SOMAIYA VIDYAVIHAR
K J Somaiya College of Science & Commerce
Autonomous (Affiliated to University of Mumbai)

Learning Outcome based Curriculum Framework

(LOCF)

For

M.Sc. II Physics

Postgraduate Programme

From

Academic year

2024-25

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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Somaiya TRUST

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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. Familarize 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 centered 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 an 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

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

5.1 Course Mapping

Semester	PSO / Course	I	II	III	IV	V	VI	VII	VIII
I	MJ I	√	√						
	MJ II								
	MJ III								
	MJ IV								
	DSE								
	RM								
II	MJ I								
	MJ II								
	MJ III								
	MJ IV								
	DSE								
	OJT								
III	MJ I								
	MJ II								
	MJ III								
	MJ IV								
	DSE								
	RP								
IV	MJ I								
	MJ II								
	MJ III								
	MJ IV								
	RP								

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 in a semester.

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	23PS1PHMJ1MTM	Mathematical Methods
2		MJ II	23PS1PHMJ2CLM1	Classical Mechanics-I
3		MJ III	23PS1PHMJ3QM1	Quantum Mechanics-I
4		MJ IV	23PS1PHMJ4CMP	Condensed Matter Physics
5		MJ P	23PS1PHMJP1 23PS1PHMJP2	Practicals based on each Major Course- [MJ1+MJ2=P1, MJ3+MJ4=P2]
6		DSE1	23PS1PHDSEMIP	8086 microprocessors
7		DSE2	23PS1PHDSESCL	Scilab
8		DSE3	23PSPH1DSEMS1	Material Science-I
9		DSEP	23PS1PHDSEMIPP 23PS1PHDSESCLP 23PS1PHDSEMS1LP	Practical based on the DSE 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- [MJ1+MJ2=P1, MJ3+MJ4=P2]
16		DSE	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- [MJ1+MJ2=P1, MJ3+MJ4=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	24PS4PHCC4AMM	Advanced Mathematical Methods
36		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	RM/OJT/ Internship CC
I	1] Mathematical Methods 2] Classical Mechanics-I 3]Quantum Mechanics-I 4] Condensed Matter Physics	1]8086 µprocessors 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]8086 µprocessors 2]Scilab 3]Material Science-I	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.II Syllabus with effect from the Academic year 2024-25

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 III									
Core Course Theory									
I	Statistical Mechanics I	24PS3PHMJ1STM1	2	30	2	15	20	30	50
II	Nuclear Physics -1	24PS3PHMJ2NPH1	2	30	2	15	20	30	50
III	Experimental Physics-I	24PS3PHMJ3EXP1	2	30	2	15	20	30	50
IV	Classical Mechanics - II	24PS3PHMJ4CLM2	2	30	2	15	20	30	50
Core Course Practical									
I	Practical I	24PS3PHMJP1	4	120			40	60	100
II	Practical II	24PS3PHMJP2	4	120			40	60	100
Discipline Specific Elective (Select any one)									
I	PIC microcontroller	24PS3PHDSEPIC	2	30	2	15	20	30	50
II	C++ programming	24PS3PHDSECPP	2	30	2	15	20	30	50

III	32 bit ARM Processor	24PS3PHDS EARP	2	30	2	15	20	30	50
Discipline Specific Elective Practicals									
I	Practicals based on discipline specific course	24PS3PHDS EPICP	2	60			20	30	50
II		24PS3PHDS ECPPP	2	60			20	30	50
III		24PS3PHDS EARPP	2	60			20	30	50
SEMESTER IV									
Core Course Theory									
I	Statistical Mechanics II	24PS4PHM JISTM2	2	30	2	15	20	30	50
II	Nuclear Physics -II	24P43PHM J2NPH2	2	30	2	15	20	30	50
III	Experimental Physics-II	24PS4PHM J3EXP2	2	30	2	15	20	30	50
IV	Advanced Mathematical Methods	24PS4PHM J4AMM	2	30	2	15	20	30	50
Core Course Practical									
I	Practical I	24PS4PHM JP1	3	90			25	50	75
II	Practical II	24PS4PHM JP2	3	90			25	50	75
OJT/Research Projects/Internship									
I	internship	24PS4PHRI A	14	420			350		350

MSc PHYSICS SEMESTER III
Core Course- I
COURSE TITLE: Statistical Mechanics=I
COURSE CODE: 24PS3PHMJISTM
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Understand Statistical Basis of Thermodynamics, in particular ensemble Theory. 2. Developing formalism of Canonical Ensemble, analysis with partition function 3. Comprehend concept of statistics of Para-magnetism, thermodynamics of magnetic systems 4. Develop formalism of Grand Canonical Ensemble		
Module I	Classical Statistical Mechanics	[15L]
Learning Objectives The module is intended to - 1. Acquire knowledge of Classical and Quantum Statistical Mechanics. 2. Study the thermodynamic behavior of systems 3. Describe elementary statistical Physics to learners 4. Establish the statistical background of thermodynamics.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Use statistics to describe systems containing huge numbers of particles.		

	2. Understand the statistical foundations of Gibbs paradox, Liouville theorem and their applications.	
1.1	Phase space and number of accessible microstates Ω given the microstate; Statistical definition of entropy; Gibb's paradox and correct counting of Microstates Ω.	3L
1.2	Ensemble Theory: Phase space density. Liouville theorem; Microcanonical Ensemble; Entropy as an ensemble average; Examples of classical ideal gas, ultra-relativistic gas, harmonic oscillators.	5L
1.3	Canonical ensemble: Equilibrium between a system and an energy reservoir, Canonical partition function and derivation of thermodynamics; Applications to classical ideal gas, system of classical and quantum mechanical harmonic oscillators, ultra-relativistic ideal gas; Energy fluctuations, Virial and equipartition theorems. Quantum systems in Boltzmann statistics – system of quantum mechanical harmonic oscillators, paramagnetic system.	7L
Module 2	**Quantum Statistical Mechanics**	**[15L]**
Learning Objectives The module is intended to - 1. Acquire the knowledge of Classical and Quantum Statistical Mechanics. 2. Study the Grand canonical ensemble, Density operator 3. Describe elementary statistical Physics to learners		

Learning Outcomes

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

1. Understand the need to use statistics to describe systems containing huge numbers of particles.
2. Use of Density operator, Liouville equation, and apply them
3. Understand Fermi and Maxwell-Boltzmann gases.

2.1	Grand canonical ensemble: Equilibrium between a system and a particle energy reservoir; Grand partition function and derivation of thermodynamics; Fluctuations	5L
2.2	Density operator, density matrix and quantum Liouville equation. Quantum statistical micro-canonical, canonical and grand canonical ensembles and their partition functions. Examples	6L
2.3	Ideal gas in q.m. micro canonical ensemble. Fermi and Maxwell Boltzmann gases	4L

References:

- Greiner, Neise and Stocker, Thermodynamics and Statistical Mechanics, Springer1995. (G)
- RK Pathria and PD Beale (P), Statistical Mechanics (3 rd ed.), Elsevier 2011.
- Kerson Huang (H), Taylor and Francis, Introduction to Statistical Physics, 2001. (H)
- F Reif, Thermal and Statistical Physics, Waveland Press, 1995Mathematical Physics: P. K. Chattopadhyay, Wiley Eastern Ltd., New Delhi (1990).

Question paper Template
MSc PHYSICS SEMESTER III
Core Course- I
COURSE TITLE: Statistical Mechanics
COURSE CODE: 24PS3PHMJISTM
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluatin g	Creating	Total marks
I	-	5	5	5	-	-	15
II	5	5	5	-	-	-	15
Total marks per question	5	10	10	5	-	-	30
% Weightage	16.6	33.3	33.3	16.6	-	-	100

MSc PHYSICS SEMESTER III
Core Course- II
COURSE TITLE: Nuclear Physics -I
COURSE CODE: 24PS3PHMJ2NPH1
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Understand all the properties of nuclei 2. Compare and study of different nuclear models and nuclear reactions. 3. Understand alpha and beta and Gamma decay theory. 4. Describe about Fermi theory and G-T transitions		
Module I	Nuclear Properties and models	[15L]
Learning Objectives The module is intended to - 1. Differentiate between types of nuclear reactions 2. Study Nuclear Properties, Measurement of Nuclear size 3. Acquire the knowledge of square well potential, Tensor force, 4. Understand nucleon-nucleon scattering		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Solve Q values for various nuclear reaction 2. Derive Q value for scattering type reaction based on momentum conservation. 3. Understand nuclear properties, models and stability.		

4. Acquire the knowledge of tensor force and nucleon-nucleon scattering		
1.1	Overview of Nuclear Physics (including Introduction to Regulatory framework and nuclear safety in India).	2L
1.2	Nuclear Properties, Measurement of Nuclear size and estimation of R_O	3L
1.3	Deuteron system and its characteristic, Estimate the depth and size of (assume) square well potential, introduction to Tensor force, nucleon nucleon scattering-qualitative discussion on results, Spin-orbit strong interaction between nucleon, double scattering experiment, The Shell Model (extreme single particle).	6L
1.4	Introduction, Assumptions, Evidences, Spin-orbit interactions, Predictions, limitation, introduction to Nilsson Model.	4L
Module 2	**Nuclear Decay**	**[15L]**

Learning Objectives

The module is intended to -

1. Differentiate between types of nuclear decay
2. Understand Fermi theory, Gamma decay and Charge-particle interaction with matter

Learning Outcomes

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

1. Understand alpha and beta and Gamma decay theory
2. Describe about Fermi theory and G-T transitions

2.1	Introduction to Beta decay and its energetics, Fermi theory, Information from Fermi–curie plots, Comparative half lives, selection rules. Fermi and G-T transitions,	9L
2.2	Gamma decay, Multipole radiation, Selection rule for gamma ray transitions. Gamma ray interaction with matter, and Charge-particle interaction with matter.	6L

References:

- Kenneth Krane, Introduction to Nuclear Physics, Wiley India Pvt. Ltd.
- Robert Eisberg and Robert Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles Wiley (2006)
- http://dae.nic.in or http://www.npcil.nic.in for 3 stage- Nuclear programme of India.
- http://www.aerb.gov.in/ for Regulatory framework and nuclear safety in India.
- H. A. Enge, Introduction to Nuclear Physics, Eddison Wesley
- E. Segre, W. A Benjamin, Nuclei and Particle
- B. L. Cohen Concepts of Nuclear Physics

Question paper Template
MSc PHYSICS SEMESTER III
Core Course- II
COURSE TITLE: Nuclear physics -I
COURSE CODE: 24PS3PHMJ2NPH1
[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 III
Core Course- III
COURSE TITLE: Experimental Physics -I
COURSE CODE: 24PS3PHMJ3EXP1
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Perform the data analysis. 2. Study various types of errors.		
Module I	Data Analysis for Physical Sciences	[15L]
Learning Objectives The module is intended to - 1. Learn data analysis, data distribution. 2. Study various types of errors.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Perform the data analysis, Measurement of various types of errors 2. Solve Numerical based on the central limit theorem, the t distribution, log normal distribution, Poisson distribution		
1.1	Experimental Error, Measurement, error and uncertainty, The process of measurement, True value and error, Precision and accuracy, Random and systematic errors, Random errors.	2L
1.2	Population and Sample, Data distributions Probability,	5L

	Probability Distribution, Distribution of Real Data, The normal distribution, The normal distribution from area under a normal curve to an interval, Distribution of sample means, The central limit theorem, The t distribution, The log-normal distribution.	
1.3	Assessing the normality of data, Population mean and continuous distributions, Population mean and expectation value, The binomial distribution, The Poisson distribution, Uncertainty in measurement, Combining uncertainties, Expanded uncertainty, Relative standard uncertainty, Coping with outliers, Weighted mean , Least squares, The equation of a straight line, Excel functions, Using the line of best fit, Fitting a straight line to data when random errors are confined to the x quantity, Linear correlation coefficient, Residuals, Data rejection, Transforming data for least squares analysis	8L
Module 2	**Vacuum technology**	**[15L]**

Learning Objectives

The module is intended to -

1. Familiarizes with Vacuum Techniques.
2. Study various types of vacuum pumps.
3. Get familiar with vacuum pump and their working.

Learning Outcomes

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

1. Describe Vacuum Techniques.

	2. Explain High Vacuum Pumps, Rotary vane pump, Ultra High Vacuum Pumps and its applications.	
2.1	Vacuum Techniques: Fundamental processes at low pressures, Mean Free Path, Time to form monolayer, Number density, Materials used at low pressures, vapour pressure Impingement rate, Flow of gases, Laminar and turbulent flow	8L
2.2	Production of low pressures; High Vacuum Pumps, Rotary vane pump, and systems, Ultra High Vacuum Pumps and System, Turbo Molecular Vacuum Pump, Measurement of pressure, Leak detections. Applications (Thin Film deposition)	7L

References:

- Data Analysis for Physical Sciences (Featuring Excel®) Les Kirkup, 2nd Edition, Cambridge University Press (2012), Chapters 1-6 and 9
- Statistical Methods in Practice for scientists ad Technologists, Richard Boddy and Gordon Smith, John Wiley & Sons (2009)
- A. Roth Vacuum Technology, North Holland Amsterdam
- D. K. Avasthi, A. Tripathi, A. C. Gupta, Ultra High Vacuum Techniques Allied Publishers Pvt. Ltd (2002)
- V. V. Rao, T. B. Ghosh, K. L. Chopra, Allied Publishers Pvt. Ltd (2001)Vacuum

Question paper Template
MSc PHYSICS SEMESTER III
Core Course- III
COURSE TITLE: Experimental Physics-I
COURSE CODE: 24PS3PHMJ3EXP1
[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 III
Core Course- IV
COURSE TITLE: Classical Mechanics -II
COURSE CODE: 24PS3PHMJ4CLM2
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Study the motion of a particle under central forces. 2. Analyse any system of oscillators and arrive at their normal modes. 3. Qualitatively and quantitatively understand the behaviour of non-linear systems. 4. Understand Fractals and how to measure them.		
Module I	Central forces and Small oscillations	[15L]
Learning Objectives The module is intended to - 1. Acquaint the learner with central forces and small oscillations		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Understand Kepler's laws of motions and be able obtain the frequencies and normal modes of oscillation.		
1.1	The Two-Body Central Force Problem: The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The virial theorem.	5L
1.2	Small Oscillations: Formulation of the problem, The eigen	10L

	value equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, Forced and damped oscillations, Resonance and beats.	
Module 2	Non Linear Dynamics	[15L]

Learning Objectives

The module is intended to -

1. Acquaint the learner with the principles of non-linear dynamics

Learning Outcomes

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

1. Analyze Chaotic systems and fractals

2.1	Nonlinear mechanics: Qualitative approach to chaos, The anharmonic oscillator, Fixed points ,bifurcations and strange attractors, Aspects of chaotic behavior, Logistic map.	8L
2.2	Henon map ,Fractals , fractal dimensions.	7L

References:

- Golstein,Poole & Safko Classical Mechanics
- Barger and Olson ,Classical Mechanics - A Modern Perspective
- Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014. ISBN: 9780813349107

Question paper Template
MSc PHYSICS SEMESTER III
Core Course- IV
COURSE TITLE: Classical Mechanics-II
COURSE CODE: 24PS3PHMJ4CLM
[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 III
Practical Major Course- I
COURSE CODE: 24PS3PHMJP1
[CREDITS - 04]

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. Energy Band gap by four probe method 2. h/e by vacuum photocell 3. Resistivity by four probe method 4. Study of microwave oscillator characteristics 5. Double slit 2 (missing order) 6. Analysis of Na spectrum 7. Ultrasonic interferometer 8. Dielectric constant of given sample 9. DC Hall effect 10. Determination of Young's modulus of metal rod by interference method **MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED INJOURNAL**

MSc PHYSICS SEMESTER I
Practical Major Course- II
COURSE CODE: 24PS3PHMJP2
[CREDITS - 04]

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. Instrumentation amplifier and applications 2. Constant Current Supply for micro ampere current Using IC 741 and LM 317 3. Delayed linear sweep by 555 4. Fixed dual power supply using 7805 and 7905 5. Study of lock-in amplifier 6. Waveform Generator using ICs 7. Study of Presettable counters – 74190 and 74193 8. Study of sample and hold circuit 9. Designing 16:1 multiplexer by cascading two 8:1 multiplexer 10. IV characteristics of solar panel 11. Carrier mobility by conductivity MINIMUM SIX EXPERIMENTS NEED TO BE DONE AND REPORTED INJOURNAL
References: • Advanced Practical Physics -Worsnop and Flint • Atomic spectra- H.E. White • Electronic Principles - A. P. Malvino

• Operational amplifiers and linear Integrated circuits - Coughlin & Driscoll • Op-amps and linear integrated circuit technology- R. Gayakwad • Semiconductor electronics by Gibson • Semiconductor measurements by Runyan • Electronic devices & circuits - Millman and Halkias • Digital principles and applications by Malvino and Leach

MSc PHYSICS SEMESTER III
Discipline Specific Elective Course- I
COURSE TITLE: PIC Microcontroller
COURSE CODE: 24PS3PHDSEMIC
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Understand the PIC microcontroller and instruction set. 2. Understand the interfacing and programming model PIC microcontroller.		
Module I	Introduction to PIC Microcontroller	15L
Learning Objectives The module is intended to 1. Introduce the microcontroller, design specially for peripheral interface 2. Understand memory management and Input/ output interface. 3. Develop knowledge of advanced microcontroller with RISC instruction set.		
Learning Outcomes		

After the successful completion of the module, the learner will be able to - 1. Study architecture of PIC microcontroller. 2. Understand instruction set and basic of input-output configuration essential for interfacing.		
1.1	Introduction to PIC microcontroller: architecture, main features of microcontroller, different generations of PIC, RC oscillator connection.	2L
1.2	PIC 16F8XX: pinout diagram, CPU registers including work register, STATUS register, FSR and INDF, PCL and PCLATCH. data memory, program memory, I/O ports.	6L
1.3	PIC instruction set and basic interfacing programs (with led and switches)	7L
Module II	Advanced features of PIC controllers	15L
Learning objectives The module is intended to - 1. Develop knowledge of advanced features of PIC microcontroller. 2. Provide insight of interfacing various common input and output devices.		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Understanding of the timers, interrupts compare and CCP module of PIC. 2. Interface various peripheral devices using PIC		

2.1	Advance features of PIC 16F877: Timers and related SFR, calculation of delay/events and related programs, Interrupts and related SFR, CCP module.	6L
2.2	PIC programming with interfacing: Hardware and software configuration of interfacing with seven segment display in multiplexing mode, LCD, keyboard. wave form generations using PIC, Interfacing with sensors.	9L

References:

- Microcontrollers: theory and applications by Ajay Deshmukh McGraw Hill Education India.
- Design with PIC microcontrollers by John B. Peatman, Pearson Education Asia
- Muhammad Ali Mazidi, Danny E. Cusey, Rolin D. McKinlay, PIC Microcontroller and Embedded Systems: Using assembly and C for PIC

Question Paper Template
MSc PHYSICS SEMESTER III
Discipline Specific Elective Course- I
COURSE TITLE: PIC Microcontroller
COURSE CODE: 24PS3PHDSEPIC
[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 III
Discipline Specific Elective Course- II
COURSE TITLE: C++ Programming
COURSE CODE: 24PS3PHDSECPP
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Summarize the principles of object-oriented programming and describe their application in C++. 2. Design and implement algorithms to solve programming problems using C++ programming effectively. 3. Design and create classes with appropriate member functions 4. Construct C++ programs for complex programming tasks.		
Module I	CPP-I	15L
Learning Objectives The module is intended to 1. Instill the ability to apply object-oriented programming (OOP) concepts to create classes and objects.		

2. Enable students to create basic C++ programs using variables, data types, operators, control flow statements, and functions.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Understand the principles of object-oriented programming and describe their application in C++. 2. Write basic C++ programs using variables, data types, operators, control flow statements, and functions.		
1.1	Need of OOPs, difference b/w structured & OOPs, OOPs Features : Classes & objects, Encapsulation, Inheritance,Polymorphism, Data Abstraction	8L
1.2	Introduction to C++, Expressions and interactivity , Making decisions, Looping , Functions , Arrays , Sorting arrays	7L
Module II	CPP-II	15L
Learning objectives The module is intended to - 1. Define a class, specifying data members and member functions, create instances (objects) of a class. 2. Understand and define inheritance, polymorphism and virtual functions.		
Learning outcomes After the successful completion of the module, the learner will be able to -		

1. Design and implement classes, create objects, and apply access specifiers effectively. 2. Implement and use virtual functions, polymorphism, inheritance effectively		
2.1	Introduction to classes: More about classes, defining a Class, creating Objects, Accessing Data Members using objects, Calling Member Functions using objects, Implementing Array of Objects, objects as parameters & return type.	8L
2.2	Inheritance, Definition, Advantages, Types of Inheritances (Single, Hirerchial, Multilevel, Multiple Hybrid), Implementing various kinds of inheritances polymorphism, virtual functions.	7L
References: • Object-Oriented Programming with C++ by E Balagurusamy • Starting Out with C++: From Control Structures through Objects by Tony Gad Pearson McGraw-Hill Education		

Question Paper Template
MSc PHYSICS SEMESTER III
Discipline Specific Elective Course- II
COURSE TITLE: C++ Programming
COURSE CODE: 24PS3PHDSECPP
[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 III
Discipline Specific Elective Course- III
COURSE TITLE: 32 bit Arm Processor
COURSE CODE: 24PS3PHDSEAR<
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Understand the architecture and the programming model of ARM microprocessors 2. Develop assembly programs for ARM development boards.		
Module I	**ARM Architecture and organization**	15L
Learning Objectives The module is intended to 1. Interpret ARM architecture with a programmer mode. 2. Describe the ARM organization and its implementation for data movement.		
Learning Outcomes After the successful completion of the module, the learner will be able to -		

1. Explain the ARM machine based on its architecture. 2. Analyze the implementation of the ARM instructions based on its organization.		
1.1	The ARM Architecture: The Acorn RISC Machine , Architectural inheritance, The ARM Programmer's model, ARM development tools.	5L
1.2	ARM Organization and Implementation: 3 – stage Pipeline ARM organization, ARM instruction execution, ARM implementation. ARM Processor Cores: ARM7TDMI	10L
Module II	**Programming with ARM instruction set**	15L
Learning objectives The module is intended to - 1. Understand about different ARM assembly instructions. 2. Learn the ARM and Thumb Instructions set.		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Write ARM and Thumb assembly program 2. Distinguish between the ARM and Thumb program		
2.1	ARM Assembly language Programming: Data processing instructions, Data transfer instructions, Control flow instructions, Writing simple assembly language programs.	5L
2.2	The ARM Instruction Set: Introduction, Exceptions, Condition execution, Branch and Branch with Link (B, BL), Branch, Branch with	10L

	Link and exchange (BX,BLX), Software Interrupt (SWI), Data processing instructions The Thumb Instruction Set: the Thumb bit in the CPSR, The Thumb programmer"s model,	

References:

- ARM System-on-Chip Architecture, by Steve Furber, Second Edition, Pearson

Question Paper Template
MSc PHYSICS SEMESTER III
Discipline Specific Elective Course- III
COURSE TITLE: 32 bit Arm Processor
COURSE CODE: 24PS3PHDSEARM
[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 III
Practical Discipline Specific Elective Course-I
COURSE CODE: 24PS3PHDSEPICP
[CREDITS - 01]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Write, compile, execute PIC programs using the timers, interrupts compare and CCP module of PIC. 2. Interface various peripheral devices using PIC
1. PIC Interfacing with LED‟s, Push Buttons. 2. PIC Interfacing with Relay; buzzer, LCD display 3. PIC for waveform generations 4. Use of built-in ADC or Interface 8-bit ADC (0804): converting an analog signal into its binary equivalent by using built-in ADC of the PIC micro-controller. **MINIMUM THREE EXPERIMENTS NEED TO BE DONE AND REPORTED INJOURNAL**
References: • Microcontrollers by Ajay V. Deshmukh, Tata-Mcgraw Hill Publication

MSc PHYSICS SEMESTER III
Practical Discipline Specific Elective Course-II
COURSE CODE: 24PS3PHDSECPPP
[CREDITS - 01]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Design and implement classes, create objects, and apply access specifiers effectively. 2. Implement and use virtual functions, polymorphism, inheritance effectively
1. C++ Programs with function 2. C++ Programs with Class 3. C++ Programs with inheritance 4. C++ Programs with over loading **MINIMUM THREE EXPERIMENTS NEED TO BE DONE AND REPORTED INJOURNAL**
References: • Object-Oriented Programming with C++ by E Balagurusamy • Starting Out with C++: From Control Structures through Objects by Tony Gaddi • Pearson McGraw-Hill Education

MSc PHYSICS SEMESTER III
Practical Discipline Specific Elective Course-III
COURSE CODE: 24PS3PHDSEARM
[CREDITS - 01]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Apply the ARM programming techniques to write ARM assembly programs..
1. Simple data movement programs with ARM 2. Simple data manipulation programs with ARM (32 bit , 64 bit addition, subtraction, multiplication, division). 3. Data branching instructions programs with ARM 4. Study of IN and OUT port of ARM7 by Interfacing switches, LEDs etc. **MINIMUM THREE EXPERIMENTS NEED TO BE DONE AND REPORTED INJOURNAL**
References: • ARM System-on-Chip Architecture, by Steve Furber, Second Edition, Pearson

MSc PHYSICS SEMESTER IV
Core Course- I
COURSE TITLE: Statistical mechanics-II
COURSE CODE: 24PS4PHMJISTM2
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Acquire the knowledge of Ideal Fermin and Bose systems. 2. Understand the statistical mechanics of systems in non-equilibrium states		
Module I	Complex Variables and Integrals	[15L]
Learning Objectives The module is intended to - 1. Study the thermodynamic behaviour of ideal gas in quantum mechanical canonical and grand canonical ensembles. 2. Study Thermodynamics of blackbody radiation. 3. Establish the thermodynamic behaviour of an ideal Fermi gas		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Use statistics to describe systems containing large numbers of particles. 2. Describe Thermodynamics of blackbody radiation 3. Understand the Thermodynamic behaviour of an ideal Fermi gas		
1.1	Ideal gas in Q.M. canonical and grand canonical ensembles; Statistics of occupation numbers.	3L

1.2	Thermodynamic behaviour of an ideal Bose gas, phenomenon of Bose Einstein condensation. Thermodynamics of blackbody radiation.	5L
1.3	Thermodynamic behaviour of an ideal Fermi gas, concept of Fermi energy, behaviour of specific heat with temperature.	7l
Module 2	Non-Equilibrium Statistical Mechanics	[15L]
Learning Objectives The module is intended to - 1. Study the. Brownian motion in details. 2. Study Master equation and Fokker-Planck equation 3. Learn about Spectral analysis of fluctuation		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Use statistics to describe systems containing huge numbers of particles. 2. Understand Langevin theory of Brownian motion and Fluctuation-dissipation theorem. 3. Understand Spectral analysis of fluctuation		
2.1	Brownian motion: as a random walk (Einstein theory), as a diffusion process; Langevin theory of Brownian motion; Fluctuation-dissipation theorem	8L
2.2	Master equation and Fokker-Planck equation.	3L
2.3	Spectral analysis of fluctuations – the Wiener-Khintchine	4l

	relations.	

References:

- Greiner, Neise and Stocker, Thermodynamics and Statistical Mechanics, Springer 1995. (G)
- RK Pathria and PD Beale (P), Statistical Mechanics (3 rd ed.), Elsevier 2011.
- Kerson Huang (H), Taylor and Francis, Introduction to Statistical Physics, 2001. (H)
- F Reif, Thermal and Statistical Physics, Waveland Press, 1995
- Landau and Lifshitz, Statistical Mechanics. Landau and Lifshitz, Statistical Mechanics, Butterworth Heinemann, 1980

Question paper Template
MSc PHYSICS SEMESTER IV
Core Course- I
COURSE TITLE: Statistical Mechanic-II
COURSE CODE: 24PS4PHMJ1STM2
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluatin g	Creating	Total marks
I	-	5	5	5	-	-	15
II	5	5	5	-	-	-	15
Total marks per question	5	10	10	5	-	-	30
% Weightage	16.6	33.3	33.3	16.6	-	-	100

MSc PHYSICS SEMESTER IV
Core Course- II
COURSE TITLE: Nuclear Physics-II
COURSE CODE: 24PS4PHMJ2NPH2
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Acquire knowledge regarding characteristics of Fusion, Solar Fusion and CNO cycle 2. Describe nuclear fission and nuclear fusion in detail. 3. Describe the Quark Model and the standard Model. 4. Explain the Properties of Neutrino		
Module I	Nuclear Reactions	[15L]
Learning Objectives The module is intended to - 1. Understand Conservation laws. 2. Study nuclear fission, its Characteristics and Energy in Fission. 3. Acquire knowledge regarding characteristics of Fusion, Solar Fusion and CNO cycle. 4. Learn about Controlled fission reaction		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Describe nuclear fission and nuclear fusion in detail. 2. Explain the details about Solar Fusion and CNO cycle		

1.1	Conservation laws, Types of nuclear reaction, Q- value equation of nuclear reaction	2L
1.2	Center of Mass frame, reaction cross sections (Classical and Quantum), Compound nuclear reaction	4L
1.3	Introduction to fission reaction, Characteristics of Fission, Energy in Fission, Controlled fission reaction, Introduction to 3 stage- Nuclear programme of India.	5L
1.4	Introduction to Fusion Reaction, Characteristics of Fusion, Solar Fusion and CNO cycle, introduction to Controlled fission reaction	4L
Module 2	Introduction to elementary particles	[15L]
Learning Objectives The module is intended to - 1. Understand the Quark Model, The standard Model 2. Study Quantum Electrodynamics, 3. Get introduce to CP violation and TCP theorem. 4. Learn about Properties of Neutrino, helicity of Neutrino, Parity		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Describe the Quark Model, The standard Model, Quantum Electrodynamics 2. Explain the Properties of Neutrino, helicity of Neutrino, Parity		
2.1	Introduction to the elementary particle Physics, The Eight-fold	3L

	way, the Quark Model, the November revolution and aftermath, The standard Model	
2.2	Revision of the four forces, cross sections, decays and resonances, Introduction to Quantum Electrodynamics, weak interactions and Unification Schemes (qualitative description)	4L
2.3	Revision of Lorentz transformations, Four-vectors, Energy and Momentum. Properties of Neutrino, helicity of Neutrino, Parity, Qualitative discussion on Parity violation in beta decay and Wu"s Experiment, Charge conjugation, Time reversal, Qualitative introduction to CP violation and TCP theorem	8L

References:

- Kenneth Krane, Introduction to Nuclear Physics, Wiley India Pvt. Ltd.
- Robert Eisberg and Robert Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles Wiley (2006)
- http://dae.nic.in or http://www.npcil.nic.in for 3 stage- Nuclear programme of India.
- http://www.aerb.gov.in/ for Regulatory framework and nuclear safety in India.
- H. A. Enge, Introduction to Nuclear Physics, Eddison Wesley
- E. Segre, W. A Benjamin, Nuclei and Particle
- B. L. Cohen Concepts of Nuclear Physics

Question paper Template
MSc PHYSICS SEMESTER IV
Core Course- II
COURSE TITLE: Statistical Mechanic-II
COURSE CODE: 24PS4PHMJISTM2
[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 IV
Core Course- III
COURSE TITLE: Experimental Physics -II
COURSE CODE: 24PS4PHMJ3EXP2
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Perform the data analysis 2. Study various types of errors		
Module I	Angular Momentum	[15L]
Learning Objectives The module is intended to - 1. Understand the working of accelerators and nuclear detectors. 2. Study different types of nuclear detectors and their working. 3. Get familiar with GM counter, NaI Scintillation detector, Gamma ray spectrometer using NaI scintillation detector		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Describe various types of nuclear detectors 2. Explain the construction and working of different types of accelerators.		
1.1	Gas Detector with emphasis on GM counter, NaI Scintillation Detector, Gamma ray spectrometer using NaI scintillation detector	7L

1.2	Accelerators: Van de Graff Generator, Sloan and Lawrence type Linear Accelerator, Proton Linear Accelerator, Cyclotron, Synchrotron. Large hadron collider (qualitative)	8L
Module 2	Characterization techniques for materials analysis	[15L]

Learning Objectives

The module is intended to -

1. Study Characterization techniques for materials analysis.
2. Get familiar with various techniques such as FTIR spectroscopy, Raman
3. Spectroscopy, Mossbauer Spectroscopy, RBS, XRD, XRF, SEM, EDAX, TEM, XPS.

Learning Outcomes

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

1. Describe various Characterization techniques used for materials analysis

2.1	UV Visible spectroscopy, FTIR spectroscopy, Raman Spectroscopy, Mossbauer Spectroscopy,	8L
2.2	RBS, XRD, XRF, SEM, EDAX, TEM, XPS	7L

References:

- William James Price Nuclear Radiation Detection-, McGraw Hill
- W.R. Leo, Springer- Verlag Techniques for Nuclear and Particle Physics Experiments,
- Glenn F. Knoll, John Wiley and sons, Inc. Radiation Detection and Measurement,
- M. S.; Blewett, J. Particle Accelerators, Livingston,
- Introduction to Nuclear Physics, HA Enge, pp 345-353

- E. Persico, E. Ferrari, S.E. Segre Principles of Particle Accelerators,
- Khangaonkar P. R., Penram An Introduction to Materials Characterization International Publishing
- G. K. Wertheim, Mössbauer Effect: Principles and Applications, Academic Press (1964),
- C. N. Banwell Fundamentals of Molecular Spectroscopy, Tata-McGraw Hill
- W.K.Chu, J.W.Mayer, M.ANicolet. Rutherford Backscattering Spectrometry, , Academic Press
- A Guide to Materials Characterization and Chemical Analysis, John P. Sibilia, Wiley VCH; 2ND edition
- Fundamentals of Surface and Thin Film Analysis, L.C. Feldman and J.W.Mayer North Holland Amsterdam
- Elements of X-ray diffraction, Cullity, B. D Addison-Wesley Publishing Company, Inc

Question paper Template
MSc PHYSICS SEMESTER IV
Core Course- III
COURSE TITLE: Experimental Physics -II
COURSE CODE: 24PS4PHMJ3EXP2
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluatin g	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 IV
Core Course- IV
COURSE TITLE: Advanced Mathematical Methods
COURSE CODE: 24PS4PHMJ4AMPM
CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Explore elements of Fourier series. 2. Perform the analysis of physics problems using intergral transorms. 3. Apply power series methods to solve physics problems. 4. Apply Greens function to solve differential equation.		
Module I	Fourier Series and Laplace Transform	[15L]
Learning Objectives The module is intended to - 1. Understand properties of Fourier series. 2. Establish the mathematical foundation to solve physics problems using suitable transforms.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Apply knowledge of Fourier series to solve physics problems. 2. Apply various transforms for solving physics problems.		
1.1	Fourier series, Properties of Fourier series, even function, odd function. Fourier transform of derivatives and Convolution theorem.	8L

1.2	Laplace transforms, Laplace transform of derivatives, Inverse Laplace transform and Convolution theorem.	7L
Module 2	Ordinary differential equations and Green's function	[15L]
Learning Objectives The module is intended to - 1. Understand the ordinary differential equations and its solution using using the Frobenius Method. 2. Understand Green's function and its applications.		
Learning Outcomes After the successful completion of the module, the learner will be able to - 1. Solve the differential equations by Frobenius Method. 2. Apply Green's function to solve differential equation.		
2.1	Ordinary differential equations: The Frobenius Method-Introduction, The solution by using power series expansion.	8L
2.2	Green's function-Introduction, The solution of the Sturm Liouville equation, Boundary conditions, Solution of the second order differential equation using Green's function.	7L

References:

- DR: H. K. Dass, Rama Varma: Mathematical Physics, S. Chand and Co. Pvt. Ltd.
- DA: H. K. Dass: Advanced Engineering Mathematics, S. Chand and Co. Pvt. Ltd.
- A.K. Ghatak, I.C. Goyal and S.J. Chua, Mathematical Physics, McMillaned
- G. Arfken: Mathematical Methods for Physicists, Academic Press
- Mathematical Physics, 4th Edition by B.D.Gupta.

Question paper Template
MSc PHYSICS SEMESTER Iv
Core Course- IV
COURSE TITLE: Advanced Mathematical Methods
COURSE CODE: 24PS4PHMJ4AMPM
[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

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, Paper Summary writing etc.
- The Semester End Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1 hours

  Semester End Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	5 M x 5 Q = 25 M	3 M x 5 Q = 15 M
2	II	5 M x 5 Q = 25 M	3 M x 5 Q = 15 M

Each question will have six sub questions a, b, c, d, e, f and out of which any three should be answered.

Evaluation pattern: Practical

- Continuous Assessment for 25 Marks [P1+P2}throughout the entire emester.
- 50 Marks Sem end Evaluation as per the following rubrics [25 marks P1+25 marks P2}

Major Core Course	CIE	Experimental Report	Viva	Total
MJ I	15 M	5 M	5 M	25 M
MJ I	15 M	5 M	5 M	25 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.