillations 5. Wavelength of Laser using a millimeter scale as a grating 6. DC Hall effect 7. Temperature dependence of Avalanche and Zener breakdown diodes 8. Carrier lifetime by pulsed reverse method MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL

MSc PHYSICS SEMESTER I
Practical Major Course- II
COURSE CODE: 23PSIPHMJP2
[CREDITS - 03]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Make layout and adjustments of the equipment. 2. Record observations and plot graphs. 3. Estimate possible errors in the observation of results. 4. Design simple experiments
1. Regulated power supply using IC LM 317 as voltage regulator 2. Regulated dual power supply using IC LM 317 & LM 337 voltage regulator 3. Constant current supply using IC 741 and LM 317 4. Active filter circuits (second order) 5. Waveform Generator using ICs 6. Instrumentation amplifier and its applications 7. Study of 8-bit DAC 8. Switching voltage Regulator MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL
References: • Advanced Practical Physics -Worsnop and Flint • Atomic spectra- H.E. White • Operational amplifiers and linear Integrated circuits - Coughlin & Driscoll • Op-amps and linear integrated circuit technology- R. Gayakwad • Semiconductor measurements by Runyan • Digital principles and applications by Malvino and Leach

MSc PHYSICS SEMESTER I
Discipline Specific Elective Course- I
COURSE TITLE: 8086 microprocessors
COURSE CODE: 23PS1PHDSEMIP
[CREDITS - 02]

<table>
<tr><th colspan="3">Course learning outcomes</th></tr>
<tr><td colspan="3">After the successful completion of the Course, the learner will be able to -
1. Describe the architecture of 8086 Microprocessor
2. Write programs using ALP for 8086 Microprocessor
3. Enlist the Instruction set of 8086 Processor
4. Explain the Interrupt mechanism of x86
5. Interface microprocessor with PPI & Keyboard and Display Controllers</td></tr>
<tr><td>Module I</td><td>Introduction to 8086 Microprocessor</td><td>15L</td></tr>
<tr><td colspan="3">Learning Objectives
The module is intended to
1. Understand the Architecture, addressing modes and instruction sets of 8086 Microprocessor.</td></tr>
<tr><td colspan="3">Learning Outcomes
After the successful completion of the module, the learner will be able to -
1. Understand the block diagram and architecture of 8086
2. Explain various instruction sets of 8086</td></tr>
<tr><td>1.1</td><td>Role of Microprocessor in Micro Computer – Brief history of Microprocessors (with specific insight into x86 family), Features of 8086 Internal Block Diagram of 8086, Execution Unit, Bus</td><td>8L</td></tr>
</table>

	Interface Unit, Addressing Modes Hardware structure of 8086-Pin Configuration, Clock, Processor activities (Interrupt, DMA, etc.), Maximum mode, Instruction cycle Assembly process, Assemblers for x86 , Instruction Design	
1.2	Data transfer Instructions, Branch instructions, Arithmetic instructions, Shift and Rotate Instructions, String Instructions, Procedures, Macros, Number Format Conversions, ASCII operations	7L
Module II	**Interrupt Mechanism of x86 & Interfacing of Chips**	**15L**
Learning objectives The module is intended to - 1. Explain Interfacing with PPI & Keyboard and Display Controllers		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Understand interrupts and their types 2. Explain interfacing of PPI and Keyboard and Display Controllers		
2.1	Interrupts of 8086, Dedicated Interrupt types, Software interrupts, Hardware interrupts, Priority of interrupts, Programmable Interrupt Controller (8259) Organization and Interfacing of PPI (8255) and Keyboard and display Interface (8279).	15L
References: • K.Ray , K M Bhurchandi, "Advanced Microprocessor & Peripherals", Tata		

McGraw Hill,3rd Edition,2013 1.

- Douglas V Hall, "Microprocessor & Interfacing: Programming and Hardware", Tata McGraw Hill, 2nd Edition,2006.
- Barry B. Brey, " THE INTEL MICROPROCESSORS-Architecture, Programming, and Interfacing", Pearson Education India. Eighth Edition

Question Paper Template
MSc PHYSICS SEMESTER I
Discipline Specific Elective Course- I
COURSE TITLE: 8086 microprocessors
COURSE CODE: 23PS1PHDSEMIP
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	-	-	-	15
II	5	5	5	-	-	-	15
Total marks per question	10	10	10	-	-	-	30
% Weightage	33.3	33.3	33.3	-	-	-	100

MSc PHYSICS SEMESTER I
Discipline Specific Elective Course- II
COURSE TITLE: SCILAB
COURSE CODE: 23PS1PHDSESCL
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Understand free simulation software 2. Code and simulate Physics equations in second order ODE		
Module I	Elements of SciLab	15L
Learning Objectives The module is intended to 1. Understand elementary functioning of scilab environment.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Program simple physics plotting		
1.1	Scilab , a freeware numerical computation software, The general environment and the console, Scilab as an interactive calculator, Scilab workspace and working directory. Plotting graphs. Simple numerical calculations, Variables, assignment and display.	8L
1.2	Scilab workspace and working directory. Plotting graphs. Simple numerical calculations, Variables, assignment and display.	7L

Module II	ODE Programming	15L
Learning objectives The module is intended to - 1. Let the learner code second order ODE.		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Code , run and simulate second order Physics equations		
2.1	Working with polynomials, Solving ODE using SciLab.	7L
2.2	Probability and statistics, Useful SciLab functions, Other application to real Physics Problems.	8L
References: • Scilab for very beginners Scilab Enterprises Versailles (France) - www.scilab-enterprises.com • Programming with SCILAB By Gilberto E. Urroz, Ph.D Distributed by info Clearinghouse.com		

Question Paper Template
MSc PHYSICS SEMESTER I
Discipline Specific Elective Course- II
COURSE TITLE: Scilab
COURSE CODE: 23PS1PHDSESCL
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	-	10	10	--	5	25
II	-	-	10	10	--	5	25
Total marks per question	-	-	20	20	-	10	50
% Weightage	-	-	40	40	-	20	100

MSc PHYSICS SEMESTER I
Discipline Specific Elective Course- III
COURSE TITLE: Material Science-I
COURSE CODE: 23PS1PHDSEMS1
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Provide the students with basic knowledge of materials in form of thin films 2. Distinguish between thin films based on their structure and properties 3. Understand the applications of thin films		
Module I	Thin Film Deposition and Surface Modification	15L
Learning Objectives The module is intended to 1. Provide a comprehensive overview of the latest developments in thin films 2. Help students become aware of the various tools available for thin films deposition and characterization 3. Develop understanding of various surface modification techniques to improve the surface properties and to evaluate their properties 4. Develop skill to select the suitable thin film deposition techniques and surface modification methods for a certain application		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Get knowledge and understanding of necessity of thin films		

2. Understand suitable thin film deposition techniques to achieve the required film property 3. Gain the understanding about different complementary techniques required for analysing thin films		
1.1	Introduction: thick and thin films Film deposition techniques: Physical methods: thermal evaporation, electron beam gun, sputter deposition of thin films and coatings: DC, RF, magnetron, ion beam, Molecular beam epitaxy, laser ablation, spin coating etc. Chemical methods: chemical vapour deposition and chemical solution deposition techniques, spray pyrolysis, ion implantation, electroplating, electro polishing, plasma enhanced deposition techniques, atomic layer deposition etc.	8L
1.2	Thin Film growth: Sequence of thin film growth, Defects and impurities, Effect of Deposition Parameters on film growth, Fundamentals of diffusion, inter-diffusion in thin metal films, mass transport in thin films; Surface modification for thin film by energy beams, plasma, laser: lithography, Cleaning, sputtering, carburizing, nitriding, cyaniding, Base Coats and Top Coats.	7L
Module II	Characterization and Application of Thin Films	15L
Learning objectives The module is intended to -		

1. Develop skill to select the suitable characterization technique for achieving specific properties of films 2. Understand the complementary techniques of analysing thin films		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Acquire the ability to analyse the data obtained from the techniques 2. Gain the knowledge about importance of different characterization techniques for studying different properties of films		
2.1	Properties of Thin Films and characterization techniques used: Mechanical: Adhesion, Thickness, Surface morphology, Stylus profilometry Chemical: composition, bonding, molecular groups etc., XPS - EDX Optical: transparency and refractive index, UV-VIS spectroscopy Electrical: conductivity / resistivity, impedance, 4-probe method Magnetic: para / dia / ortho magnetic nature, NMR spectroscopy	9L
2.2	Applications of thin film Reflection and anti-reflection coatings, thin film solar cells, strain gauges and gas sensors, thin film diode and transistor, Magnetic films - computer memories, tribological coatings.	6L
References: • L. I. Maissel and Glang, "Handbook of Thin Film Technology", McGraw Hill Higher Education, 1970. • J. C. Anderson, "The Use of Thin Films in Physical Investigation", Academic Press		

Inc., 1966.

- R.W. Berry, P.M. Hall and M.T. Harris, "Thin Film Technology", Van Nostrand, 1968.
- Thin Film Phenomenon by K.L. Chopra, McGraw-Hill
- Materials Science of Thin Films by Milton Ohring
- Thin-Film Deposition: Principles and Practice by Donald Smith

Question Paper Template
MSc PHYSICS SEMESTER I
Discipline Specific Elective Course- III
COURSE TITLE: Material Science -I
COURSE CODE: 23PS1PHDSEMS1
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	10	10	-	-	-	25
II	5	10	10	-	-	-	25
Total marks per question	10	20	20	-	-	-	50
% Weightage	20	40	40	-	-	-	80

MSc PHYSICS SEMESTER I
Practical Discipline Specific Elective Course-I
COURSE CODE: 23PSIPHDSEMIPP
[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Write simple programmes (8086) and execute them
1. 8/16-bit addition and subtraction 2. Multiplication & Division of 8-bit numbers 3. 8/16-bit block transfer 4. To find greatest/smallest number from a list of numbers 5. To find positive/negative numbers from a list of numbers 6. To find odd/even numbers 7. To sort the numbers in ascending/descending order 8. To find the square root of a number **MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL**
References: • A. K.Ray , K M Bhurchandi, "Advanced Microprocessor & Peripherals", Tata McGraw Hill,3rd Edition,2013

MSc PHYSICS SEMESTER I
Practical Discipline Specific Elective Course-II
COURSE CODE: 23PS1PHDSESCLP
[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Write simple programs to simulate physics events and solving second order ODEs
1. Write a program to perform basic operations on matrices 2. Write a program to generate unit impulse and unit step signals and sequence 3. Write a program to find even and odd part of the signal 4. To solve the differential equation dy/dx=-x with x(0)=0. y(0)=-2 from x=0 to 10 with interval =1 5. To solve the differential equation using Euler's Method with given initial value condition. 6. Determination of Kinetic energy to be imparted to recoil electron using Scilab. 7. Determination of barrier tunneling probability. **MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL**
References: • Scilab Manual for Basic Simulation Laboratory by Dr Kantipudi Mvv Prasad Sreyas Institute Of Engineering & Technology

MSc PHYSICS SEMESTER I
Practical Discipline Specific Elective Course-III
COURSE CODE: 23PSIPHDSEMSIP
[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Understand the applications of thin films
1. Operation of vacuum coating unit. 2. Deposition of thin film using vacuum coating unit. 3. Grain Size measurement using optical microscope 4. Laser Experiments – Wavelength and Particle Size Determination 5. Refractive index of Material using He-Ne laser. 6. Resistivity of Ge sample by van der Pauw method at different temperature and determination of band gap 7. Investigating Crystal structure and miller indices of the given XRD Pattern 8. Image analysis, finding defects, particle size analysis from SEM images **MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL**
References: • L. I. Maissel and Glang, "Handbook of Thin Film Technology", McGraw Hill Higher Education, 1970. • J. C. Anderson, "The Use of Thin Films in Physical Investigation", Academic Press Inc., 1966. • R.W. Berry, P.M. Hall and M.T. Harris, "Thin Film Technology", Van Nostrand, 1968. • Thin Film Phenomenon by K.L. Chopra, McGraw-Hill

MSc PHYSICS SEMESTER I
RP/OJT/FP/Internship/Apprenticeship
COURSE TITLE: Research Publication and Ethics
COURSE CODE: 24PSIPHRMG
[CREDITS - 04]

<table>
<tr><th colspan="3">Course learning outcomes</th></tr>
<tr><td colspan="3">After the successful completion of the Course, the learner will be able to -
1. Analyse literature and formulate research questions
2. Comprehend the relevance of the tools for data collection and analysis
3. Compose a research proposal or scientific report
4. Understand Research integrity and publication ethics</td></tr>
<tr><th>Module I</th><th>Overview of Research and it's Methodologies</th><th>15L</th></tr>
<tr><td colspan="3">Learning Objectives
The module is intended to
1. Explore the basic dimensions of research
2. Impart quantitative and qualitative knowledge for conducting meaningful research
3. Understand some basic concepts of research and its methodologies</td></tr>
<tr><td colspan="3">Learning Outcomes
After the successful completion of the module, the learner will be able to -
1. Review literature and frame research problems</td></tr>
<tr><td>1.1</td><td>Definition of research, postulate, proposition, Characteristics of</td><td>6L</td></tr>
</table>

	research, objective of research, nature of research, importance of research, research process, Difference between research method and research process.	
1.2	Introduction to literature review, Need for literature review, Methodology of literature review .	4L
1.3	Need for the Problem formulation, Criteria for selecting a problem, Identifying variables. Evaluating problems, Reasoning of a hypothesis.	5L
Module II	Data Collection, Analysis and Interpretation	15L
Learning Objectives The module is intended to - 1. Identify various methods for conducting research 2. Understand various methods to analyze the data		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Design quantitative data collection procedures for a research topic of interest 2. Analyze the data by using different methods		
2.1	Methods of data collection: survey, interview, observation, experimentation and case study; Descriptive statistics: Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation)	6L

2.2	Inferential statistics: Hypothesis testing, Z test, T test; regression analysis (basic concepts)	5L
2.3	Role of simulation, calibration methods, error analysis, and background handling in experimental design.	4L
Module III	**Writing Research Proposals and Reports**	**15 L**
Learning Objectives The module is intended to - 1. List and describe sections required in any research proposal /paper 2. Outline various practical guidelines for writing research proposal /paper 3. Role of funding agencies in research		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Develop a complete research proposal, appropriate for a research topic of interest		
3.1	Art of scientific writing: steps to better writing, flow method, organization of material and style, structure and components of research	4L
3.2	Types of reports: Research paper, thesis, research project reports, drawing figures, footnotes, tables, references, etc in a research paper, review writing	4L
3.3	Publication process: selection of journal, citation index, impact factor, h-index, i 10 index indexed and non indexed journals, presenting a paper in a conference, development of	4L

	communication skills in scientific seminars	
3.4	Role of funding agencies in research, overview of various funding agencies (DST-SERB, UGC, CSIR, BRNS, DRDO), national and international research project grants and fellowships	3L
Module IV	Scientific Conduct and Publication Ethics	15 L
Learning Objectives The module is intended to - 1. List and describe ethical responsibilities of researchers when conducting research 2. Understand the Importance of intellectual property rights		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Identify and apply key ethical components while doing research		
4.1	Scientific Conduct: Ethics with respect to science and research, Intellectual honesty and research integrity, Plagiarism, Redundant publications Scientific misconduct: falsification, fabrication, duplication, overlapping	4L
4.2	Publication Ethics: Definition, Best practices, initiatives and guidelines, conflicts of interest, Publication misconduct, Violation of publication ethics, authorship and Contributorship, identification of publication misconduct, complaints, appeals,	6L

	predatory publishers and journals	
4.3	Intellectual Property Right: Basic concepts and types of intellectual property (patent, copyright and trademark)	5L

References:

- Management Research Methodology, K. N. Krishnaswamy, A. I. Sivakumar, M.
- Mathirajan, 2006, Pearson Education, New Delhi.
- Research Methodology, Methods and Techniques, C. R. Kothari, 2nd edition, 2008,New Age International Publication.
- Research Methodology, A step by step guide for beginners, R. Kumar, 6th edition,2009, Pearson Education
- Data reduction and error analysis for the physical sciences, P. R. Bevington and D. K. Robinson, 3rd edition, McGraw-Hill
- Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, C. J. Holland,2007, Entrepreneur Press
- https://edge.sagepub.com/mertler2e

MSc PHYSICS SEMESTER II
Core Course- I
COURSE TITLE: Applied Electronics
COURSE CODE: 23PS2PHMJIAEL
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Describe the concept of various circuits used in power electronics. 2. Discuss the working and applications of photonic devices.		
Module I	Photonic Devices	[15L]
Learning Objectives The module is intended to - 1. Compare different types of Optical Sources and Detectors. 2. Analyse working and characteristics of LEDs, Laser Diodes and Solar cells.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Explain various optical sources and detectors. 2. Describe working principles and characteristics of optical sources and detectors.		
1.1	Optical Sources and Detectors: Radiative transitions and optical absorption, Coherent and Non- Coherent sources, quantum efficiency, modulation capability of optical sources. PIN, APD, noise analysis in detectors.	5L

1.2	LEDs: Working principle and characteristics. Different types of LEDS: homo junction and heterojunction LEDS, surface emitting and edge emitting LEDs, OLED, white LED. Laser Diodes: Working principle and characteristics. Solar cells: working principle and characteristics (as PV devices)	1OL
References: • Keiser, G. Optical Fiber Communications, Mcgraw Hill, Int. Student Ed. • B.G. Streetman and S. Banerjee; Solid State Electronic Devices, 5th edition, Prentice Hall of India, NJ, 2000.		
Module 2	Power Electronics	[15L]
Learning Objectives The module is intended to - 1. Understand the power electronics system and its applications. 2. Analyse working different types of DC-DC converters. 3. Describe applications of DC-Dc converters.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Describe and distinguish between various power electronics system and their components. 2. Illustrate DC-DC converters and describe their working.		
2.1	Power Electronics: Introduction to Power electronic systems, Power electronics versus linear electronics, Classification power processors and converters, scope and applications.	5L

	Semiconductor Power Switches: General properties of semiconductor power switches, Power electronic devices such as diode, thyristor, GTO, IGBT and MOSFET. Comparison of semiconductor power switches	
2.2	DC – DC Converters: Types, Analysis, Control of converters: time ratio and current limit control. Principles of Step up and Step-down Switching Voltage converters. Analysis of buck, boost, buck-boost converters, Cuk converters. Application of DC – DC converters. switch-mode power supplies, uninterruptible power supplies (UPS)	1OL

References:

- Dr. P. S.Bimbhra" Power Electronics" Khanna Publishers 5th edition
- M. D. Singh,K. B. KHanchandani "Power Electronics"Mc Graw Hill 7 Th Reprint 2010
- Alok Jain, Power Electronics and its applications, 2nd Edition, Penram International India.Matrices and Tensors in Physics (3rd edition): A.W.Joshi, New Age International (P) Ltd. Publishers,New Delhi (2000).

Question paper Template
MSc PHYSICS SEMESTER II
Core Course- I
COURSE TITLE: Applied Electronics
COURSE CODE: 23PS2PHMJIAEL
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	3	7	7	2	6	-	25
II	2	15	0	2	6	-	25
Total marks per question	5	22	7	4	12	-	30
% Weightage	10	44	14	8	24	-	100

MSc PHYSICS SEMESTER II
Core Course- II
COURSE TITLE: Classical Electrodynamics
COURSE CODE: 23PS2PHMJ2CED
[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Apply the concept of electro -magnetic waves to vacuum, matter and waveguides. 2. Study retarded potentials and radiation from charged particles		
Module I	Waves in Conducting Media and Waveguides	[15L]
Learning Objectives The module is intended to - 1. Explain the concept of waves in conducting medium. 2. Derive the frequency dependence of various wave properties. 3. Analyze the propagation of electromagnetic waves through waveguides		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Derive frequency dependence of various wave properties like refractive index, conductivity and polarizability. 2. Describe the propagation of electromagnetic waves through waveguides		
1.1	Plane waves in conducting media, skin effect and skin depth,	8L

	frequency dependence of conductivity, frequency dependence of polarizability, frequency dependence of refractive index.	
1.2	Wave guides, Propagation of waves between conducting planes, waves in hollow conductors, TE and TM waves, rectangular waveguides, phase velocity and group velocity, resonant cavities, introduction to transmission lines.	7L

References:

- Classical Electrodynamics, J.D. Jackson, 4th edition, (John Wiley and Sons.)2005.
- Introduction to Electrodynamics, D.J. Griffith, 2nd edition, (Prentice Hall)1989.
- Classical Electromagnetic Radiation, Heald and Marion, 2nd (1980) Academic Press
- W.Greiner, Classical Electrodynamics (Springer- Verlag, 2000) (WG).
- Electromagnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore (1987)
- Classical Electrodynamics; S P Puri, Tata McGraw Hill Publishing Company Ltd., New Delhi, (1990).

Module II	Retarded Potentials and Radiation	[15L]

Learning Objectives

The module is intended to -

1. Explain the concept of retarded potentials and fields
2. Study the power radiated from accelerating charges.
3. Explain application of concept of radiation to antennas

Learning Outcomes

After the successful completion of the module, the learner will be able to -

1. Explain the retarded potentials and fields 2. Derive the expression for power radiated from charges. 3. Summarize the working principle of antennas.		
2.1	Retarded potentials, The Lienard- Wiechert potentials, Field produced by charged particle in uniform motion, radiation from accelerated charge at low velocities, radiation from charged particle with colinear velocity and acceleration.	8L
2.2	Antennas, antenna characteristics, Electric dipole radiation, Hertzian Dipole, linear antennas, center tap antenna, Magnetic dipole radiation.	7L
References: • Classical Electromagnetic Radiation, Heald and Marion, 2nd (1980) AcademicPress • W.Greiner, Classical Electrodynamics (Springer- Verlag, 2000) (WG).		

Question paper Template
MSc PHYSICS SEMESTER II
Core Course- II
COURSE TITLE: Classical Electrodynamics -I
COURSE CODE: 23PS2PHMJ2CED
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	2	13	7	3	-	-	25
II	2	12	6	5	-	-	25
Total marks per question	4	25	13	8	-	-	50
% Weightage	8	50	26	16	-	-	100

MSc PHYSICS SEMESTER II
Core Course- III
COURSE TITLE: Quantum Mechanics -II
COURSE CODE: 23PS2PHMJ3QM2
[CREDITS - 02]

<table>
<tr><th colspan="3">Course Learning Outcomes</th></tr>
<tr><td colspan="3">After the successful completion of the Course, the learner will be able to -
1. Solve problems in angular momentum and ladder operators, Understands Pauli's spin matrices and their commutations.
2. Understands Time dependent and time independent perturbation and its applications</td></tr>
<tr><td>Module I</td><td>Angular Momentum</td><td>[15L]</td></tr>
<tr><td colspan="3">Learning Objectives
The module is intended to -
1. Introduce the concepts of ladder operator and Pauli's matrices.
2. Familiarize learner with various operations pertaining to spin.</td></tr>
<tr><td colspan="3">Learning Outcomes
After the successful completion of the module, the learner will be able to -
1. Perform commutation operations among angular momenta.
2. Use Pauli's matrices properties.</td></tr>
<tr><td>1.1</td><td>Ladder operators, eigenvalues and eigen functions of L^2 and Lz using spherical harmonics</td><td>4L</td></tr>
</table>

1.2	Addition of angular momentum, Clebsch Gordon coefficients for $j_1=j_2=1/2$ and $j_1= 1$, $j_2 =1/2$, coupled and uncoupled representation of eigenfunctions	5L
1.3	Angular momentum matrices; Pauli spin matrices; spin eigen functions; free particle wave functions including spin, addition of two spins	6L
References: • Richard Liboff, Introductory Quantum Mechanics, 4thed., 2003. (RL) • DJ Griffiths, Introduction to Quantum Mechanics, 3rd Edition 2018. (DG) • Nouredine Zettili, Quantum Mechanics- Concepts and Applications, 2nd edition, 2009, Wiley (NZ)		
Module II	**Perturbation Theory**	**[15L]**
Learning Objectives The module is intended to - 1. Introduce the concept of Perturbation. 2. Understand the applications of Perturbation.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Apply time dependent perturbation to Quantum Mechanics Problems. 2. Apply time independent perturbation to Quantum Mechanics Problems		
2.1	Perturbation Theory: 1. Time-independent perturbation theory: First-order and second- order corrections to non- degenerate perturbation	6L

	theory.	
2.2	Degenerate perturbation theory - First order energies and secular equation. Time-dependent perturbation theory and applications.	6L
2.3	RITZ Variational method	3L

References:

- Richard Liboff, Introductory Quantum Mechanics, 4thed., 2003. (RL)
- DJ Griffiths, Introduction to Quantum Mechanics, 3rd Edition 2018. (DG)
- Nouredine Zettili, Quantum Mechanics- Concepts and Applications, 2nd edition, 2009, Wiley (NZ)

Additional References:

- W Greiner, Quantum Mechanics: An Introduction, 4th. ed., 2004.
- R Shankar, Principles of Quantum Mechanics, 2nd ed., 1994.
- SN Biswas, Quantum Mechanics, 1998.
- A Ghatak & S Lokanathan, Quantum Mechanics: Theory &Applications. 5th ed., 2004.

Question paper Template
MSc PHYSICS SEMESTER II
Core Course- III
COURSE TITLE: Quantum Mechanics -II
COURSE CODE: 23PS2PHMJ3QM2
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	3	12	10	-	-	25
II	-	8	10	7	-	-	25
Total marks per question	--	11	22	17	-	-	50
% Weightage	-	22	44	34	-	-	100

MSc PHYSICS SEMESTER II
Core Course- IV
COURSE TITLE: Atomic and Molecular physics
COURSE CODE: 23PS2PHMJ4AMP
CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to - 1. Study the fine structure of the hydrogen atom 2. Apply Schrodinger equation to two electron systems 3. Acquire the knowledge of various types of couplings in atomic system 4. Study the general theory of advanced spectroscopy and spectrometers		
Module I	Atomic Physics	[15L]
Learning Objectives The module is intended to - 1. Understand the fine structure of hydrogen atom and apply Schrodinger equation to multi-electron system 2. Compare the fine structure spectrum with hyperfine spectrum. 3. Study general theory of NMR spectroscopy 4. Acquire the knowledge of various types of coupling.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Evaluate energy splitting under magnetic field 2. Analyse hyperfine spectrum and corelate with isotope effect 3. Describe principle and working of NMR and IR spectroscopy		

	4. Calculate number of energy levels in various types of couplings	
1.1	(Review: Atomic spectrum, Spectroscopic terms, Quantum numbers, Total angular momentum, The magnetic moment of atom, Lande g factor) Fine structure of hydrogenic atoms - Zeeman effect in strong and weak field, Paschen Back effect	5L
1.2	Stark Effect, Nuclear spin and Hyperfine structure, isotope effect, NMR spectroscopy: principle, working, applications	5L
1.3	Term symbols, Selection rules, Exchange symmetry of wave functions, Pauli's exclusion principle, L-S and j-j coupling schemes, allowed terms in the coupling, The central field, ground and excited state of two-electron atoms	5L
Module II	**Molecular Spectroscopy**	**[15L]**

Learning Objectives

The module is intended to -

1. Explain the theory of electronic spectrum
2. Acquire the knowledge of different molecular rotational and vibrational spectrums.
3. Study general theory of Microwave spectroscopy
4. Acquire the knowledge of basics of IR spectroscopy.

Learning Outcomes

After the successful completion of the module, the learner will be able to -

1. Describe the principle and working of UV/ VIS spectroscopy
2. Evaluate the wavenumbers for the spectrum of rotating linear diatomic

	molecule 3. Derive the expression for energy levels of molecular vibrational for diatomic molecules 4. Summarize the working principle of Microwave spectroscopy 5. Describe the principle and working of IR spectroscopy	
2.1	Electronic Spectroscopy: Molecular orbital approximation theory, Vibrational and rotational structure of electronic spectra, example: UV / Visible spectroscopy: principle,working, applications	4L
2.2	Molecular rotational spectroscopy: Classification of molecules: linear, spherical, symmetric and asymmetric tops, rotational energy levels of rigid and non-rigid diatomic molecules, isotope effect and intensity of rotational lines, example: Microwave spectroscopy: principle, working, applications	6L
2.3	Molecular vibrational spectroscopy: Vibration of molecules: vibrational energy levels of diatomic molecules, simple harmonic and anharmonic oscillators, diatomic vibrating rotator and vibrational-rotational spectra. Example: IR spectroscopy: principle, working, applications	5L

References:

- 1. Robert Eisberg and Robert Resnick, Quantum physics of Atoms, Molecules, Solids, Nuclei and Particles, John Wiley & Sons, 2nd ed, (ER)
- B.H. Bransden and G. J. Joachain, Physics of atoms and molecules, Pearson Education 2nd ed, 2004 (BJ)
- C. N. Banwell, Fundamentals of molecular spectroscopy, Tata McGraw-Hill, 3rd

ed

- G. K. Woodgate, Elementary Atomic Structure, Oxford university press, 2nd ed, (GW).
- G. Aruldhas, Molecular structure and spectroscopy, Prentice Hall of India 2nd ed, 2002 (GA)
- Ira N. Levine, Quantum Chemistry, Pearson Education,5th edition, 2003 (IL) Publications 1999.
- M. Ali Omar "Elementary Solid State Physics" Addison Wesley (LPE)

Question paper Template
MSc PHYSICS SEMESTER II
Core Course- IV
COURSE TITLE: Atomic and Molecular physics
COURSE CODE: 23PS2PHMJ4AMP
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluatin g	Creating	Total marks
I	-	12	3	5	5	-	25
II	-	5	7	13	-	-	25
Total marks per question	-	17	10	18	5	-	50
% Weightage	-	34	20	36	10	-	100

MSc PHYSICS SEMESTER II
Practical Major Course- I
COURSE CODE: 23PS2PHMJP1
[CREDITS - 03]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Make layout and adjustments of the equipment. 2. Record observations and plot graphs. 3. Estimate possible errors in the observation of results. 4. Design simple experiments
1. Characteristics of a Geiger Muller counter and measurement of dead time 2. Ultrasonic Interferometry- Velocity measurements in different Fluids 3. Double slit- Fraunhofer diffraction (missing order etc.) 4. Barrier capacitance of a junction diode 5. Dielectric constant of liquid 6. Michelson's Interferometer. 7. Double slit- Fraunhofer diffraction (Determination of slit width) 8. Determination of Young's modulus of metal rod by interference method MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL

MSc PHYSICS SEMESTER II
Practical Major Course- II
COURSE CODE: 23PS2PHMJP2
[CREDITS - 03]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Make layout and adjustments of the equipment. 2. Record observations and plot graphs. 3. Estimate possible errors in the observation of results. 4. Design simple experiments
1. Adder-subtractor circuits using ICs 2. Study of Presettable counters - 74190 and 74193 3. TTL characteristics of totem pole, open collector and tristate devices 4. Shift registers 5. Interfacing TTL with buzzers, relays, motors and solenoids. 6. Study of sample and hold circuit 7. 16 channel digital multiplexer 8. Temperature on off controller using IC MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL
References: • Experiments in Modern Physics- Mellissions • Manual of experimental physics -EV-Smith • Advance practical physics - Worsnop and Flint • Digital principles and applications -Malvino and Leach • Digital circuits practice - R.P. Jain • Semiconductor measurements by Runyan • Integrated Circuits - K. R. Botkar

MSc PHYSICS SEMESTER II
Discipline Specific Elective Course- I
COURSE TITLE: 8051 Microcontroller
COURSE CODE: 23PS2PHDSEMIC
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Develop an in-depth understanding of the operation of microcontrollers. 2. Get the knowledge about assembly language programming 3. Understand the concept of interrupts and interfacing. 4. Acquire the knowledge about the architecture of microcontroller 5. Study the programming model of microcontroller 6. Write an assembly program for specified applications.		
Module I	Introduction to 8051	15L
Learning Objectives The module is intended to 1. Compare microprocessor and microcontroller 2. Understand various types of controllers and their specific applications 3. Study architecture of 8051 microcontroller 4. Acquire the knowledge about basics of assembly language 5. Study various instructions available in 8051 assembly programming 6. Understand various addressing modes present in 8051 instructions set		

Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Differentiate between microprocessor and microcontrollers 2. Analyse types of microcontrollers and their suitability for different applications 3. Describe in detail pins available, their functions and architecture of 8051 microcontroller 4. Understand the concepts of assembly language programming 5. List and compare different groups of instructions in 8051 assembly 6. Explain different types of addressing modes present in 8051 assembly.		
1.1	Introduction: Difference between microprocessor and microcontroller, types of microcontrollers and architectures, Overview of 8051 family, Applications of Microcontrollers.	2L
1.2	8051 Architecture: 8051 pin description, oscillator and clock, Registers, role of PC and DPTR, PSW, Internal Memory Organization, Special function registers, External memory interfacing,	7L
1.3	I/O Ports and serial port, timers and counters, Basics of Assembly programming, Addressing Modes, Instruction set, Assembly programs for data management and manipulation in different types of memories	6L
Module II	Programming in 8051	15L
Learning objectives The module is intended to -		

1. Study jumping and branching instructions in 8051 assembly 2. Understand port programming for communication purpose 3. Explain data manipulation by using arithmetic and logical instructions 4. Acquire the knowledge of timer and counter programming 5. Explain the interfacing of 8051 with electrical components		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Analyse logic behind different assembly programs and write the efficient one using branching of code 2. Describe different types of ports, their special functions and use for communicating with external connected devices 3. Evaluate outputs of small codes with arithmetic and logical instructions 4. Calculate the time required for the execution of the loop in assembly 5. Study the interfacing of electrical and electronic components like LED, keyboard, DC motor etc.		
2.1	Assembly Language Programming for 8051: Braching: Jump Loop and Call Instructions, I/O Port Programming, Arithmetical and Logical Instructions, Coding for serial communication	4L
2.2	Timer and Interrupt programming: Programming 8051 Timers, Counter Programming, Programming Timer Interrupts, Programming External hardware Interrupts	5L
2.3	I/O Interfacing: Interfacing with Light Emitting Diodes (LEDs), Push Buttons, Relays and Latch Connections and Keyboard; Interfacing 7-Segment Displays, LCD, ADC and DAC etc. with	6L

	89C51 Microcontroller IC. Interfacing and operating DC motor	

References:

- Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, „The 8051 Microcontroller and Embedded Systems", Second Edition, Pearson Prentice Hall.
- Kenneth J. Ayala, „The 8051 microcontroller", Cengage Learning, 2004
- RSG: - Microprocessor Architecture, Programming and Applications with the 8085 by Ramesh S. Gaonkar, Fifth Edition Penram International Publication (India)
- AB: - Advanced Microprocessors and Peripherals by a K Ray and K M Bhurchandi Second Edition Tata McGraw-Hill Publishing Company ltd.
- Douglas V. Hall, Microprocessors and interfacing, programming and hardware, (TMH)
- Dr. Rajiv Kapadia (Jaico Pub.House) The 8051 Microcontroller & Embedded Systems
- K.J.Ayala, Penram International 8086 Microprocessor: Programming and Interfacing
- Design with PIC microcontrollers by John B. Peatman, Pearson Education Asia.
- Programming & customizing the 8051 microcontroller By Myke Predko, TMH

Question Paper Template
MSc PHYSICS SEMESTER II
Discipline Specific Elective Course- I
COURSE TITLE: 8051 Microcontroller
COURSE CODE: 23PS2PHDSEMIC
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	6	12	2	-	5	-	25
II	2	8	5	2	4	4	25
Total marks per question	8	20	7	2	9	4	50
% Weightage	16	40	14	4	18	8	100

MSc PHYSICS SEMESTER II
Discipline Specific Elective Course- II
COURSE TITLE: Python Programming
COURSE CODE: 23PS2PHDSEPYP
[CREDITS - 02]

<table>
<tr><th colspan="3">Course Learning Outcomes</th></tr>
<tr><td colspan="3">After the successful completion of the Course, the learner will be able to -
1. Write Python code , compile, debug and run.
2. Apply various data types and control structures in Python programming.
3. Construct python conditional and looping statements
4. Understand class inheritance and poly</td></tr>
<tr><th>Module I</th><th>Elements of SciLab</th><th>15L</th></tr>
<tr><td colspan="3">Learning Objectives
The module is intended to
1. Learn syntax of Python programming language.
2. Learn core Python scripting elements such as variables, expression and operators</td></tr>
<tr><td colspan="3">Learning Outcomes
After the successful completion of the module, the learner will be able to -
1. Understand basic concepts in python.
2. Explore contents of files, directories and text processing with python</td></tr>
<tr><td>1.1</td><td>Introduction to Python, Interpreter v/s compiler Installing Anaconda, Python IDEs.</td><td>3L</td></tr>
</table>

1.2	Python simple coding statements, Print statement and print formats, Data types and Data structures, Python Operators (Mathematical and Logical), Assignment statements, Input Output statements.	12L
Module II	Python Programming with Functions and Class	15L
Learning objectives The module is intended to - 1. Learn how to write loops and decision statements in Python. 2. Learn how to write functions and pass arguments in Python		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Learn loops and decision statements in Python. 2. Write functions and pass arguments in Python		
2.1	Conditional statements, Looping statements.	6L
2.2	Python namespaces and scopes, Packages and modules, imports, User defined function, Introduction to OOP, Classes, Objects, Interfaces, Inheritance.	9L
References: • Python in easy steps(2018) : Mike McGrath, BPB publications • Python made simple(2019) : Rydhm Beri, BPB publications • Let us Python, 5th Edition(2019) : Yashwant Kanetkar and Aditya Kanetkar, BPB publications		

Question Paper Template
MSc PHYSICS SEMESTER II
Discipline Specific Elective Course- II
COURSE TITLE: Python Programming
COURSE CODE: 23PS2PHDSEPYP
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	-	5	10	10	-	25
II	-	-	5	10	10	-	25
Total marks per question	-	-	10	20	20	-	50
% Weightage	-	-	20	40	40	-	100

MSc PHYSICS SEMESTER II
Discipline Specific Elective Course- III
COURSE TITLE: Material Science-II
COURSE CODE: 23PS2PHDSEMS2
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Provide an overview of nanomaterials and their synthesis. 2. Explains the unique and exceptional properties of nanomaterials as compared to the bulk material. 3. Elaborate specific applications of nanotechnology		
Module I	Nanoscience and Nanomaterials	15L
Learning Objectives The module is intended to 1. Introduce the students to the world of nanoscience and provide knowledge of various synthesized and natural nanomaterials 2. Give knowledge the properties of nanomaterials which are different from their bulk counterparts		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Familiar with various manufacturing techniques to obtain simple/complex shapes 2. Manipulate bulk material to create new nanomaterials for the custom and		

	specific applications. Gain the understanding about different complementary techniques required for analysing thin films	
1.1	Introduction to nanotechnology: Physics of low-dimensional materials, quantum effects, 1D, 2D and 3D confinement, Zero-, One-, Two- and Three- dimensional structure, Size control of metal nanoparticles and their properties Nanofabrication: patterning of soft materials by self-organisation and other techniques, chemical self-assembly, artificial multilayers, cluster fabrication etc.	4L
1.2	Synthesis of Nanomaterials - I: Top down and bottom-up synthesis approach, physical and chemical techniques for nanomaterial synthesis, sol-gel, hydrothermal, freeze drying, mechanical alloying and mechanical milling, ion implantation, Chemical vapour deposition	5L
1.3	Synthesis of Nanomaterials - II: Fundamentals of nucleation growth, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, emulsion etc. Electrochemical Approaches: anodic oxidation of alumina films, porous silicon, and pulsed electrochemical deposition. Preparation of nanomaterials like gold, silver, different types of nano-oxides, nanotube and wire formation, carbon nanotubes, graphene preparation	6L

Module II	Characterization and Application of Nano Materials	15L
Learning objectives The module is intended to - 1. Impart basic knowledge on the manufacturing techniques of various nano-materials. 2. Make students aware of the huge potential of nanomaterials and nanostructures in engineering and technologies.		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Impart basic knowledge on the manufacturing techniques of various nano-materials. 2. Make students aware of the huge potential of nanomaterials and nanostructures in engineering and technologies.		
2.1	Characterization of Nanomaterials: Principle, Theory, Working of characterization techniques- X-Ray Diffraction, Scanning Electron Microscopy, Transmission Electron Microscopy, Field Emission Scanning Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy, Photoluminescence Spectroscopy, Impedance Spectroscopy, Thermal Gravimetric Analysis	8L
2.2	Applications: Advantages of nano electrical and electronic devices, micro and	7L

	nanoelectromechanical systems – sensors, actuators, optical switches, diodes and nano-wire transistors - data memory lighting and displays, fuel cells and photo-voltaic cells, Nano-catalysts, nanostructures for molecular recognition (quantum dots, nanorods, nanotubes) - Molecular encapsulation and its applications Biomedical applications: Drug delivery system in medical treatment, Targeted chemo - cancer treatment, tissue regeneration, growth and repair	

References:

- Nanocomposite science and technology, Pulikel M. Ajayan, Wiley-VCH 2005
- Nanolithography and patterning techniques in microelectronics, David G. Bucknall, Wood head publishing 2005
- Transport in Nanostructures, D.K. Ferry and S.M. Goodmick, Cambridge university press 1997.
- Optical properties of solids, F. Wooten, Academic press 1972
- Micro and Nanofabrication, Zheng Cui, Springer 2005
- Nanostructured materials, Jackie Y. Ying, Academic press 2001
- Nanotechnology and nanoelectronics, W.R, Fahrner, Springer 2005
- Nanoengineering of structural, functional and smart materials, Mark J. Schulz, Taylor & Francis 2006.
- S.P. Gaponenko, Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.
- W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate(Eds.), Handbook of Nano Science, Engg. and Technology, CRC Press, 2002.

Question Paper Template
MSc PHYSICS SEMESTER II
Discipline Specific Elective Course- III
COURSE TITLE: Material Science II
COURSE CODE: 23PS2PHDSEMS2
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	10	10	-	-	-	25
II	5	10	10	-	-	-	25
Total marks per question	10	20	20	-	-	-	50
% Weightage	20	40	40	-	-	-	100

MSc PHYSICS SEMESTER II
Practical Discipline Specific Elective Course-I
COURSE CODE: 23PS4PHDSEMICP
[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Write simple programmes (8051) and execute them
1. Simple data manipulation programs. (8/16-bit addition, subtraction, multiplication, division, 8/16 bit data transfer, cubes of nos., to rotate a 32- bit number, finding greatest/smallest number from a block of data, decimal / hexadecimal counter) 2. Study of IN and OUT port of 8031/51 by Interfacing switches, LEDs and Relays: to display bit pattern on LED's, to count the number of "ON" switches and display on LED's, to trip a relay depending on the logic condition of switches, event counter (using LDR and light source) 3. Study of external interrupts (INTO/INT1) of 8031/51. 4. Study of internal timer and counter in 8031/51. 5. Interfacing 8031/8051 based experiments: (Any two experiments from 1, 2 & 3) 1. Interfacing 8 bit DAC with 8031/51 to generate waveforms: square, saw tooth, triangular. 2. Interfacing stepper motor with 8031/51: to control direction, speed and number of steps. 3. Interface 8-bit ADC (0804) with 8031/51: to convert an analog signal into its binary equivalent. **FIRST EXPERIMENT IS COMPULSORY AND 2 FROM 2 TO 5.**

MSc PHYSICS SEMESTER II
Practical Discipline Specific Elective Course-II
COURSE CODE: 23PS2PHDSEPYPP
[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Write python code for given problem statements
1. Read two integer numbers from the keyboard and print minimum value using ternary operator. 2. Program for finding minimum of 3 numbers using nesting of ternary operators. 3. Write Python programs to demonstrate the following: i) input( ) ii) print( ) iii) 'sep' attribute iv) 'end' attribute v) replacement Operator ({ }) 4. Python program using functions, 5. Python program with class and object. 6. Write a Python program to display the sum of first n numbers 7. Write a Python program to display the given pattern **MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL**
References: • PYTHON PROGRAMMING LAB (AO594193) LAB MANUAL

MSc PHYSICS SEMESTER II
Practical Discipline Specific Elective Course-III
COURSE CODE: 23PS2PHDSEMS2P
[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Provide the students with basic knowledge of materials in form of thin films 2. Distinguish between thin films based on their structure and properties 2. Understand the applications of thin films
1. Determine the size of nanoparticles using spectrophotometer 2. Effect of ball milling / grinder time on particle size and surface area of nanoparticles 3. Synthesis of Nano-metals (Ag, Au, Cu) and studying its optical properties. 4. Studying Antibacterial effect by Ag nanoparticles 5. Grain Size measurement using optical microscope 6. Fabrication of Nano-Semiconductor or quantum dots (CdS, Si) and determine its band gap. 7. Strain analysis and Particle size determination by XRD and Phase determination by JCPDS. **MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED IN JOURNAL**

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

1) The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate the development of a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Evaluation (CIE) and Semester End Examination (SEE).
- The CIE is taken at regular intervals in the form of Seminar presentations, MCQ based tests, Research Paper Reading ,Paper Summary writing etc.
- The Semester End Examination shall be conducted by the College at the end of each semester (30M) Duration: 1.5 hours

Semester End Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	25 M	15 M
2	II	25 M	15 M

Evaluation pattern: Practical (I and II)

- Continuous Assessment for 25 Marks per practical throughout the entire Semester.
- 50 Marks Sem end Evaluation as per the following rubrics

Major Core Course	Experiment	Experimental Report	Viva	Total
P I	40	5 M	5 M	50 M
P II	40	5 M	5 M	50 M

Evaluation pattern: Practical (DSE)

- Continuous Assessment for 20 Marks per practical throughout the entire Semester.
- 30 Marks Sem end Evaluation as per the following rubrics

Discipline Specific Course	Experiment	Viva	Total
	25 M	5 M	30 M

10. Programme and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24)
2. Third letter 'P' designates postgraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'PH' is for Physics discipline (PH-Physics). This forms the programme code 23PSPH. For the further course codes programme code is amended as follows
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Discipline Specific elective course code, (DSE) alphabets followed by a digit (1/2) followed by three letters specifying the course title are used.
8. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.