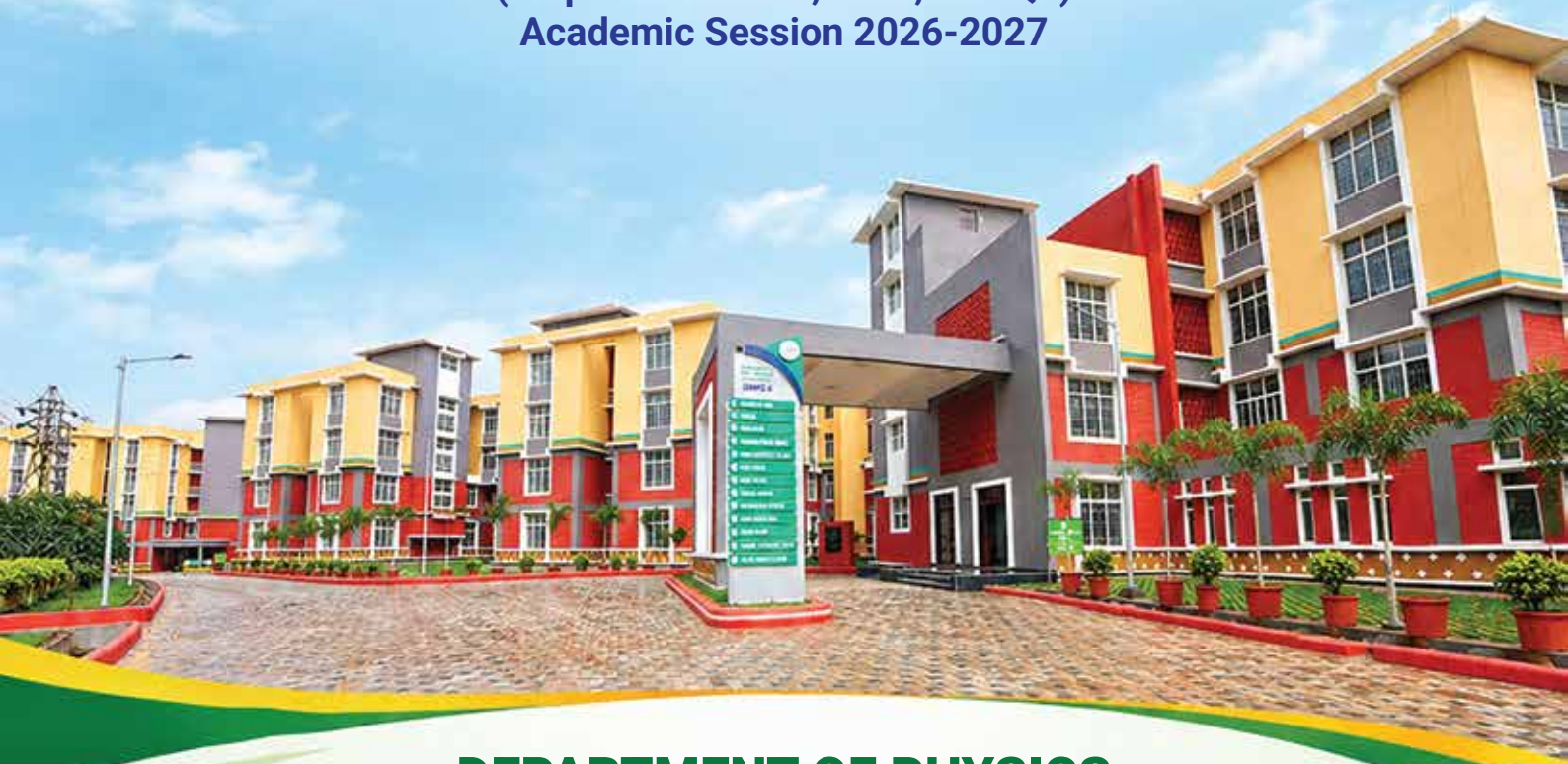
KISS

KALINGA INSTITUTE OF SOCIAL SCIENCES

CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMME

MASTER OF SCIENCE (M.SC.) IN PHYSICS

(As per NEP-2020, NCrF, NHEQF)
Academic Session 2026-2027



DEPARTMENT OF PHYSICS

SCHOOL OF INDIGENOUS KNOWLEDGE, SCIENCE AND TECHNOLOGY

KALINGA INSTITUTE OF SOCIAL SCIENCES (KISS)
DEEMED TO BE UNIVERSITY

Higher Education Campus, KISS Campus-3, Bhubaneswar, Odisha, 751024
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I. About the School and Department

i) About the School

The School of Indigenous Knowledge, Science and Technology, KISS Deemed to be University, was established in 2017-18 with a view of Indigenous scientific knowledge and technological development in a symbiotic relationship with Nature. Indigenous people have an innate understanding of natural resources available in our ecosystem which was in a supine state over the years. In the age of globalization, the tribes who are the real custodians of indigenous knowledge are far behind in the race of technological advancement.

Gradual developments of such people in varied facets of life enable them to explore their traditional knowledge for human welfare. As the over-exploitation of natural resources threatens the ecological balance and sustainable livelihood of tribal people, it is imperative to study our time-tested indigenous knowledge and tribal technology with greater vigour.

Hence, an innovative School – **School of Indigenous Knowledge, Science and Technology** – has been set up to promote, preserve and protect indigenous knowledge and implement it for sustainable development.

The importance of this School is to disseminate advanced knowledge by providing instructional and research facilities in tribal medicinal systems through physiochemical analysis, geosciences and their impact on the health conditions. The importance of gemology in their culture, Sutras and sub-sutras of Vedic mathematics, a nutritional component of the food habit of tribes, intellectual property rights to preserve and conserve the biodiversity of indigenous people and advancement in technologies relating to the natural resources of the tribal areas as well as in other branches of learning as it may deem fit.

This could be possible by teaching innovative courses in *Indigenous Knowledge and Intellectual Property Rights, Tribal Sports, Nutrition and Health Management,*

Indigenous People and the Science of Gemology and Vedic Mathematics. The courses attempt to examine indigenous knowledge and technology, blending both traditional and modern scientific methods from interdisciplinary and multidisciplinary approaches. The School of Indigenous Knowledge, Science and Technology constantly endeavors to improve the knowledge and practice content of its academic programme to match the local, regional, national and international standards.

This School has introduced four innovative interdisciplinary programmes viz. Physics, Chemistry, Mathematics and Computer Science with specialization in Indigenous Knowledge, Science and Technology in the first phase with the approval of UGC to provide impetus to research in Indigenous Knowledge, Science and Technology with multi-disciplinary education facility free of cost. Besides implementing Sustainable Development Goals of the United Nation, the school has been able to bring about the much needed socio-economic changes in the tribal hinterland of Odisha and its neighbouring states.

Because of the school's unique excellence to help the tribal students develop their vocational, entrepreneurial and life skills, it has been trying to break the vicious cycle of poverty and social isolation of tribal communities. The school also seeks to raise the consciousness of the tribal students that the people of their communities have a right to access varied indigenous resources and opportunities in order to live a self- sufficient, adequate and dignified life.

ii) About the Department

The Department of Physics, under the School of Indigenous Knowledge, Science and Technology (IKST), KISS Deemed to be University, Bhubaneswar, was established in 2017–18 with the vision of providing quality education, promoting innovative research, and addressing contemporary scientific and technological challenges through interdisciplinary and multidisciplinary approaches. The department functions in alignment with the mission and vision of the School of IKST, which is dedicated to integrating modern scientific knowledge with indigenous knowledge systems for sustainable development and the empowerment of tribal communities. Since its inception, the department has been committed to excellence in teaching, research, innovation, and community engagement. It offers Undergraduate (B.Sc.), Postgraduate (M.Sc.), and Doctoral (Ph.D.) programmes designed in accordance with the National

Education Policy (NEP) 2020 and Outcome-Based Education (OBE) principles. The curriculum is regularly revised to incorporate recent advances in physical sciences, including condensed matter physics, nanotechnology, materials science, computational physics, renewable energy, quantum physics, electronics, photonics, and semiconductor physics. The department provides a strong foundation in theoretical concepts complemented by extensive laboratory training using modern experimental techniques, computational tools, and scientific instrumentation. It is supported by a dedicated team of qualified faculty members actively engaged in teaching, research, and academic administration. Faculty members regularly publish research articles in reputed national and international journals and participate in conferences, seminars, workshops, faculty development programmes, and collaborative research activities. The department promotes interdisciplinary research by collaborating with scientists and researchers from various academic institutions, research organizations, and industries. Research activities focus on areas such as condensed matter physics, density functional theory (DFT), nanomaterials, advanced functional materials, renewable energy materials, semiconductor devices, computational modelling, optoelectronic materials, and sustainable technologies. Special emphasis is placed on research related to indigenous resources, renewable energy, traditional knowledge systems, environmental sustainability, and scientific innovations that benefit tribal communities and society at large. The department possesses well-equipped teaching and research laboratories that provide students with hands-on experience in experimental physics, electronics, optics, material characterization, computational simulations, and advanced scientific techniques. Students are encouraged to undertake research projects, internships, industrial training, and dissertation work to enhance their practical skills, analytical abilities, and scientific temperament. The department also organizes seminars, guest lectures, workshops, industrial visits, science outreach programmes, and expert interactions to expose students to emerging trends in physical sciences and technological innovations. The department encourages multidisciplinary collaborations across various schools of the University to develop innovative scientific solutions to regional, national, and global challenges. The department maintains a learner-centric environment supported by ICT-enabled teaching, continuous assessment, mentoring, and career guidance. Students are motivated to participate in national and international conferences, science exhibitions, innovation programmes, competitive examinations,

and research-oriented activities. The department also encourages publication of student research, intellectual property generation, entrepreneurship, and collaborative projects with industries and national research laboratories. By integrating modern physical sciences with indigenous knowledge systems and sustainable technological practices, the department contributes significantly to achieving the Sustainable Development Goals (SDGs) and national priorities. With its strong commitment to academic excellence, innovation, and community engagement, the department continues to uphold the vision of the School of Indigenous Knowledge, Science and Technology and the mission of KISS Deemed to be University in serving local, regional, national, and global needs.

ii) Vision & Mission of the School

Vision:

Be an internationally acclaimed School, recognized for excellence in teaching, research, consultancy and outreach; skill development and social entrepreneurship for tribal youth by promoting Indigenous Science and Technology.

Mission:

- Foster all-round development of students through multi-faceted education.
- Focus on Indigenous Science and Technology with the help of innovative courses like Vedic Mathematics, Indigenous people and the Science of Gemology, Tribal Sports, Nutrition and Health Management, Indigenous Knowledge and Intellectual Property Rights.
- Engage with local, national and global communities to get ideas about Indigenous Science and Technological applications for contemporary needs and problems and become successful in life.
- Manage resources for self-employment and create employment for others.

II. M.Sc. in Physics Programme

M.Sc. in Physics is a two-year postgraduate programme designed in alignment with the National Education Policy (NEP) 2020, the National Credit Framework (NCrF), the National Higher

Education Qualification Framework (NHEQF Level 8), and the UGC Curriculum and Credit Framework for Postgraduate Programmes (2023). The programme integrates core competencies in various thrust areas of Physics along with Indigenous Science and Technology. Along with innovative tribal courses, the programme integrates fundamental and applied physics, including Classical Mechanics, Quantum Mechanics, Electrodynamics, Mathematical Physics, Statistical Mechanics, Solid State Physics, Atomic and Molecular Physics, Nuclear and Particle Physics, Electronics, Computational Physics, Materials Science, Nanoscience and Nanotechnology, Renewable Energy Physics, Photonics, Semiconductor Physics, Condensed Matter Physics, Advanced Experimental Physics, Computational Modelling, Research Methodology, and Scientific Ethics.

Students are provided with opportunities to develop strong conceptual understanding, analytical thinking, computational and experimental skills, and research competencies in Physics, enabling them to build successful careers in academia, research institutions, industries, scientific organizations, and higher education. In addition, the curriculum incorporates lectures, laboratory experiments, case studies, field visits, SWAYAM MOOC courses, seminars, workshops, research projects, internships, dissertations, and scientific presentations organized from time to time, ensuring a holistic, multidisciplinary, and experiential learning environment consistent with the objectives of NEP 2020.

II. Process of Curriculum Development

The department of Chemistry under the School of Indigenous Knowledge, Science and Technology follow consultative process in the development of the course curriculum.

Following are the stages of curriculum development:

(i) Formation of syllabus Committee with members having specialized domain knowledge.

(ii) Consultation with stakeholders comprising alumni, students, employers etc.

(iii) Review and approval by all faculty members of the Department.

(iv) Scrutiny and approval by Board of Studies (Experts from Outside).

(v) Final approval by Academic Council of the University.

(vi) Integration of NEP-2020, NCrF and NHEQF guidelines.

III. Definition of Components

(i) '**Academic Programme'** means the entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to

be taught and evaluated in a teaching programme or jointly under more than one such programme.

(ii) **'Course'** means a segment of a subject that is part of an Academic Programme.

(iii) **'Course Structure'** means a list of courses (Core, Specialization, Discipline Specific Elective, MOOCs/Open Elective and skill based) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.

(iv) **'Core Course'** means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v) **'Discipline Specific Elective'** Courses offered in the same Programme of the School.

(vi) **'Open Elective Course'** means an elective course which is available for students of all programmes, including students of same department and the students of other Programme will opt these courses.

(vii) **'Skill Enhancement Courses'** means the skill-based courses and are aimed at providing hands-on-training, competencies, skill- based knowledge.

(viii) **'Credit'** means the value assigned to a course which indicates the level of instruction; One hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit.

(ix) **'SGPA' means 'Semester Grade Point Average'** calculated for individual semester and 'CGPA' is 'Cumulative Grade Points Average' calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together. To benefit the student a formula for conversation of Grand CGPA into percentage marks is given in the Transcript.

IV. NCrF Aligned Components (National Credit Framework)

1. Operational Definition of Credit (NCrF Standard)

"1 Credit = 30 Notional Learning Hours."

A standard 4 credit course = 120 Notional Learning Hours.

i) NCrF-Compliant Course Engagement Table

Component	**Operational Definition**	**Hours (Example for 4-credit course)**
Face-to-Face Lectures	Concept delivery, interactive instruction	45
Tutorials / Labs / Field	Hands-on practice, experimentation	30
Independent Self-Study	Pre-reading, journal review	20
Continuous Assessment	Assignments, quizzes, mid-term	12
Final Semester Exam Preparation	Revision, project completion	13
Total Notional Hours	**Must equal 30 hours × credits**	**120**

MOOC Courses (SWAYAM and SWAYAM Plus)

According to the UGC guidelines integrated into the new curriculum structures, Higher Education Institutions (HEIs) are permitted to allow students to take up to 40% of their total courses in a semester through the national MOOC platform, SWAYAM (or SWAYAM Plus for industry-aligned courses).

Credits earned via SWAYAM are mapped directly against the appropriate NHEQF academic level and digitally stored in the student's Academic Bank of Credits (ABC) to count toward their final degree, diploma, or certificate.

ii) NCrF Category Wise Credit Distribution (UGC CCFUP Compatible)

This programme is a two-year course divided into four-semesters. The course is of 90 credits and for the award of degree a student will be required to complete the credits as per the University norm.

Course Credit Scheme

Semester	Core Courses		IKS		Dissertation		Grand Total Credits
	No. of Papers	Total Credits	No. of Papers	Total Credits	No. of Papers	Total Credits	
I	5	20	1	4			24
II	5	20	1	4			24
III	5	18	1	4			22
IV	-	-			1	20	20
Total Credits for the Course		58		12		20	90

These exit awards correspond to progressive NHEQF / NSQF levels and are fully NCrF-compliant for credit accumulation, mobility and re-entry through the Academic Bank of Credits.

V. Eligibility for Admissions with number of Seats:

As per the admission guidelines and brochure of the KISS Deemed to be University

VI. Examination Pattern: As per NEP 2020

The medium of examination is English which will be reflected in their final grade sheet/certificate. Provided that for a language subject answers are to be in that language. Sanskrit may be written in Odia script but language has to be Sanskrit.

i. Duration of the Examinations-Mid Semester & End Semester:

Duration of examination for all term End examination shall be for 2.5 hours and for all Mid Term examination for 1 hour irrespective of full marks in the course/subjects and irrespective of credit. The practical examinations shall be of 2 hours duration.

Each School shall have a designated faculty as Examination Coordinator to be decided by the Vice Chancellor in addition to the Controller of Examinations of the University.

Continuous Evaluation and Mid Semester Examination:

a) Mid semester examination will be of 1-hour duration for 20/10 marks (20 for subjects having no practical and 10 for subject with practical papers). There shall be no pass mark in Mid Semester examination.

b) The Mid-Semester Examination shall be conducted and valued by the Faculty who are teaching the corresponding paper. A student who fails to appear in a Mid-Semester

Examination **will be allowed one more chance to** take the same examination before appearing the concerned term-end examination. There will be no provision to re-appear in the Mid-Semester Examination for improvement.

c) For subjects with practical there will be a Mid-Semester practical examination carrying 10 marks.

d) The University authority of the valuation zones will preserve the answer Script of the End Semester examination for 06 months from the date of publication of result for reference.

e) A student has to appear the mid semester examination positively. Absence in the mid semester examination will be considered as fail however the candidate may be allowed to appear the mid semester examination before commencement of the concerned Term-End examination under special case duly considered by the HoD (for the ***candidates who represent the University or State for Inter- University or inter-state competitions in Games and Sports or attending different recognized National level camps/any critical medical case duly certified by the designated medical officer).***

ii. Distribution of Marks in End Semester and Continuous Evaluation:
(Irrespective of credit in a course/Paper)

Course Type	Maximum Marks	Semester-End theory Mark	Continues Evaluation Marks /Sessional	Mid Semester theory Mark	Semester-End and Practical mark	Mid Semester Practical Mark
Without Practical	**100**	**60**	**20**	**20**	**----**	**--**
With Practical	**100**	**50**	**10**	**10**	**20**	**10**
Thesis/ Dissertation/ Seminar/Field Work	**100**	**------**	**-------**	**-------**	**-------**	**-------**

The **modes of evaluation** of **Thesis/ Dissertation/ Seminar/Field Work** shall be as follows:
Literature Review
Synopsis Presentation
Field Work / Data Collection and Data Analysis
Findings and Conclusions
Presentation and Viva-Voce

iii. Distribution of Sessional Marks:(Continuous Evaluation)

Course Type	Maximum Mark	Mid Semester	Attendance	Surprise Test/Quiz/Viva	Assignment/ Presentation
Without Practical	**40**	**20**	**Above 95%- 5 Marks**	**10**	**05**

With Practical	**30**	(Theory 10 + Practical 10)=20	**85%-94%-** **75%-84%-**	**4 Marks** **3 Marks**	**05**	**Nil**

iv. Examination Question Pattern of End Term Examination and Mark Distribution:

The evaluation process may cover summative and formative aspects and assess understanding applications, articulation, program and course outcome.

Question Pattern		**With Practical**	**Without Practical**
Part-I –Objective	**Answer in MCQ/ in one word/in one sentence as directed**	**1x5=5**	**1x6=6**
Part-II- Very Short Type	**Answer within 50 words. Answer any 3 out of 5 questions (with practical) and Answer any 5 out of 7 question (without practical)**	**2x3=6**	**2x5=10**
Part-III- Short Type	**Answer within 250 words Answer any 3 out of 5 questions (with practical) and Answer any 4 out of 6 question (without practical)**	**5x3=15**	**5x4=20**
Part-IV- Long Type	**Answer within 800 words. Answer any 3 out of 5 questions**	**8x3=24**	**8x3=24**
Total		**50**	**60**
For Practical Paper		**One Major Experiment-10 Record-05 Viva voce-05**	---------

v. Examination Question Pattern of Mid Semester Examination and Mark Distribution

Question Pattern		**With Practical**	**Without Practical**
Part-I –Objective	**Answer in MCQ/ in one word/in one sentence as directed**	**1x3=3**	**1x6=6**
Part-II- Very Short Type	**Answer within 50 words. Answer any 1out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical)**	**2x1=2**	**2x2=4**

Part-III- Short Type	**Answer within 250 words Answer any 1 out of 2 questions (with practical) and answer any 2 out of 3 questions (without practical)**	**5x1=5**	**5x2=10**
Total		**10**	**20**
For Practical Paper		**One Major Experiment- 5 Record- 02 Viva voce-03**	---

VII. Duration and Types of Courses and Process of Multiple Entry and Exit

NHEQF-Aligned Components (National Higher Education Qualifications Framework)

NHEQF Level Mapping for Multi-Entry / Multi-Exit

"This programme is structured according to the multi-entry, multi-exit parameters defined by UGC. The progressive qualification bands map directly onto the National Higher Education Qualifications Framework (NHEQF)."

Milestone / Year Completed	Exit Award	NHEQF Level	Standard Credit Range
Year 1(Sem I-II)	Post-Graduate Diploma	Level 6.0	48 Credits
Year 2(Sem III-IV)	Master's degree in Chemistry	Level 6.5	90 Credits
	Doctoral Degree	Level 8.0	Credits for coursework and a thesis and published work

IX. Programme Educational Objectives (PEOs):

The Objective of this program is to ensure career path of the students. Students can be self-employed in the tribal community or elsewhere; or becomes a social entrepreneur; or can adopt research studies to enhance their skills for sustainable livelihood and become a researcher; they can pursue higher studies; or become a professional for policy making and its execution.

PEO1: Aim of this unique program is to enable the students to learn, evaluate and develop analytical ability mainly in the field of science and technology and to ensure preservation of tribal resources. They should be able to

highlight the philosophical approach of the tribes towards economic life.

PEO2: To explore and innovate scientific knowledge through the application of indigenous knowledge by utilizing the treasured indigenous knowledge of Professors of Practice and collaborate with national and international universities and organizations, especially for undertaking spiritual studies and research on tribal communities.

PEO3: To offer online and offline certificate courses for enrichment and refinement of their skills and computer literacy for attaining global competency and formulate tribal centric development models, publish reports and organize conferences and seminars on issues relating to indigenous science and technology.

PEO4: To create ample scope for the researchers in the field of science and technology from a tribal perspective by integrating relevant aspects of indigenous knowledge with traditional subjects like Physics, Chemistry, Mathematics and Computer Science and to make proper use of natural resources and indigenous knowledge for sustainable environmental development.

PEO5: To equip the students with knowledge in indigenous science and technology and turn them into agents of social transformation in their respective communities and promote culture of credibility, transparency and reliability for continuous quality enhancement of academic and institutional governance.

X.Programme Outcomes (POs):

The expected attributes for a post graduate in Chemistry shall be expert disciplinary knowledge with communication skills, critical thinking, problem solving, research related skills, digital literacy, self-directed lifelong learning with high social commitment and ethical awareness.

PO1	Moral & Ethical Values	Apply ethical principles and commit to professional ethics and responsibilities and norms of the scientific practice.
PO2	Disciplinary Knowledge	Acquire an understanding of the nature, practice and application of the chosen area of study
PO3	Communication Skills	Ability to speak, read, writes, listen and understand clearly in person or through electronic media and make meaning of the world by connecting people, ideas, books, media and technology. Present complex chemical information clearly and concisely. Prepare laboratory reports, dissertations and seminar presentations.
PO4	Critical Thinking, Problem solving & Analytical reasoning	Ability to engage in reflective and independent thinking by understanding the concepts in every area of Mathematics with Indigenous Science and Technology and take informed actions after identifying the assumptions that frame their thinking and actions, checking out the degree to which these assumptions are accurate and valid and looking at ideas and decisions from different perspectives. Ability to examine the results and apply them to various problems appearing in different branches of Mathematics with Indigenous Science and Technology. Identify assumptions and limitations and formulate coherent scientific arguments. Analyse and synthesise data from various sources and support conclusions with evidence. Ability to address scientific problems and offer a solution for the same.

		Capacity is to analyze synthesize data and derive influences for valid conclusions Capability to analyze the impact of chemistry on the overall development of tribal society. Identify logical flaws in chemical reasoning and interpretations. Analyse and synthesise chemical data and address alternative viewpoints logically.
PO5	Indian knowledge Systems(IKS)	Integrates traditional Indian scientific knowledge with modern chemical sciences. Connects ancient practices with areas such as medicinal chemistry, dyes, ceramics and materials science. Promotes understanding of traditional methods of natural products and indigenous technologies. Encourages sustainable and eco-friendly approaches in chemical processes and resource utilization. Develops interdisciplinary learning by linking chemistry with Ayurveda, environmental science, and material applications. Enhances ethical scientific practices and awareness of India's historical contributions to chemistry and allied sciences. Provides deeper insight into the role of ancient Indian knowledge in the development of modern chemical technologies.
PO6	Research-Related Skills	Ability to search for, locate, extract, organize, evaluate, and use or present information which has relevance with different Scientific issues. Ability to identify the research gaps and developments in various branches of Chemistry and Indigenous Science. Skills to design and execute experiments and dissertation work. Competence in selecting appropriate methodologies, instruments and statistical tools.

		Understanding of research ethics, safety norms and responsible conduct of research.
PO7	Cooperation/Team work	Convey ideas and information effectively to a range of audiences for a variety of purposes and contribute in a positive and collaborative manner to achieving common goals. Participate in collaborative experiments, projects and seminars. Contribute efficiently as a team member in academic, industrial and research environments.
PO8	Digital Literacy	Capability to use various technical ICT tools (Data analytics) for exploring, analyzing, and using the information for different purposes.
PO9	Experiential & Life – long learning	Students would seek hands-on learning to perform in the real world by acquiring knowledge, skills and attitude, so that they will be able to present them effectively to their employers.
PO10	Leadership Qualities	Students are expected to have the qualities like high integrity, accountable for actions, sense of empathy, humanity, resilience, positivity, influencing and a vision. They are expected to engage in professional behaviour and have the potential to be an entrepreneur and take leadership roles in their chosen occupations or careers and communities.
PO11	Professional & Decision-making Skills	Students are expected to exhibit skills that would demonstrate what they are capable of contributing to their job role and fulfill duties of the position they would seek. Ability to achieve professional integrity and professional behavior, as well as the skills and attitudes necessary to plan for one's career and to stay current in dynamic world.
PO12	Environment Awareness and Sustainability	Able to understand the issues of environment trends and would endeavor for their lasting solutions.

		Apply chemical knowledge to environmental protection and pollution control. Practice green chemistry and sustainable laboratory methods. Contribute to waste management, resource conservation and climate action.

XI. Programme Specific Outcomes (PSOs)

PSO1: The students will be able to perform theoretical, computational, and experimental investigations, simulate physical systems, and analyse scientific data obtained from experiments and numerical modelling. They will also develop a scientific outlook not only in various branches of Physics but also in the field of Indigenous Science and Technology.

PSO2: The students will acquire advanced knowledge of Classical Mechanics, Quantum Mechanics, Electrodynamics, Statistical Mechanics, Solid State Physics, Atomic and Molecular Physics, Nuclear Physics, Electronics, Computational Physics, Materials Science, Nanoscience and Nanotechnology, Renewable Energy Physics, and Photonics. They will develop the ability to apply these concepts to analyse and solve scientific and technological problems.

PSO3: The students will be able to identify, analyse, and solve complex theoretical and experimental problems using modern scientific instruments, computational tools, and simulation techniques. They will apply interdisciplinary knowledge in areas such as Condensed Matter Physics, Materials Science, Semiconductor Physics, Optoelectronics, Nanotechnology, Renewable Energy, Computational Modelling, and Advanced Experimental Physics.

PSO4: The students will receive training for employment in academic institutions, research laboratories, national scientific organizations, government agencies, industries, quality assurance laboratories, instrumentation facilities, and multidisciplinary research projects. They will also be prepared for careers in higher education, scientific research, and technological innovation at national and international levels.

PSO5: The students will acquire proficiency in the use of modern experimental techniques, scientific instrumentation, computational software, and data analysis methods for qualitative and quantitative investigation of physical systems. They will develop the competence required for research, industrial applications, scientific consultancy, and professional careers in Physics and allied disciplines.

COURSE STRUCTURE OF POSTGRADUATE PROGRAMME

M.Sc. Physics

SEMESTER DETAILS: The course comprises four semesters.

SEMESTER-I					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
PH40001	Mathematical Methods and Application	3	0	1	4
PH40003	Classical Mechanics	3	0	1	4
PH40005	Quantum Mechanics	3	0	1	4
IK40051	Scientific Research Methods	3	1	0	4
PH40007	Artificial Intelligence in Physics	3	0	1	4
IK40053	Vedic Mathematics	3	1	0	4
	Total				**24 Credits**
SEMESTER-II					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
PH40002	Advanced Condensed Matter Physics	3	0	1	4
PH40004	Digital Electronics and Microprocessor	3	0	1	4
PH40006	Applied Optics	3	0	1	4
PH40008	Nanoscience and Nanotechnology	3	0	1	4
PH40010	Electro Dynamics	3	0	1	4
IK40052	Indigenous People and the Science of Gemology	3	1	0	4
	Total				**24 Credits**
Grand Total					**48 Credits**
Exit Point: Postgraduate Diploma Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma					

SEMESTER-III					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
RM50001	Research Methodology	3	1	0	4
RE50003	Research and Publication Ethics	2	0	0	2
CA50005	Computer applications and data analysis	3	0	1	4
IK50051	Indigenous Knowledge and Intellectual Property Rights	3	0	1	4
	Choose Any two				
PH50031	Physics of Materials	3	0	1	4
PH50033	Nuclei and Particle Physics	3	0	1	4
PH50035	Statistical Physics of Non-interacting and Interacting Systems	3	0	1	4
PH50037	Molecular Spectroscopy and Application	3	0	1	4
	Total				22 Credits

SEMESTER-IV					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
RT50082	Research Thesis	0	0	20	20
	Total				20 Credits
Grand Total		20 Credits			

Exit Point: Master's Degree

Students will be awarded M.Sc. degree in Physics, provided they secure 90 credits

SEMESTER-I

SEMESTER-I

COURSE CODE	NAME OF THE COURSE	CREDITS			
		L	T	P	TOTAL
PH40001	Mathematical Methods and Application	3	0	1	4
PH40003	Classical Mechanics	3	0	1	4
PH40005	Quantum Mechanics	3	0	1	4
IK40051	Scientific Research Methods	3	1	0	4
PH40007	Artificial Intelligence in Physics	3	0	1	4
IK40053	Vedic Mathematics	3	1	0	4
	Total				**24 Credits**

Course Code: PH40001

Course Title: Mathematical Methods and Application

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Objectives:

Students will be able to

1. Use complex analysis in solving physical problems.

2. Use Green functions.

3. Use the orthogonal polynomials and other special functions.

4. Use the Fourier Series and integral transformation.

Course Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		2	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember the Bessel function, Recurrence relations, and generating function.	PO1 (3)
CO2	Understand Green's functions in 1D, 2D, and 3D problems.	PO2(3)
CO3	Apply Tensor Calculus: Differentiation of a tensor.	PO2(3), PO4(2)
CO4	Analyse various powers of a matrix, roots of a matrix, the exponential of a matrix, and the logarithm of a matrix.	PO7(3)
CO5	Evaluate the functions using the Cayley-Hamilton theorem.	PO4 (3)

Course Duration: 60 hours

Course Content:

Unit –I(10 Classroom Contact Hours)

Differential equations and their solutions: Bessel's differential equation, power series solution, Bessel function, Recurrence relations, generating function. Integral representation of Jn', Orthogonality Condition, Bessel functions of half-odd order, Neumann function Nn' and Properties, Asymptotic forms of Jn and Nn. Spherical Bessel function j1 and n1, Rayleigh's for j1 and n1, orthonormality of spherical Bessel functions.

Unit – II(15 Classroom Contact Hours)

Hyper-geometric equation, solutions and properties, Gauss formula, Linear relationships of hyper-geometric functions, Confluent hyper-geometric function and properties, Integral representation, Relation of confluent hyper-geometric functions with other special functions.Solution of non-homogeneous equation: Green's function. Symmetry of Green's functions, Green's functions in 1D, 2D, and 3D problems, eigenfunction expansion technique. Complex variable: Residue theorem, its application to evaluate definite integrals.

Unit – III(10 Classroom Contact Hours)

General tensor analysis: Contravariant and covariant vectors, Tensor of rank two. Tensor algebra (addition, subtraction, outer product, inner multiplication), relative tensors, Kronecker delta and Levi-Civita tensor density. Symmetry property of tensors, Pseudo-tensors, Metric tensor, and properties.Tensor Calculus: Differentiation of a tensor, Covariant derivative of Contravariant and covariant vectors and tensors, Tensor forms of gradient, divergence, curl, and the Laplacian, geodesic equation.Einstein's law, Parallel displacement, Curvature of Riemannian space, commutation law of covariant differentiation, covariant curvature tensor, symmetries of curvature tensor, Bianchi identity.

Unit – IV (15 Classroom Contact Hours)

Matrices: Eigen value Problem, determination of eigen values, eigenvectors and their properties, diagonalization of a matrix, eigen vectors of commutating matrices. Cayley-Hamilton theorem, conditions of diagonalizability, functions of a diagonalizable matrix, powers of a matrix, roots of a matrix, exponential of a matrix, logarithm of a matrix, evaluation of functions using Cayley-Hamilton theorem.

SDG Mapping

SDG	Rationale
SDG 4	Data literacy
SDG 9	Innovation in analytics

SDG 10	Reducing inequality through transparent data
SDG 13	Climate data visualization

Practical: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH40001 LAB : MATHEMATICAL METHODS AND APPLICATION

1. Study of basic matrix operations.
2. To solve linear equation.
3. Determination of Eigen values and Eigen vectors of a Square matrix.
4. Solution of Partial Differential Equations.
5. Solution of Differential Equations using Euler's Method.
6. Solution of differential equation using 4th order Runge- Kutta method.

Essential readings:

1.Mathematical Methods for Physicists: G.B. Arfken and H.J. Weber and Harris(Elsevier)

2.Mathematical Methods of Physics: J Mathews and R.L. Walker (Pearson)

3.Mathematical Physics: P.K. Chattopadhyay (New Central)

4.Mathematics for Physicists and Engineers: Pipes.(McGraw-Hill)

5.Matrices and tensors in Physics: A.W.Joshi (Phi)

6.Gravitation and Cosmology: S.Weinberg. (Wiley)

7.Vector Analysis: Spiegel (Schaum) (TMH)

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory and Practical Examination

Course Code: PH40003

Course Title: CLASSICAL MECHANICS

Total Credits: 04 (Credits: Theory-03, Practical-01)
Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

Students will be able to articulate and describe:

1. Relative motion. Inertial and non-inertial reference frames.
2. Parameters defining the motion of mechanical systems and their degrees of freedom.
3. Study of the interaction of forces between solids in mechanical systems.
4. Centre of mass and inertia tensor of mechanical systems.

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember the concepts, nature and significance of Classical Mechanics.	PO1 (3)
CO2	Understand the Parameters defining motion in a mechanical system.	PO2(3)
CO3	Apply the interaction of forces between solids in mechanical systems.	PO2(3), PO4(2)
CO4	Analyze Small oscillations.	PO7(3)
CO5	Evaluate the problems based on Classical Mechanics.	PO4 (3)

Course Content:

Unit – I(10 Classroom Contact Hours)

The Kinematics of Rigid Body Motion: Definition of rigid body, degrees of freedom, orthogonal transformation, and properties of transformation matrix. The Euler angles, Euler's Theorem on the motion of a rigid body. Finite and infinitesimal rotations. Rate of change of a vector. The Coriolis force effect. The rigid body equations of motion: Angular momentum and kinetic energy of motion about a point. Tensors and diadics. The inertia tensor and the moment of inertia.

Unit – II(10 Classroom Contact Hours)

The eigenvalues of the inertia tensor and the Principal axis transformation. Euler's equations of motion. Torque-free motion of a rigid body. The Hamilton equations of motion: Legendre transformation and the Hamilton equations. Cyclic coordinates and conservation theorem. Routh's procedure and oscillation about steady motion. Derivation of Hamilton's equations from a variational principle. The principle of least action.

Unit-III**(10 Classroom Contact Hours)**

Hamilton-Jacobi Theory: Hamilton-Jacobi equations for i) principal function ii) characteristic functions. Harmonic oscillator problem as an example of the Hamilton – Jacobimethod, separation of variables in the H-J equation. Action angle variables. The Kepler problem in action angle variables.

Unit-IV (15 Classroom Contact Hours)

Small oscillations: Potential energy in quadratic approximation, conditions ofoscillation, Lagrange's equation for degrees of freedom, oscillating systems, T matrix, V matrixand similarity transformation, normal frequencies and normal modes, normal coordinates with examples, free vibration of a linear tri atomic molecule.

SDG Mapping

SDG	Rationale
SDG 4	Data literacy
SDG 9	Innovation in analytics
SDG 10	Reducing inequality through transparent data
SDG 13	Climate data visualization

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH40003 LAB: CLASSICAL MECHANICS

1. Observe and measure the Coriolis Effect in a rotating reference frame.
2. Determination of Principal Axes and Moments of Inertia USING Inertia pendulum, 3D rigid body samples, CAD software

3.Verify Euler's equations for the rotational motion of a rigid body.using: Rotating disc apparatus, torque and angular velocity sensors and data acquisition system

4.. study the Application of Transformation Matrices in Rotational Kinematics using Simulation software for visualizing 3D rotations, rotational matrices, mechanical models**.**

5.StudyQuadratic Approximation of Potential Energy in Oscillating Systems with Pendulum setup with small angular displacement, force sensors, software for potential energy analysis.**Measurement of Hall co-efficient.**

6. study Inertia Tensor 3D rigid bodies using, MI apparatus, computational tools for tensor analysis. **To obtain b~H loop.**

7.Study of Torque-Free Motion of a Rigid Body using Gyroscope, high-speed motion capture system, software for trajectory analysis.**Characteristics of transistor.**

8. Study the vibration modes of a linear triatomic molecule modelusing.molecular model kit, frequency analyzer, computational modeling software.

9.Determination of Plank's constant

Essential readings:

1. Classical Mechanics: H. Goldstein ,safko and Phoole (Pearson)

2. Mechanics: L.D. Landau and K.M. Lifshitz(Elsevier)

3. Particle Dynamics : J.B. Marion (Cengage)

4. Classical Mechanics :Rana and Joag (TMH)

5. Classical Mechanics: R.D. Gregory, Cambridge University Press,2006.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)

End semester University Theory and Practical Examination

Course Code: PH40005

Course Title: Quantum Mechanics

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

1. This course is aimed to introduce basic concepts and ideas on Quantum Mechanics.

2. The Classroom Contact Hours will focus on essential physical principles supported by mathematical developments when required.

3. Every idea will be also illustrated with some technological application.

4. The students will participate actively in the discussions andinits probable future modifications.

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember Linear vector space Formulation: Linear vector space (LVS) and its generality, Vectors - scalar product, metric space, basis vectors	PO1 (3)
CO2	Understand the Operators and their properties- a review, Operators representing observables. Expectation values of operators, Hermitian operators, Eigen values and eigenvectors.	PO2(3)
CO3	ApplyTime-evolution of quantum states, Time-evolution operator. Time-dependence of quantum states and observables.	PO2(3), PO4(2)
CO4	Analyse the components of orbital angular momentum operator. Eigen values and eigen functions of by operator method. Matrix representations of L, and L^2. Spin angular momentum of spin ½ particles, Pauli spin operators.	PO7(3)
CO5	Evaluate Solution of Harmonic Oscillators problem in Heisenberg picture.	PO4 (3)

Course Content:

Unit – I(10 Classroom Contact Hours)

Linear vector space Formulation: Linear vector space (LVS) and its generality, Vectors - scalar product, metric space, basis vectors, linear independence, linear superposition of general quantum states, orthogonality of basis-vectors, completeness, Schmidt's orthonormalization procedure, Dual space, Bra and ket vectors.

Unit –II(10 Classroom Contact Hours)

Operators and their properties- a review, Operators representing observables. Expectation values of operators, Hermitian operators, Eigen values and eigen vectors of Hermitian operators, Complete set of eigen vectors of a Hermitian operator, a basis set, Expansion theorem, Completeness and closure property. Expansion of an arbitrary ket using complete set of co- ordinate eigenkets and identification of the co-efficient of expansion as the wave function in co-ordinate representation such as momentum, energy etc. Unitary transformation of basis vectors and operators. Matrix representation of ket vectors and bra- vectors and operators. Canonical commutation relation and dimensionality of Hilbert space.

Unit –III(10 Classroom Contact Hours)

Quantum Dynamics: Time-evolution of quantum states, Time-evolution operator. Time-dependence of quantum states and observables in Schrodinger, Heisenberg and Interaction (Dirac) picture. Equations of motion. Solution of Harmonic Oscillators problem in Heisenberg picture.

Unit – IV (15 Classroom Contact Hours)

Rotational symmetry under rotation of co-ordinate system. Orbital angular momentum as the generator of transformation under rotation. Transformation of scalar operator and a vector operator under rotation leading to various commutation properties of with other vector or scalar operators. Raising and lowering operators Lie-Algebra for the components of orbital angular momentum operator. Eigen values and eigen functions of by operator method. Matrix representations of , and L^2 . Spin angular momentum of spin ½ particles. Pauli spin operators and their properties. Eigen values and eigen functions. Spinor transformation under rotation of co-ordinate system. Total angular momentum q . Lie-Algebra for the components Eigen value problems of Angular momentum matrices. Addition of angular momenta and C. G. coefficients for states with (i) and (ii) .

SDG Mapping

SDG	**Rationale**
SDG 4	**Data literacy**
SDG 9	**Innovation in analytics**

SDG 10	**Reducing inequality through transparent data**
SDG 13	**Climate data visualization**

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH40005 LAB: ADVANCED QUANTUM MECHANICS

1. Simulation of the time evolution of a quantum state using the Schrödinger equation..
2. study the transformation properties of scalar and vector operators under rotation Using computational tools .
3. Study Representation of bra and ket vectors and operators in matrix form using computational tools.
4. To Explore the properties of Pauli spin matrices and simulate spin-½ particles.
5. Conduct experiments using Electron Spin Resonance (ESR) or Nuclear Magnetic Resonance (NMR) apparatus to study spin and magnetic moments in quantum mechanics.

Computational Tools and Software to be used-

6. **MATLAB:** Useful for matrix manipulations, solving differential equations, and symbolic computations.
7. **Python (with libraries such as NumPy, SciPy, and SymPy):** Excellent for numerical simulations, matrix operations, and symbolic algebra.
8. **Quantum Simulation Software:** Tools like QuTiP (Quantum Toolbox in Python) can be used for simulating quantum systems.

Essential readings:

1. Quantum Mechanics: Sakurai (Pearson)
2. Quantum Mechanics: Schiff (McGraw Hill)

3. Quantum Physics: Gasiorowicz (Wiley)

4. Quantum Mechanics: Merzbacher (Wiley)

Note: Latest edition of the text books should be used.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory and Practical Examination

Course Code: IK40051

Course Title: Scientific Research Methods

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Objectives:

This course introduces students to the principles and methodologies of scientific research. It develops skills in research design, literature review, hypothesis formulation, data collection, statistical analysis, ethical research practices, scientific writing, and publication, enabling students to conduct independent, rigorous, and high-quality research in interdisciplinary scientific and technological domains.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- **CO1 (Knowledge/Remember):** Recall and describe the fundamental concepts of scientific research, research methodologies, research ethics, literature review, hypothesis formulation, research design, and data collection techniques.

- **CO2 (Understanding):** Explain and interpret the principles of qualitative and quantitative research methods, sampling techniques, statistical analysis, experimental design, research ethics, intellectual property rights, and scholarly communication.
- **CO3 (Application):** Apply appropriate research methodologies, statistical tools, and data analysis techniques to formulate research problems, conduct scientific investigations, and interpret research findings.
- **CO4 (Analysis):** Analyze research literature, evaluate experimental results, assess the validity and reliability of data, and critically examine scientific findings using appropriate analytical and statistical methods.
- **CO5 (Synthesis/Evaluation):** Design and conduct independent research by integrating scientific methodologies, ethical practices, statistical analysis, and academic writing skills to prepare research proposals, technical reports, dissertations, and research publications.

CO-PO-PSO Mapping

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	–	2	2	3	1	–	2	2	3	2	1	–	2	2
CO2	–	2	–	3	–	3	–	3	2	–	2	–	3	–	3	1
CO3	1	3	2	3	1	3	1	2	2	–	2	–	2	1	3	2
CO4	–	2	3	2	–	2	1	3	2	–	2	–	2	–	2	2
CO5	3	2	2	2	2	3	–	1	2	2	3	1	1	–	2	2

Course Duration: 45 hours
Course Syllabus:

Unit 1: Scope of Research [5 Classroom Contact Hours]
Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment, collect and analyse data, interpret and report, scope and importance.
Unit 2: Literature Survey, Databases and Research metrics [15 Classroom Contact Hours]
Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, Digital: Databases and their responsible use: Google Scholar, Web of science, Scopus, UGC INFONET, SciFinder, PubMed, ResearchGate, E-consortium, e-books; Search techniques: Phrase, Field, Boolean, Proximity, Concept, Limiting/Refining Search Results. Research metrics: Impact factor of Journal, h-index, i10 index, Altmetrics, Citation index. Author identifiers/or profiles: ORCID, Publons, Google Scholar, ResearchGate, VIDWAN.

Unit 3: Communication in Science [13 Classroom Contact Hours]
Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor, and thesis. Thesis writing – different steps and software tools (Word processing, LaTeX, Chemdraw, Chemsketch etc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA, Oxford etc), annotated bibliography, Citation

management tools: Mendeley, Zotero and Endnote; footnotes. Oral presentation/posters – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication, electronic manuscript submission, effective oral scientific communication and presentation skills.

Unit 4: Ethical Practices in Research and Publication [12 Classroom Contact Hours]
Scientific Conduct: Ethics with respect to science and research, Scientific Misconducts: falsification, fabrication and plagiarism, similarity index, software tools for finding plagiarism (Turnitin, Urkund etc), redundant dublications Publication Ethics: Introduction, COPE (Committee on Publication Ethics) guidelines; conflicts of interest, publication misconduct: problems that lead to unethical behaviour and vice versa, types, violation of publication ethics, authorship and contributorship, predatory publishers and journals IPR - Intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS).

Total Practical / Lab Experiments: [30 Lab Contact Hours]

1. Collection of journal articles on a particular topic using Google Scholar and creating a database.
2. Collection of journal articles on a particular topic using Science Direct and creating a database.
3. Collection of journal articles on a particular topic using Scopus and creating a database.
4. Drawing chemical structure, reactions and mechanisms using Chemsketch or ISIS draw or any other software.
5. Collection of chemical structure using ChemSpider and creating a database.
6. Curve fitting using freely available softwares/apps (any one)
7. Making of power point presentation
8. Technical writing on topics assigned.
9. Demonstration for checking of plagiarism using recommended software

- **Reference Book:**

1. Kothari, C. R. & Garg, G. (2019). *Research Methodology: Methods and Techniques* (4th Edition). New Age International Publishers, New Delhi.
2. Day, R. A. & Gastel, B. (2024). *How to Write and Publish a Scientific Paper* (9th Edition). Cambridge University Press..
3. Gopalakrishnan, S. (2019). *Patent Law and Intellectual Property*. Eastern Book Company, Lucknow.
4. Bird, A. (2020). *Understanding Scientific Method*. Routledge, London..
5. Wallwork, A. (2020). *English for Writing Research Papers* (2nd Edition). Springer Nature, Cham.
6. Resnik, D. B. (2020). *The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust*. Springer Nature, Cham.

SWAYAM Course

Research Methodology - https://onlinecourses.nptel.ac.in/noc24_ge41/preview

SDG Mapping for this Course

SDG No.	SDG Title	Rationale

SDG 4	Quality Education	Strengthens research skills, ethical awareness and scientific communication for higher education
SDG 9	Industry, Innovation & Infrastructure	Supports innovation through responsible research, data analysis and publication practices
SDG 16	Peace, Justice & Strong Institutions	Encourages integrity, transparency, accountability and trust in scientific research

Course Code: PH40009

Course Title: Artificial Intelligence in Physics

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objective:

To provide students with an understanding of how artificial intelligence (AI) can be applied to solve complex problems in physics, enabling them to analyze physical data, develop AI models, and apply these techniques to various areas of physics research, while fostering critical thinking, analytical reasoning, and collaborative skills.

Course Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	2	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Physical data using AI techniques to solve complex problems (Complex problem-solving, Analytical reasoning).	PO1 (3)

CO2	AI models and algorithms for their effectiveness in physics research (Critical Thinking, Research-related skills).	PO2(3)
CO3	AI-based solutions for physical data analysis using appropriate tools and programming languages (Digital Literacy, Self-Directed Learning).	PO2(3), PO4(2)
CO4	Effectively in teams to develop AI applications in physics, demonstrating leadership and teamwork skills (Cooperative/Teamwork, Leadership readiness).	PO7(3)
CO5	Technical concepts and findings related to AI in physics clearly and effectively (Communication Skills, Multicultural competence and inclusive spirit).	PO4 (3)

Syllabus:

Unit 1: Introduction to AI in Physics (9 hours)

- Overview of AI and its importance in physics
- Types of AI: Machine learning, deep learning, neural networks
- Applications of AI in physics: Particle physics, astrophysics, condensed matter physics
- Basic concepts of data science and AI
- Case studies of AI applications in physics

Unit 2: Data Collection and Preprocessing (9 hours)

- Sources of physical data: Experiments, simulations, observations
- Data preprocessing techniques: Cleaning, normalization, transformation
- Feature selection and extraction
- Handling missing data and outliers
- Practical implementation using Python and R

Unit 3: Machine Learning Techniques in Physics (9 hours)

- Supervised learning: Regression, classification
- Unsupervised learning: Clustering, dimensionality reduction

- Neural networks and deep learning
- Model evaluation and validation
- Practical implementation using scikit-learn and TensorFlow

Unit 4: AI Applications in Physics Research (9 hours)

- AI in particle physics: Event classification, anomaly detection
- AI in astrophysics: Image analysis, object detection
- AI in condensed matter physics: Phase transition prediction, material property prediction
- AI in quantum physics: Quantum state classification, quantum control
- Practical implementation using physics-specific AI tools

Unit 5: Advanced Topics and Future Directions (9 hours)

- Explainable AI and model interpretability
- Ethical considerations and data privacy in AI research
- AI in environmental physics and sustainability
- Emerging trends and research directions in AI in physics
- Developing a personal ethical framework for AI research

Exercises:

1. Collect and preprocess a physical dataset.
2. Implement data normalization and transformation techniques.
3. Develop a regression model to predict physical properties.
4. Implement a classification algorithm for a physical dataset.
5. Perform clustering on a physical dataset and interpret the results.
6. Develop a neural network model for a physical prediction task.
7. Evaluate the performance of different AI models.
8. Implement an AI model for event classification in particle physics.
9. Perform image analysis for astrophysical data using AI techniques.
10. Predict material properties using machine learning.
11. Develop a phase transition prediction model using AI.
12. Implement a quantum state classification algorithm.
13. Analyze spectroscopic data using AI techniques.

14. Develop an AI model for environmental physics analysis.
15. Evaluate the ethical implications of an AI application in physics.
16. Collaborate on a group project to develop an AI application in physics.
17. Write a report on the application of AI in a specific area of physics.
18. Present a case study on the use of AI in astrophysics.
19. Research and present on the future trends in AI in physics.
20. Participate in a debate on the ethical considerations of AI in physical research.

Textbook:

- **"Artificial Intelligence in Physics"** by Stephen Wolfram

Reference Books:

- **"Machine Learning for Physics and Astronomy"** by Viviana Acquaviva
- **"Data Science for Physics and the Life Sciences"** by J. I. Read and T. J. Loredo
- **"Deep Learning for the Life Sciences: Applying Deep Learning to Genomics, Microscopy, Drug Discovery, and More"** by Bharath Ramsundar, Peter Eastman, Patrick Walters, and Vijay Pande.

SDG Mapping

SDG	Rationale
SDG 4	Data literacy
SDG 9	Innovation in analytics
SDG 10	Reducing inequality through transparent data
SDG 13	Climate data visualization

Course Code: IK40053

Course Title: Vedic Mathematics

Total Credits: 04 (Credits: Theory-03, Tuorial-01)

Total Classroom Contact Hours: Theory- 45 and Tutorial-30

Course Outcomes:

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1	PSO2	PSO3	PSO4

CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Objectives:

COs	**Course outcomes**	**Mapping COs with POs (High-3, Medium-2, Low-1)**
CO1	Remember Mathematics in Vedas, different sutras and sub sutras, examples of sutras and sub sutras.	PO1 (3)
CO2	Understand Arithmetic progression in Ancient India and different techniques. Simple equations,	PO2(3)
CO3	Factorization, H.C.F, Partial fractions, differential calculus in Vedic mathematics.	PO2(3), PO4(2)
CO4	Analyze the Development and meaning of "ethno mathematics", Numerals and naming systems.	PO7(3)
CO5	Evaluate the problems based on different sutras and sub sutras.	PO4 (3)

Syllabus:

Unit-I: Introduction to Mathematics in Vedas, different sutras and sub sutras, examples of sutras and sub sutras. Basic Concepts of Ancient Arithmetic, development and their uses. Different operations in Vedic mathematics: Addition, subtraction, multiplication, division, square, square root, cube and cube root and Examples.

Unit – II: Knowledge on Arithmetic progression in Ancient India and different techniques. Simple equations, quadratic equations, Cubic equation, biquadrate equation, simultaneous equation in Vedic mathematics.

Unit – III: Mathematical numbers in Indian Tradition and different types of problems relating to Vedic sutras. Factorization, H.C.F, Partial fractions, differential calculus in Vedic mathematics.

Unit – IV: Mathematical Concept in Tribal Tradition: Ethno mathematics: development and meaning of "ethno mathematics", Numerals and naming systems, Mathematics in folk art,

Informal mathematics. Pythagoras theorem, integration by partial fractions, Apollonius theorem, Analytical geometry in Vedic mathematics

Suggested Readings:

1. Vedic Mathematics space book by S,.JK. Cosmic Kapoor- 2005

2. Vedic Arithmetic and Development of basic concepts Dr. K.P. Chamola – 2006 Arithmetic

Note: Latest edition of the text books should be used.

SDG Mapping

SDG	Rationale
SDG 4	Data literacy
SDG 9	Innovation in analytics
SDG 10	Reducing inequality through transparent data
SDG 13	Climate data visualization

SEMESTER-II

SEMESTER-II					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
PH40002	Advanced Condensed Matter Physics	3	0	1	4
PH40004	Digital Electronics and Microprocessor	3	0	1	4
PH40006	Applied Optics	3	0	1	4
PH40008	Nanoscience and Nanotechnology	3	0	1	4
PH40010	Electro Dynamics	3	0	1	4
IK40052	Indigenous People and the Science of Gemmology	3	1	0	4

	Total				**24 Credits**

Course Code: PH40002

Course Title: ADVANCED CONDENSED MATTER PHYSICS

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

1 Explain the significance and value of condensed matter physics, both scientifically and in the wider community.

2. The subject treats functional materials from an experimental viewpoint, solid state theory and properties.

3: Critically analyze and evaluate experimental strategies, and decide which is most appropriate for answering specific questions.

4: Apply key analysis techniques to typical problems encountered in the field.

Course Outcomes:

CO	**PO 1**	**P O2**	**PO 3**	**PO 4**	**P O 5**	**P O6**	**P O7**	**P O8**	**P O9**	**P O1 0**	**P O1 1**	**P O1 2**	**PS O1**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	**Course outcomes**	**Mapping COs with POs (High-3, Medium-2, Low-1)**
CO1	Remember the concepts of phonon interaction, Second quantized form of Hamiltonian, Lattice Vibrations.	PO1 (3)

CO2	Understand the Wave equation for an electron in a periodic potential, effective mass of electrons in crystals, Holes, Tight binding approximation.	PO2(3)
CO3	Apply skills for Construction of Fermi surface, Experimental methods of study of Fermi surface	PO2(3), PO4(2)
CO4	Analyze concepts of Electron Interaction.	PO7(3)
CO5	Evaluate Dielectric function of an interacting electron gas.	PO4 (3)

Syllabus:

Unit – I (10 Classroom Contact Hours)

Lattice Vibrations: Born – Oppenheimer Approximation, Hamiltonian for lattice vibrations in the harmonic approximation, Normal modes of the system and quantization of lattice vibrations – phonons, Electron – phonon interaction, Second quantized form of Hamiltonian for electrons and phonons in interaction.

Unit – II (10 Classroom Contact Hours)

Energy Bands: Wave equation for an electron in a periodic potential, Bloch functions, Brillouin zones, diagram under free electron approximation, Nearly free electron approximation – Diffraction of electrons by lattice planes and opening of gap in diagram. Effective mass of electrons in crystals, Holes, Tight binding approximation

Unit – III (10 Classroom Contact Hours)

Fermi Surface: Construction of fermi surface, Experimental methods of study of Fermi surface, Cyclotron Resonance, de Hass van Alphen effect.

Unit – IV(15 Classroom Contact Hours)

Electron Interaction: Perturbation formulation, Dielectric function of an interacting electron gas (Lindhard's expression), Static screening, Screened impurity, Kohn effect, Friedel Oscillation and sum rule, Dielectric constant of semiconductor, Plasma oscillations. Transport Properties: The Boltzmann equation, Electrical conductivity, General Transport co-efficients, Thermal conductivity, Thermoelectric effect, Hall effect, Elementary idea on Quantum Hall Effect, Magneto resistance, Elementary idea on Giant magneto resistance and colossal magneto resistance.

SDG Mapping

SDG	Rationale
SDG 4	Data literacy
SDG 9	Innovation in analytics
SDG 10	Reducing inequality through transparent data
SDG 13	Climate data visualization

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH40002 LAB : ADVANCED CONDENSED MATTER PHYSICS

1. Using computational techiniques simulate lattice vibrations. **(Model Construction)** Create a 1D chain of atoms connected by springs to represent a crystal lattice using Python with NumPy and to simulate the atomic displacements and compute the normal modes.
2. Perform cyclotron resonance experiments to Measure the effective mass of electrons.
3. Measure electrical and thermal conductivity and Study transport properties of materials.
4. Study Hall effect measurements to Measure the carrier concentration and mobility and study quantum hall effect.

(Tools and Software:-Python with NumPy, SciPy, and MatplotlibMATLAB: For numerical simulations and plotting.Equipment: cyclotron resonance apparatus, and thermal/electrical conductivity measurement setups.)

5 Simulate energy band structures.and Study the formation of energy bands and gaps and visualize Bloch functions and Brillouin zones..

Essential readings:

1.Principles of the Theory of Solids – J. M. Ziman

2.Introduction to Solid State Physics – C. Kittel

3.Advanced Solid State Physics – Philip Philips, Overseas Press, India Pvt Ltd.

4.Introduction to Modern Solid State Physics – Yuri M. Galperin

5.Solid State Physics – Aschroft, Mermin

6.Introduction to Solids – Azaroff

7.Elementary Solid State Physics – Omar

8.Principles of Condensed Matter Physics – Chaikin and Lubensky

9.Solid State Physics, Essential Concepts – David W. Snoke, Pearson Publication, 2009

Note: Latest edition of the text books should be used.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory and Practical Examination

Course Code: PH40004

Course Title: Digital Electronics

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Objectives:

1. To acquaint students with various basic digital gates used in digital systems and develop logical circuits using Boolean gates, construction of various logic circuits using basic gates.

2. To understand the Combinational Circuits using Logic Gates and the Sequential Logic Circuits using flip-flops.

3. To understand the Digital Logic Family and design Register, Counter and Sequence Generator.

4. To understand the Basic Fundamentals of the 8085 Microprocessor.

Course Outcomes:

CO	PO 1	PO 2	PO 3	PO 4	P O 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember Decimal, binary, octal and hexadecimal number systems	PO1 (3)
CO2	Understand Half and full adders, half and full subtractors, multiplexer.	PO2(3)
CO3	Apply the input/output interfacing devices in simple programs for addition /subtraction.	PO2(3), PO4(2)
CO4	Analyse the Application of Microprocessors	PO7(3)
CO5	Evaluate the microprocessor-based data acquisition	PO4 (3)

Unit-I(10 Classroom Contact Hours)

Number Systems: Decimal, binary, octal and hexadecimal number systems, Inter conversion of decimal, binary and hexadecimal numbers, BCD numbers, BCD addition and subtraction. Logic Gates: AND, OR, NOT, NAND, NOR, and exclusive OR gates, NAND and NOR gates as universal gates. De Morgan’s theorems, standard POS and SOP forms, min-term and maxterm representation of Boolean functions, simplification of Boolean functions using K-maps (upto 4 variables).

Unit-II (10 Classroom Contact Hours)

Combinational Circuits : Half and full adders, half and full subtractors, multiplexer, de-multiplexer, encoder, decoder, BCD-to-seven segment decoder. Flip-flops : R-S, J-K, master-slave and edge triggered J-K, T and D Flip-flops. Sequential Circuits : Shift registers, ring counters, ripple and synchronous counter. Concept of timer IC 555 and its use for waveform generation (a stable and monostable only).

Unit-III (10 Classroom Contact Hours)

Introduction to Microprocessors : Evolution of microprocessors, organisation, architecture and pin description of 8085 microprocessor, addressing modes and instruction set, input / output interfacing devices (8255, 8251), simple programs for addition / subtraction, developmental trends in microprocessor technology (8086, 80186, 80286, 80386, 80486 and Pentium).

Unit-IV (15 Classroom Contact Hours)

Application of Microprocessors : Application of Microprocessors in Geophysical Instrumentation : Microprocessor based data acquisition, frequency, temperature and voltage measurements using microprocessors.

SDG Mapping

SDG	Rationale in M.Sc. Physics
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH40004 LAB :

DIGITAL ELECTRONICS AND MICROPROCESSORS

1. Study of basic gates.
2. Realisation of Gates by using Universal Building Blocks.
3. Realisation of Flip-Flops
4. 4-bit & 8-bit Binary Adders.
5. Addition of two 8-bit numbers.
6. Subtraction of two 8 - bit numbers.
7. BCD addition.

Essential readings:

Suggested Books:

1. Digital Electronics Book by Morris Mano

2. Fundamentals of Digital Circuits by A Anandkumar

3. Digital Electronics by R P Jain

4. Digital Electronics Book by Salivahanan

Note: Latest edition of the text books should be used.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)

End semester University Theory and Practical Examination

Course Code: PH40006

Course Title: APPLIED OPTICS

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

1. To be able to apply the fundamental concepts of optics in lasers, optical fiber communications and optoelectronics. Outcomes:

2. To Identify few different applications of optics i.e. Laser, Fiber Optics, Optoelectronics and Non Linear Optics.

3. To Analyze different laser systems and its applications in various fields.

4. To Apply the concept of optical fiber, its construction and importance in communication physics. Classify the concepts of opto-isolaters and opto-couplers.

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Pedagogy: Classroom Contact Hours, Assignments, Case discussion,Quiz, Group discussions and Seminars

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember Optics of solids.	PO1 (3)
CO2	Understand Fourier Optics.	PO2(3)
CO3	Apply Laser Spectroscopy.	PO2(3), PO4(2)
CO4	Analyze Optical fibers.	PO7(3)
CO5	Evaluate Spatial frequency filtering.	PO4 (3)

Course Content:

Unit –I (10 Classroom Contact Hours)

Optics of solids: Plane wave in anisotropic media, types of crystal, Double Refraction at a Boundary, Optical Activity, Faraday Rotation in Solids, Magneto-optic and Electro-optic Effects, Introduction to Nonlinear Optics.

Unit –II (10 Classroom Contact Hours)

Fourier Optics: Basics of Fourier transformation operation, Definition of spatial frequency and transmittance function, Fourier transform by diffraction and by lens, Spatial frequency filtering, types of filters, Abbe-Porter experiments, phase-contrast microscope.

Holography: Principle of holography, On-axis and off-axis hologram recording and reconstruction, Types of hologram and applications.

Unit –III (10 Classroom Contact Hours)

spectroscopy: Laser-induced breakdown spectroscopy (LIBS), Laser induced fluorescence spectroscopy, Nonlinear spectroscopy: linear and nonlinear absorption, saturation spectroscopy two-photon and multi-photon spectroscopy, Applications of laser spectroscopy: single molecule detection, trace level detection of explosives and hazardous gases, LIDAR.

Unit –IV(15 Classroom Contact Hours)

Optical fibers: Guided modes of step-index and graded index fibers, Propagation light in optical fibers, Numerical aperture and Applications of optical fibers in Communication and Sensing.

SDG Mapping

SDG	Rationale in M.Sc. Physics
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH40006 LAB: APPLIED OPTICS

1. Study birefringence in anisotropic media.

(Equipment: Calcite crystal, polarized light source, polarizer, analyzer)

2. Measure optical rotation in optically active substances.(Equipment:Polarimeter, optically active solution (e.g., sugar solution,)

3. Demonstrate Faraday rotation in solids.

(Equipment: Faraday rotation apparatus, strong magnetic field, transparent paramagnetic material).

4. Perform spatial filtering using different types of filters.(Equipment: Laser, lenses, spatial filters (e.g., low-pass, high-pass).

5. Measure the numerical aperture of optical fibres.(Equipment: Laser, optical fiber, screen.)

6. Demonstrate the use of optical fibers in communication. (Equipment: Fibre optic communication kit, fiber optic sensors.)

Essential readings:

1. Optics- Ajay Ghatak (2012), Tata McGraw-Hill, 5th Edition

2. Laser Spectroscopy: Basic Concepts and Instrumentation – W. Demtroder (2004), Springer,, 3rd Edition.

3. Introduction to Fourier Optics- J. W. Goodman, (2005), Ben Roberts, 3rd Edition

4. Holography: A Practical Approach- G. K. Ackerman and J. Eichler, (2007), Wiley-VCH, 1st Edition

5. https://onlinecourses.nptel.ac.in/noc24_ph39/preview

Note: Latest edition of the textbooks should be used.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory and Practical Examination

Course Code: PH40008

Course Title: NANOSCIENCE AND NANOTECHNOLOGY

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

1. To understand (i) the influence of dimensionality of the object at the nanoscale on their properties; (ii) size and shape-controlled synthesis of non-materials and their future applications in industry.
2. To explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at the nanoscale.
3. To choose an appropriate synthesis technique to synthesise quantum nanostructures of desired size, shape and surface properties.
4. To correlate properties of nanostructures with their size, shape and surface characteristics.
5. To appreciate the enhanced sensitivity of non-material-based sensors and their novel applications in industry

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Pedagogy: Classroom Contact Hours, Visual Presentation, Assignments, Case discussion, Projects and Seminars

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember the concepts of Nano science and nanotechnology.	PO1 (3)
CO2	Understand the Classification of nanomaterials: 0D, 1D, 2D, 3D.	PO2(3)

CO3	Apply skills to know the Characteristic feature of nanomaterials, Density of states for various classes of Nano materials**.**	PO2(3), PO4(2)
CO4	Analyze different approach of synthesis.	PO7(3)
CO5	Evaluate Density of states for various classes of nanomaterials	PO4 (3)

Course Content:

Unit I(10 Classroom Contact Hours)

Background to Nanoscience and nanotechnology: Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, large surface to volume ratio for nano materials, influence of nano over micro/macro, size effects and crystals.

Unit II (10 Classroom Contact Hours)

Moore's law, Classification of nanomaterials: 0D, 1D, 2D, 3D; Characteristic feature of nanomaterials,Density of states for various classes of nano materials, quantum confinement effect on nanomaterials,2D- Quantum well, 1D-Quantum wire, OD-Quantum dot, Surface and physical properties of nanomaterials.

Unit III (10 Classroom Contact Hours)

Nanomaterials fabrication: Different approaches of synthesis, Bottom-up approach (Coprecipitation, Sol-Gel Process, Hydrothermal/Solvothermal Methods, Thin-Film Deposition Mechanism, Physical Vapour Deposition (PVD), Chemical Vapour Deposition (CVD)), Top-Down approach (Powder metallurgy, Lithography), characterisation of nano materials.

Unit IV(15 Classroom Contact Hours)

Basic features of CNT and Graphene, Application of Nanomaterial: Ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, Nano composites.

SDG Mapping

SDG	Rationale in M.Sc. Physics
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH40008LAB :

NANO SCIENCE AND NANO TECHNOLOGY

1. Understand the synthesis of nanoparticles using chemical methods.

Equipment: Chemicals (e.g., silver nitrate, sodium citrate), beakers, magnetic stirrer, hot pl

2. Study the density of states for different classes of nanomaterials.

Equipment: Computer with simulation software.

3, Demonstrate the quantum confinement effect in nanomaterials.

Equipment: Quantum dot samples, spectrometer

.4. Synthesize nanomaterials using the sol-gel process.

Equipment: Precursors (e.g., tetraethyl orthosilicate), solvents, beakers, magnetic stirrer, furnace.

5. Deposit thin films using Physical Vapor Deposition (PVD) or Chemical Vapor Deposition (CVD).

Equipment: PVD or CVD apparatus, substrates, source materials.

6.study the application of nanomaterials in molecular electronics.

Equipment: Nanowires, electrodes, measurement setup.

7. Synthesize and characterize carbon nanotubes.

Equipment: CVD setup, carbon source (e.g., methane), substrat

Essential readings:

1. Nanoparticles: From theory to applications – G. Schmidt (2004), Wiley Weinheim, 1st Edition.

2. An Introduction to Nanomaterials and Nanoscience- A.K. Das, D. Mahua (2017), CBS Publishers. 1st Edition

3. Foundations for Nanoscience and Nanotechnology – Nils O Peterson (2017), CRC Press, 1st Edition

4. A Textbook of Nanoscience and Nanotechnology – T. Pradeep (2012), Tata McGraw-Hill, 1st Edition

5. Introduction to Nanoscience and Nanotechnology – K. K. Chattopadhyay and A. N. Banerjee (2009) PHI Learning Pvt Ltd, 1st Edition

6. Essentials in Nanoscience and Nanotechnology – N. Kumar and S. Kumbhat (2016), Wiley, 1st Edition

7. https://onlinecourses.swayam2.ac.in/cec24_cy03/preview

Note: Latest edition of the text books should be used.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory and Practical Examination

Course Code: PH40010

Course Title: ELECTRODYNAMICS

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

The course gives

1. Introducing the mathematical tools used in electrodynamics.

2. Review of electrostatics and magnetostatics in matter.

3. Providing easy headway into the covariant formulation of Maxwell's equations.

4. Teaching basic principles of waveguides and transmission lines.

4. Rendering insights into fields generated by oscillating sources, and their applications.

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Pedagogy: Classroom Contact Hours, Visual Presentation, Assignments, Case discussion, Projects, and Seminars

Course Learning Outcomes:

COs	**Course outcomes**	**Mapping COs with POs (High-3, Medium-2, Low-1)**
CO1	Ability to use basic mathematical tools to solve problems in electrodynamics.	PO1 (3)
CO2	Gaining proficiency in electrostatics and magnetostatics.	PO2(3)
CO3	Obtaining command of four-vector and tensor notations.	PO2(3), PO4(2)
CO4	Learning about TM, TE, and TEM modes in waveguides and understanding radiation by moving charges.	PO7(3)
CO5	Ability to use basic mathematical tools to solve problems in electrodynamics.	PO4 (3)

Course Content:

Unit – I

The concept of a scalar potential. Poisson's and Laplace's equations for scalar potential. Green's

theorem, Electrostatic field energy density. Solutions of Laplace's equation in rectangular, spherical, and cylindrical coordinates using the method of separation of variables, Method of images, and the Multipole expansion of potential due to a localized charge distribution.

Unit – II

Electrostatics in matter: Polarization and electric displacement vector. Electric field at the boundary of an interface, Linear dielectrics. Magnetostatics, Biot-Savart Law, Ampere's Law, Scalar and Vector potentials, Magnetic moment of a current distribution. Macroscopic magnetostatics, Magnetization. M and H vectors, Boundary conditions.

Unit – III

Electromagnetic induction, Faraday's Law, Maxwell's equations, Maxwell's equations in matter, Conservation of charge, Poynting's theorem, Solutions of Maxwell's Equations, Covariant formulation of electrodynamics, Inhomogeneous wave equations and their solutions. Electromagnetic waves in matter, Reflection and refraction at a plane interface between dielectrics, Fresnel's equations. Phase velocity and group velocity.

Unit – IV

Transmission lines and wave guides; Dynamics of charged particles in static and uniform electromagnetic fields. EM Field of a localized oscillating source. Fields and radiation in dipole and quadrupole approximations. Antenna; Radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula.

SDG Mapping

SDG	**Rationale in M.Sc. Physics**
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Course Code: PH40010 LAB: ELECTRODYNAMICS

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

1. Measure the elastic modulus of cubic crystals.

Equipment: Ultrasonic pulse-echo setup, cubic crystal sample.

2. Study point and line defects in crystals.

Equipment: Electron microscope (SEM/TEM), crystal samples.

3. Measure the Hall effect in metals and semiconductors.

Equipment: Hall effect setup, magnetic field source, metal and semiconductor samples.

4. Study the electrical properties of intrinsic and impurity-doped semiconductors.

Equipment: Semiconductor characterization setup, intrinsic and doped semiconductor samples.

6. Measure the magnetic susceptibility of diamagnetic and paramagnetic materials.

Equipment: Magnetic susceptibility balance, diamagnetic and paramagnetic samples.

7. Study the properties of superconductors and the Meissner effect.

Equipment: Superconductor samples, cryostat, magnetic field setup.

Essential readings:

1. Introduction of Electrodynamics:C.Kittel (Wiley)

2. Electrodynamics: A Omar (Pearson)

3. Electrodynamics: Ashcroft and Mermin (Cengage)

4. Electrodynamics: A.J. Dekker.

Note: The latest edition of the textbooks should be used.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- PowerPoint presentation on important topics.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End-of-semester University Theory and Practical Examination

Course Code: IK40052

Course Title: Indigenous People and the Science of Gemology

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Classroom Contact Hours: Theory- 45 and Tutorial-30

Course Learning Objectives:

1. This course imparts expertise and knowledge to the world of gemstones.
2. It enables the student to get a fair idea to identify, grade and value gemstones together with the market dynamics, trends, and terminologies.

3. **Course Outcomes**:

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Recognize the terminology and nomenclature of gemology**.**	PO1 (3)
CO2	Explain the skills on gems mineralogy and genesis.	PO2(3)
CO3	Employ the skills to identify and characterize different gem stones by means of physical and optical techniques.	PO2(3), PO4(2)

CO4	Exploring the science behind different colours of gemstones and their healing effects.	PO7(3)
CO5	Rating the physical and optical properties of gemstones and apply their knowledge for grading and engraving.	PO4 (3)

Course Content:

UNIT-I: Introduction to the world of Gemstones

Ancient history of Gem stones, Mythology related to Gem stones, Use of Gems among indigenous people, Crystallography, study on crystal growth, formation of atomic lattice, originand structure of gem stones, twinned crystal, Rough gemstone identification, knowledge of identification process.

UNIT-II: Properties of Gemstones

Physical and optical properties of gemstones, grading parameters of gemstones, various shapes and cutting of gemstones, Engraving on stones, drilled stones, Interlink of beauty, rarity, durability and its effect on valuation, Internal and external factors that affects valuation

UNIT-III: Colour and Healing Power

The healing power of Gem stones, Tribal concept on Gemstones, Scientific approach of gemstones, Top gemstones with their colours and healing qualities, Science behind different colours of gemstones and their healing effects, precious gemstones found in tribal areas. Tribal ornaments having gemstones, semi precious stones and their practical identification, organic gemstones, ornament making techniques in both traditional and modern, Ornament design, stones used in fine and fashion jewelers, rare stones collection.

UNIT-IV: Terminology and nomenclature

Terminology and nomenclature of gemstones as per Indian and International markets, weights used in the gem trade, Market system of gems buying and selling, Gems and human race, Career and jobs, Scope in Gemology, Gemology as a tool for tribal development.

Essential Readings:

1. Colour encyclopedia of Gemstones by Joel. E. Arem
2. The Gemsstones Handbook by Arthur Thomas
3. Precious Stones, Vol-I & II: Max Bauer
4. Gemstones of the World: Walter Schumann
5. Gemology: Cornelius S. Hurlbut& Robert C Kammerling
6. Popular Gemology: Richard M Pearl

7. Dictionary of Gems and Gemology: Robert M Shiplley
8. Gemmolog: Peter G Read
9. Gem: Smiths Onian
10. Stoned:Jewellery,obsession: Aja Raden
11. Rocks,Minerals and Gems: John Farndon

Note: Latest edition of the textbooks should be used.

SDG Mapping

SDG	**Rationale in M.Sc. Physics**
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

SEMESTER-III

Grand Total		**48 Credits**			
Exit Point: Postgraduate Diploma Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma					
SEMESTER-III					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
RM50001	Research Methodology	3	1	0	4
RE50003	Research and Publication Ethics	2	0	0	2

CA50005	Computer applications and data analysis	3	0	1	4
IK50051	Indigenous Knowledge and Intellectual Property Rights	3	0	1	4
	Choose Any two				
PH50031	Physics of Materials	3	0	1	4
PH50033	Nuclei and Particle Physics	3	0	1	4
PH50035	Statistical Physics of Non-interacting and Interacting Systems	3	0	1	4
PH50037	Molecular Spectroscopy and Application	3	0	1	4
	Total				22 Credits

Course Code:RM50001

Course Title: Research Methodology

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Classroom Contact Hours: Theory- 45 and Tutorial-30

Course Learning Objective:

1. To equip students with the foundational principles and advanced techniques of research methodology.
2. It is enabling them to conduct and evaluate scientific research effectively, with a strong emphasis on ethical practices and innovation.

Course Outcomes:

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-

CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Outcomes:

COs	**Course outcomes**	**Mapping COs with POs (High-3, Medium-2, Low-1)**
CO1	**Apply** complex problem-solving skills to design and execute research studies, utilizing appropriate methodologies and tools.	PO1 (3)
CO2	**Evaluate** and **critique** research literature to foster critical thinking and develop well-reasoned arguments.	PO2(3)
CO3	**Analyze** data using statistical and computational techniques to derive meaningful insights and support analytical reasoning.	PO2(3), PO4(2)
CO4	**Collaborate** effectively in teams to conduct research, demonstrating cooperative skills and leadership readiness.	PO7(3)
CO5	**Create** and **communicate** research findings clearly and effectively, showcasing digital literacy and multicultural competence.	PO4 (3)

Course Content:

Unit 1: Introduction to Research Methodology (6 hours)

- Understanding the research process
- Formulating research questions and hypotheses
- Overview of qualitative and quantitative methods

Textbook: "Research Methods for Business: A Skill Building Approach" by Uma Sekaran and Roger Bougie

Unit 2: Literature Review and Critical Analysis (6 hours)

- Conducting a systematic literature review

- Critical appraisal of research articles
- Ethical considerations in research

Reference Book: "The Literature Review: Six Steps to Success" by Lawrence A. Machi and Brenda T. McEvoy

Unit 3: Research Design and Data Collection (6 hours)

- Experimental, quasi-experimental, and non-experimental designs
- Sampling techniques and data collection methods
- Ensuring validity and reliability in research

Reference Book: "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell

Unit 4: Data Analysis and Interpretation (6 hours)

- Descriptive and inferential statistics
- Data analysis software and tools
- Interpreting research findings

Reference Book: "Discovering Statistics Using IBM SPSS Statistics" by Andy Field

Unit 5: Research Communication and Dissemination (6 hours)

- Writing research reports and papers
- Presentation skills for seminars and conferences
- Research impact and knowledge transfer

Reference Book: "Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded" by Joshua Schimel

SDG Mapping

SDG	**Rationale in M.Sc. Physics**

SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Course Code: RE50003

Course Title: Research and Publication Ethics

Total Credits: 02 (Credits: Theory-02

Total Classroom Contact Hours:

Course Objectives:

1. To provide students with a comprehensive understanding of ethical principles and issues in research,
2. It is enabling them to conduct responsible and ethical research while fostering critical thinking, analytical reasoning, and collaborative skills.

- **Course Outcomes**:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	**Analyze** ethical dilemmas in research and apply ethical principles to resolve them (Complex problem-solving, Analytical reasoning).	PO1 (3)
CO2	**Evaluate** the ethical implications of research practices and policies (Critical Thinking, Research-related skills).	PO2(3)
CO3	**Design** and **implement** research projects that adhere to ethical standards (Autonomy, responsibility, and accountability, Self-Directed Learning).	PO2(3), PO4(2)
CO4	**Collaborate** effectively in teams to address ethical issues in research, demonstrating leadership and teamwork skills (Cooperative/Teamwork, Leadership readiness).	PO7(3)
CO5	**Communicate** ethical considerations and solutions clearly and effectively (Communication Skills, Multicultural competence and inclusive spirit).	PO4 (3)

Course Contents:

UNIT-I: Introduction to Research Ethics (9 hours)

- Definition and importance of research ethics
- Historical perspectives on research ethics
- Key ethical principles: Respect for persons, beneficence, and justice
- Ethical guidelines and codes of conduct
- Case studies of ethical breaches in research

UNIT-II: Ethical Issues in Research Design and Conduct (9 hours)

- Informed consent and voluntary participation
- Privacy and confidentiality
- Risk assessment and management
- Ethical considerations in data collection and analysis

- Plagiarism and academic integrity

UNIT-III: Ethical Issues in Publication and Peer Review (9 hours)

- Authorship and contributorship
- Conflicts of interest
- Peer review process and ethical responsibilities
- Retraction and correction of published work
- Ethical considerations in open access publishing

UNIT-IV: Ethical Issues in Collaborative and Interdisciplinary Research (9 hours)

- Collaboration and communication in research teams
- Ethical issues in interdisciplinary research
- Intellectual property and data sharing
- Cultural sensitivity and inclusivity in research
- Ethical considerations in international research

UNIT-V: Emerging Ethical Issues and Future Directions (9 hours)

- Ethical implications of emerging technologies in research
- Environmental and sustainability considerations in research
- Ethical issues in big data and AI research
- Future trends and challenges in research ethics
- Developing a personal ethical framework for research

Textbook:

- **"Research Ethics: A Reader"** by Deni Elliott and Judy E. Stern

Essential Readings:

- **"The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust"** by David B. Resnik
- **"Responsible Conduct of Research"** by Adil E. Shamoo and David B. Resnik
- **"Ethics in Research"** by Ian Gregory-Smith

SDG Mapping

SDG	Rationale in M.Sc. Physics
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Course Code: CA50005

Course Title: Computer Applications and data Analysis

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

The objective of this course is to:

1. Increase knowledge and requisite skills of participants on the use of SPSS and to enable the scholars make the most of this powerful software package while allowing them to work independently with SPSS on their own data and provide a solid foundation for advanced data analysis work.

2. Increase proficiency of scholars on the use of Basic computer Applications and SPSS.

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Have idea about basic computer hardware and software.	PO1 (3)
CO2	Command on MS-office package for organized compiling and presentation of a research thesis and Conversance with the use of SPSS for data analysis and decision making.	PO2(3)
CO3	Learn how to formulate and test different hypotheses.	PO2(3), PO4(2)
CO4	Learn using different analytical and research related software packages.	PO7(3)
CO5	Have idea about basic computer hardware and software.	PO4 (3)

Course Inputs

Unit – I: Computer Basics and Computer Fundamentals

Hardware and Software. Functional units comprising a typical computer configuration: input/output, fixed and removable data storage, internal storage, control and arithmetic/logic unit. The concepts relating to execution speed, data access times, storage capacities and similar comparative aspects of hardware performance. Operating Systems, Windows, Linux etc. Application software, role and functions of commonly available applications. Computer Network Concept- Data communication and network terminology, IP address and its significance, Internet, Multimedia, WWW, FTP, E-mail, and Web pages. Concept of VPNs. Concept of Network security and management

Unit-II: Computer Application Microsoft Word:

Creating and editing documents, formatting text and paragraphs, formatting documents, creating and formatting tables, illustration documents with graphics. Creating a web page, mail merge and document merging, working with styles and templates, developing multi-page documents, integrating Word with other applications, exploring advanced graphics, and building forms. working with charts and diagrams

Unit-III: Microsoft Excel:

Building and editing worksheets, formatting a worksheet, working with charts, working with formulas and functions, managing workbooks and preparing them for the web, automating worksheet tasks with macros, using lists, analyzing list data, enhancing charts and worksheets, using analysis tools, analyzing data with pivot tables, and exchanging data with other programs.

Unit-IV: Microsoft PowerPoint

Creating a presentation with Microsoft PowerPoint, modifying a presentation, inserting objects into presentation, finishing a presentation, working with advanced tools and masters, enhancing charts, inserting illustration, objects and media clips, using advanced features.

Unit–V: Statistical Analysis

The analysis will be done with the help of SPSS, and other statistical packages. The syllabus includes the following topics: Descriptive Analysis: Mean, Median, Mode, Standard Deviation and Correlation. Regression Analysis, t-test, chi-square test, R- Square test, ANOVA, etc using SPSS

References:

1. Hari Shankar Asthana, Braj Bhushan, Statistics for Social Sciences (With SPSS Applications, PHI Publication.

2. Jesus Salcedo, Keith McCormick, SPSS Statistics for Dummies, 3rd Edition (Paperback), Wiley Publication.

3. Sabine Landau and Brian S. Everitt, A Handbook of Statistical Analysis Using SPSS

4. Goel, Computer Fundamentals, Pearson Education, 2010.

5. K. Kalyanaraman, Hareesh N. Ramanathan, P.N. Harikumar, Statistical Methods for Research: A Step-by-Step Approach Using IBM SPSS, Atlantic Publication

6. R. Panneerselvam, Research Methodology, 2nd Edition, PHI Publication

SDG Mapping

SDG	Rationale in M.Sc. Physics
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Course Code: PH50031

Course Title: Physics of Materials

Total Credits: 04 (Credits: Theory-03, Practical-01)
Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Learning Objectives:

The course gives

1. Understand and explain the fundamental and advanced concepts of physics of materials, including crystal structures, electronic, magnetic, dielectric, and functional materials.

2. Analyse the physical properties of materials and relate material behaviour to structure, bonding, defects, and applications in modern technology.
3. Develop knowledge of advanced materials such as nanomaterials, smart materials, energy materials, and carbon-based materials for emerging scientific and technological applications.
4. Apply various materials characterisation techniques such as X-ray diffraction (XRD), microscopy, spectroscopy, and thermal analysis for the investigation of material properties and performance. Pedagogy: Classroom Contact Hours, Visual Presentation, Assignments, Case discussion, Projects and Seminars

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember the advanced concepts and techniques in quantum mechanics, including time-dependent and time-independent perturbation theory, the WKB approximation, and variational methods.	PO1 (3)
CO2	Understand and analyse quantum scattering theory, including partial wave analysis, the Born approximation, the Lippmann-Schwinger equation, and scattering cross-sections.	PO2(3)
CO3	Apply the principles of relativistic quantum mechanics, including the Dirac equation, spinors, symmetries, and the Klein-Gordon equation, to solve problems involving fermions and spin-0 particles.	PO2(3), PO4(2)

CO4	Analyse and understand the foundations of quantum field theory, including second quantisation, field operators, and the application of creation and annihilation operators in quantum fields.	PO7(3)
CO5	Evaluate and solve many-body quantum systems using techniques such as Hartree-Fock theory, quantum statistical mechanics, and the analysis of exchange and correlation effects in identical particle systems	PO4 (3)

Course Contains

Unit I: Structure and Properties of Materials

Classification of materials: metals, semiconductors, insulators, polymers, ceramics, and composites; crystal structure, crystal systems, Bravais lattices, unit cell and Miller indices; crystal defects (point, line, and surface defects); bonding in solids (ionic, covalent, metallic, hydrogen, and van der Waals bonding); mechanical, thermal, electrical, optical, and magnetic properties of materials.

Unit II: Electronic, Dielectric and Magnetic Materials

Free electron theory and band theory of solids; conductors, semiconductors, and insulators; intrinsic and extrinsic semiconductors, Hall effect and applications; dielectric materials, polarisation and ferroelectricity; magnetic properties of materials: dia-, para-, ferro-, ferri-, and antiferromagnetism; superconductivity and applications.

Unit III: Functional and Advanced Materials

Nanomaterials: synthesis methods and size-dependent properties; carbon nanostructures (graphene, carbon nanotubes, fullerenes); smart materials and shape memory alloys; polymers, composites, and biomaterials; energy materials: battery materials, fuel cells, photovoltaic and perovskite materials; applications in electronics and energy devices.

Unit IV: Materials Characterization Techniques

X-ray diffraction (XRD) and crystal structure determination; electron microscopy techniques (SEM, TEM); scanning probe microscopy (AFM, STM); spectroscopic techniques (UV-Visible, FTIR, Raman spectroscopy); thermal characterization (DTA, DSC, TGA); electrical, optical, and magnetic characterization methods; applications of characterization techniques in material analysis.

Suggested Books

- Introduction to Solid State Physics – Charles Kittel
- Materials Science – M. A. Wahab
- Materials Science and Engineering: An Introduction – William D. Callister Jr.
- Solid State Physics – S. O. Pillai

SDG Mapping

SDG	**Rationale in M.Sc. Physics**
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: 50031

Exp. 01. By analysing the Zeeman Effect in mercury vapour, determine the fine structure constant by Fabry-Perot Interferometry. (Experiment)

Exp. 02. Calculate the energy difference between the singlet and triplet state of He Atom. (Mathematical solutions only)

Exp. 03. Two identical particles of spin 1/2 are enclosed in a one-dimensional box potential of length L with walls at x=0 and x=L. Find the Ground state energy. (You can use any programming language)

References

Text Books:

1. Classroom Contact Hours on Quantum Field Theory - Ashok Das (2008), World Scientific, 2nd Edition.

2. Advanced Quantum Mechanics- J. J. Sakurai (2002), Pearson Education India, 4th Edition

3. Relativistic Quantum Mechanics- J. D. Bjorken and S. D. Drell (1964), Mc-Graw Hill, 1ST Edition

Reference Books:

4. Relativistic Quantum Mechanics- L. Maiani and O. Benhar (2012) CRC Press, 1st Edition

5. Relativistic Quantum Physics- Tommy Ohlsson (2011) Cambridge University Press, 1st Edition

6. Quantum Field Theory- L. H. Ryder (2017) Cambridge University Press, 2nd Edition

7. Advanced Quantum Mechanics- F. Schwabl (2005), Springer, 3rd Edition

Course Code: PH50033

Course Title: NUCLI AND PARTICLE PHYSICS

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course learning objectives

Students will try to learn;

1. The fundamental principles governing nuclear and particle physics and have a working knowledge of their application to real life problems.

2. About the subatomic physics, including radioactivity, experimental techniques, nuclear structure, particle interactions, and particle collisions and decays.

3. Skills needed to explain how radiation detector function and use for the measurement of radioactivity.

4. About the different types of nuclear reactors in use and how they produce nuclear energy for the useful purposes.

Course Outcomes:

CO	**PO 1**	**P O2**	**PO 3**	**PO 4**	**P O 5**	**P O6**	**P O7**	**P O8**	**P O9**	**P O1 0**	**P O1 1**	**P O1 2**	**PS O1**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course outcomes

COs	**Course outcomes**	**Mapping COs with POs (High-3, Medium-2, Low-1)**
CO1	Remember the fundamental concepts and principles of nuclear and particle physics, including nuclear structure, radioactivity, and the standard model of particle physics.	PO1 (3)
CO2	Remember the fundamental concepts and principles of nuclear and particle physics, including nuclear structure, radioactivity, and the standard model of particle physics.	PO2(3)
CO3	Understand the forces and interactions that govern nuclear processes and particle behavior, such as	PO2(3), PO4(2)

	strong, weak, and electromagnetic interactions, as well as conservation laws in nuclear and particle reactions.	
CO4	Evaluate the impact of advances in nuclear and particle physics on technology and society, such as energy production, medical applications, and fundamental research in cosmology and astrophysics.	PO7(3)
CO5	CO3. Apply theoretical and experimental methods to solve problems in nuclear decay, reaction rates, cross-section calculations, and particle interactions.	PO4 (3)

Course Contains

UNIT- I

Beta and Gamma decay: Fermi's theory of beta decay, allowed and forbidden transitions, selection rules, non-conservation of parity in beta decay, direct evidence for the neutrino, gamma decay and selection rules (derivation of transition probabilities not required). (5 Classroom Contact Hours)

UNIT- II

Energy loss of charged particles and gamma rays : Mechanism, Ionization formula, Stopping power and range, radiation detectors – multiwire proportional counter, scintillation counter and Cerenkov detector. (5 Classroom Contact Hours)

UNIT- III

Reactor Physics : Slowing down of neutrons in a moderator, average log decrement of energy per collision, slowing down power, moderating ratio, slowing down density Fermi age equations, four-factor formula. (5 Classroom Contact Hours)

UNIT- IV

High energy physics: Types of interaction in nature-typical strengths and time-scales, conservation laws, charge-conjugation, Parity and Time reversal, CPT theorem, Gell-Mann-Nishijima formula, intrinsic parity of pions, resonances, symmetry classification of elementary particles, quark

hypothesis, charm, beauty and truth, gluons, quark confinement, asymptotic freedom. (10 Classroom Contact Hours)

Practicals: Credits: 01

1. To determine the first excitation potential of gas *(*Argon) by Franck-Hertz experiment. Apparatus: Tetrode tube filled with experimental Argon.
2. G.M counters-Characteristics, Deadtime and counting statistics
3. Study Electron spin Resonance.
4. Study of plasma parameters using single/double probe.

Essential readings:

1. Introductory Nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
5. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
6. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
8. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
9. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
10. Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991)
11. https://onlinecourses.nptel.ac.in/noc24_ph41/preview

SDG Mapping

SDG	**Rationale in M.Sc. Physics**
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills

SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Course Code: PH50035

Course Title: Statistical Physics of Non-Interacting and Interacting Systems

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course Objectives:

1. To learn to use classical statistics to compute the macroscopic properties of the system by using the knowledge of microscopic properties of the particles.
2. To understand the theory of radiation by using the statistical properties of particles obeying classical mechanics.
3. To predict the laws of radiations assuming that the photons behave quantum mechanically and follow Bose-Einstein statistics.
4. To investigate various physical systems and phenomena arising due to the particles following Bose-Einstein statistics.

Course Outcomes:

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1

CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Outcomes:

COs	**Course outcomes**	**Mapping COs with POs (High-3, Medium-2, Low-1)**
CO1	Remember the foundational concepts and laws of statistical mechanics, including the Boltzmann distribution, the concepts of microstates and macrostates, and the statistical basis of thermodynamics.	PO1 (3)
CO2	Understand the connections between microscopic particle dynamics and macroscopic observable properties, utilizing statistical methods to bridge these scales, specifically through the study of ensembles (canonical, grand canonical, micro-canonical).	PO2(3)
CO3	Apply statistical mechanics theories to calculate thermodynamic quantities such as entropy, temperature, chemical potential, and free energy for various systems.	PO2(3), PO4(2)
CO4	Analyze real-world systems and phenomena using statistical mechanics, such as phase transitions, critical phenomena, and quantum statistics of bosons and fermions.	PO7(3)
CO5	Evaluate the implications of statistical mechanical models in complex systems in fields such as materials science, quantum computing, and biophysics, and critically discuss the limits of these models.	PO4 (3)

Course Contains

UNIT- I

Ideal quantum systems: a. Properties of ideal Bose gas: Bose-Einstein condensation: Transition in liquid He4 ,Super fluidity in He4 . Photon gas: Planck's radiation law. Phonon gas: Debye's theory of specific heat of solids. b. Properties of ideal Fermi gas: Review of the thermal and electrical properties of an ideal electron gas. Landau levels, Landau diamagnetism. White dwarf and Neutron stars. (10 Classroom Contact Hours)

UNIT-II

Strongly interacting systems: Ising model. Idea of exchange interaction and Heisenberg Hamiltonian. Ising Hamiltonian as a truncated Heisenberg Hamiltonian. Exact solution of one-dimensional Ising system (Matrix methods). Bragg-William's approximation (Mean field theory) and the Bethe-Peierls approximation. (6 Classroom Contact Hours)

Unit-III

Phase transition: General remarks. Phase transition and critical phenomena. Critical indices. Landau's order parameter theory of phase transition. (3 Classroom Contact Hours)

Unit -IV

Fluctuations. Thermodynamic fluctuations. Spatial correlations in a fluid. Brownian motion: Einstein-Smoluchowski's theory. (4 Classroom Contact Hours)

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH50035

1. Plot for functions with energy at different temperatures for
    i. Maxwell-Boltzmann distribution
    ii. Fermi-Dirac Distribution
    iii. Bose-Einstein Distribution.
2. To study Einstein-Smoluchowski's Theory of Brownian motion using a microscope.
3. Verify and plot the Dulong and Petit law for measuring the heat capacity per mole of various elements.
4. Computational study and analysis of the behaviour of particles in a box satisfying Newtonian mechanics.

5. Plot the Planck law of black body radiation for high and low temperatures.

Books Recommended

1. Sanchez Bowley, Introductory Statistical Mechanics, Oxford University Press

2. R. K. Pathria, Statistical Mechanics

3. K. Huang, Introduction to Statistical Mechanics

4. Silvio R. A. Salinas, Introduction to Statistical Mechanics.

5. F. Reif, Fundamentals of Statistical and Thermal Physics.

6. Kadanoff, Statistical Mechanics. World Scientific.

7. R. Kubo, Statistical Mechanics. (Collection of problems)

SDG Mapping

SDG	**Rationale in M.Sc. Physics**
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Course Code: PH50037

Course Title: Molecular Spectroscopy and Application

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Classroom Contact Hours: Theory- 45 and Practical-30

Course objectives

1. To impart quality education in physical sciences, helpful for societal improvement

2. To acquire a comprehensive understanding of advanced principles and concepts in Physics.

3. To include recent developments in the advanced level of Theoretical and Experimental Physics

4. To enhance the syllabus qualitatively for teaching, research, consultancy and industry

Course Outcomes:

CO	PO 1	P O2	PO 3	PO 4	P O 5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PS O1	PS O1	PS O2	PS O3	PS O4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Remember fundamental concepts and principles related to atomic and molecular physics, including atomic spectra, molecular bonding, and the basics of quantum mechanics as applied to atomic and molecular systems.	PO1 (3)
CO2	Understand the theoretical models and experimental techniques used in atomic and molecular physics, such as the Schrödinger equation for hydrogen-like atoms, molecular orbitals, and spectroscopy methods.	PO2(3)

CO3	Apply quantum mechanical models to solve problems involving the energy levels, transition probabilities, and interaction of light with atoms and molecules.	PO2(3), PO4(2)
CO4	Analyze experimental data from spectroscopic techniques, including infrared (IR), ultraviolet-visible (UV-Vis), and nuclear magnetic resonance (NMR) spectroscopy, to deduce structural and dynamic properties of atoms and molecules.	PO7(3)
CO5	Evaluate the implications of atomic and molecular physics in fields such as materials science, nanotechnology, and biological systems, and assess the future potential of these technologies.	PO4 (3)

Course Contains

Unit -I

Born-Oppenheimer approximation and separation of electronic and nuclear motions in molecules. Band structures of molecular spectra. (2 Classroom Contact Hours)

Unit-II

Microwave and far infrared spectroscopy: Energy levels of diatomic molecules under rigid rotator and non-rigid rotator models. Selection rules. Spectral structure. Structure determination. Isotope effect. Rotational spectra of polyatomic molecules. Stark effect. (5 Classroom Contact Hours)

Unit -III

Infrared spectra: Energy levels of diatomic molecules under simple harmonic and anharmonic (no deduction necessary for this one) models. Selection rules and spectral structures. Morse potential energy curves. Dissociation energies. Isotope effect. Rotational – vibrational coupling. Parallel and perpendicular modes. Symmetry properties of molecular wave functions and nuclear spins. (7 Classroom Contact Hours)

Unit -IV

Raman spectroscopy. Rotational, Vibrational, Rotational-Vibrational Raman spectra. Stokes and antistokes Raman lines. Selection Rules. Spectral structures. Nuclear spin and its effect on Raman spectra. (3 Classroom Contact Hours) 5. Vibrational spectra of poly atomic molecules. Normal modes. Selection rules for Raman and infrared spectra. Complementarity of Raman and infrared spectra. Normal modes of CO2 molecule. Normal modes of other simple triatomic molecules

Practicals: Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

Course Code: PH50037

1.Measurement of Lande's g factor using ESR apparatus.

2. Study of a gamma-ray spectrometer.

3. Study of Rotational Spectroscopy of Diatomic Molecules.

4. Study of NMR spectroscopy.

Books Recommended:

1.G. Herzberg. 'Molecular Spectroscopy (Diatomic Molecules)' Van-Nostrand.

2. G. M. Barrow. 'Molecular Spectroscopy'. McGraw-Hill.

3. J. MichaelHollas. ' Modern spectroscopy'. John-Wiley & sons.

4. C. L. Banwell and E. M. McCash. 'Fundamentals of Molecular Spectroscopy' Tata- McGraw-Hill..

5. Guarulhos 'Molecular Spectroscopy'.

6. Bransden and Joachin. 'Atoms and Molecules'

7. F.A.Cotton. 'Chemical application to Group theory

SDG Mapping

SDG	Rationale in M.Sc. Physics
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills
SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

Course Code: IK50051

Course Title: Indigenous Knowledge and Intellectual Property Rights

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Classroom Contact Hours: Theory- 45 and Tutorial-30

Course Learning Objectives:

1. The main objective of this course is to know how the Intellectual Property Rights
2. Protect Consumers and Families of Indigenous people relating to their safety, reliability, and effectiveness of their purchases.
3. It also give them for local level decision-making in food security, human and animal health, education and other vital economic and social activities.

Course Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Define the concept ,meaning and theories of Property.	PO1 (3)
CO2	Describe the fundamental legal principles relating to confidential information, copyright, patents, designs, trademarks and unfair competition.	PO2(3)
CO3	Alphabetize the knowledge for the development and reform of intellectual property right institutions and their likely impact on creativity and innovation.	PO2(3), PO4(2)
CO4	Explain the current and emerging issues relating to the intellectual property protection.	PO7(3)
CO5	Measuring knowledge about layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights.	PO4 (3)

Course Contents:

UNIT-I: Introduction to Intellectual Property Rights: Concept and meaning.

Theories of Property - An Overview, Intellectual Property as an Instrument of Development.

Introduction to Patent Law (a) Paris Convention (b) Patent Cooperation Treaty (c) WTO- TRIPS (d) Harmonization of CBD and TRIPs

UNIT-II: Indian Patent Law (a) The Patents Act, 1970 (b) Amendments to the Patents Act (c) Patentable Subject Matter, Patentability Criteria (d) Procedure for Filing Patent Applications, Patent Granting Procedure (e) Revocation, Patent Infringement and Remedies (f) Relevant Provisions of the Biological Diversity Act, 2002 (g) Access and Benefit Sharing Issues

UNIT-III: Copyright, Neighboring Rights and Industrial Designs. Introduction to Copyright.

Indian Copyright Law: (a) The Copyright Act, 1957 with its amendments (b) Copyright works (c) Ownership, transfer and duration of Copyright (d) Renewal and Termination of Copyright (e) Neighbouring Rights (f) Infringement of copyrights and remedies

Industrial Designs (a) Need for Protection of Industrial Designs (b) Subject Matter of Protection and Requirements (c) The Designs Act, 2000 (d) Procedure for obtaining Design Protection (e) Revocation, Infringement and Remedies

UNIT-IV: Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights.

Geographical Indications: Concept of Appellations of Origin, Indication of Source and Geographical Indication, The Geographical Indications of Goods, Infringement, Penalties and Remedies. Layout-Designs of Integrated Circuits: Conditions and Procedure for Registration, Duration and Effect of Registration, Assignment and Transmission

The Protection of Plant Varieties and Farmers' Rights: The Protection of Plant Varieties and Farmer's Rights Act, 2001., Protection of Plant Varieties and Farmers' Rights, Registration of Plant Varieties and Essentially derived variety, Duration, Effect of Registration and Benefit Sharing, Farmers' Rights, Plant Varieties Protection Appellate Tribunal, Infringement, Offences, Penalties and Procedure

Books Recommended**:**

1. Text Book of Intellectual Property Rights by N.K. Acharya.
2. Intellectual Property Rights-Infringement and Remedies by Ananth Padamanabhan.
3. Intellectual Property Rights (IPRS): TRIPS Agreement and Indian Laws by E.T.Lokganathan
4. Law Relating to Intellectual Property Rights by V. K. Ahuja.
5. Law Relating to Intellectual Property Right by V.L. Wadehra.
6. Arai, Hisamitsu. "Intellectual Property Policies for the Twenty-First Century: The Japanese Experience in Wealth Creation", WIPO Publication Number 834 (E). 2000. wipo.int
7. Bettig, R. V. (1996). Critical Perspectives on the History and Philosophy of Copyright. In R. V. Bettig, Copyrighting Culture: The Political Economy of Intellectual Property. (pp. 9–32). Boulder, CO: Westview Press.
8. Boldrin, Michele and David K. Levine. "Against Intellectual Monopoly", 2008. dkleving.com

Note: The Latest edition of the textbooks should be used.

SDG Mapping

SDG	**Rationale in M.Sc. Physics**
SDG 4	Enhances data literacy, analytical thinking, and scientific reasoning skills

SDG 9	Encourages innovation in scientific computing, data analytics, and physics-based modelling
SDG 10	Promotes transparent, open, and fair data practices to reduce inequality in access to scientific knowledge
SDG 13	Application of data visualisation techniques to climate physics, environmental monitoring, and sustainability studies

SEMESTER-IV

SEMESTER-IV					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
RT50082	Research Thesis	0	0	40	20
	Total				20 Credits
Grand Total		20 Credits			

Course Code: RT50082

Course Title: Research Thesis

Total Credits: 20 (Credits: Practical-40)

Full Marks: 500 Marks

Course Objectives

This course aims to provide students with comprehensive exposure to advanced physics research through independent project work and a dissertation. The course enables students to apply

theoretical and computational concepts of physics to real-world problems, develop experimental or simulation-based research skills, analyse scientific data, and present research findings in a structured and ethical manner.

Project Work and Dissertation: Writing

Project Work:

Each student shall undertake a research project in a specialised area of Physics such as Condensed Matter Physics, Materials Science, Computational Physics, Nuclear Physics, Optics, Electronics, or Interdisciplinary Physics. The project may be experimental, theoretical, or computational in nature.

The project shall be carried out under the supervision of a faculty member. The student is required to identify a research problem, review relevant literature, design methodology, collect and analyse data, and interpret results using appropriate physics principles and tools.

Dissertation:

The dissertation shall be prepared based on the project work carried out by the student under the supervision of the allotted guide. The completed dissertation must be submitted to the Department at least fifteen days before the commencement of the end-of-semester examination.

The dissertation shall be evaluated jointly by an external examiner and an internal examiner (supervisor) based on the quality of research work, dissertation report, seminar presentation, and viva voce examination.

Mode of Evaluation

Sl. No.	Mode of Evaluation	Credits
1	Selection of Research Topic and Synopsis Presentation	4
2	Literature Review and Research Methodology	4
3	Experimental / Computational Work and Data Collection	4

4	Data Analysis, Interpretation, and Dissertation Writing	4
5	Seminar Presentation and Viva Voce Examination	4
TOTAL		**20**

Note:

The dissertation must be submitted by the student positively before the end-of-semester examination.

Course Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3		3		-	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	2

Course Learning Outcomes

CO 1: Understand the process of scientific research in physics and identify research problems.

CO 2: Apply theoretical, experimental, and computational techniques to investigate physical phenomena.

CO 3: Analyze and interpret experimental or simulated data using appropriate statistical and visualization tools.

CO 4: Develop skills in scientific writing, documentation, and effective presentation of research outcomes.

CO 5: Demonstrate professional ethics, critical thinking, and independent research capability in physics.

SDG Mapping

- **SDG 4:** Quality Education – Enhancing research skills and data literacy
- **SDG 9:** Industry, Innovation and Infrastructure – Innovation through scientific research and analytics
- **SDG 10:** Reduced Inequalities – Transparent and open scientific data practices
- **SDG 13:** Climate Action – Physics-based analysis of climate and environmental data

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