MANONMANIAM SUNDARANAR UNIVERSITY

TIRUNELVELI

M.Sc PHYSICS

(For those who joined in 2023-2024 academic year)

SYLLABUS FOR III AND IV SEMESTERS

Template proposed by TANSCHE

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
Core-I	5	7	. Core-IV	5	6	Core-VII	5	6	Core-XI	5	6
Core-II	5	7	Core-V	5	6	Core-VIII	5	6	Core-XII	5	6
Core – III	4	6	Core – VI	4	6	Core – IX	5	6	Project with viva voce	7	10
Elective -I Discipline Centric	3	5	Elective – III Discipline Centric	3	4	Core – X	4	6	Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
Elective-II Generic:	3	5	Elective -IV Generic:	3	4	Elective - V Discipline Centric	3	3	Skill Enhancement course / Professional Competency Skill	2	4
			Skill Enhancement I	2	4	3.6 Skill Enhancement II	2	3	Extension Activity	1	
						3.7 Internship/ Industrial Activity	2	-			
	20	**30**		**22**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -91											

Activate Windows

Template followed by the previous board of Study

Sem–I	Credit	Hours	Sem-II	Credit	Hours	Sem-III	Credit	Hours	Sem–IV	Credit	Hours
Core-I	5	7	. Core-IV	5	6	Core-VII	5	6	Core-XI	5	6
Core-II	5	7	Core-V	5	6	Core-VIII	5	6	Core-XII	5	6
Core – III	4	6	Core – VI	4	6	Core – IX	5	6	Project with viva voce	7	10
Elective -I Discipline Centric	3	5	Elective – III Discipline Centric	3	4	Core – X	4	6	Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
Elective-II Generic:	3	5	Elective - IV Generic:	3	4	Elective - V Discipline Centric	3	3	Skill Enhancement course / Professional Competency Skill	2	4
			Skill Enhancement I	2	4	3.6 Skill Enhancement II	2	3	Extension Activity	1	
						3.7 Internship / Industrial Activity	2	-			
	20	**30**		**22**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -91											

M.Sc PHYSICS (2023-24)

SEMESTER – III:

COURSE COMPONENTS	NAME OF THE COURSE	Hours	Credits	Exam Hrs	MAX MARKS	
					CIA	EXT
Core-VII	Quantum Mechanics-II	5	5	3	25	75
Core-VIII	Condensed Matter Physics	5	5	3	25	75
Core-IX	Numerical Methods and Programming in C++	5	5	3	25	75
Core X	Practical – III: Advanced Physics Experiments I and Microprocessor 8085 & Microcontroller 8051 Programming	6	4	6	50	50
Discipline Centric Elective- V	**Spectroscopy or Research Methodology in Physics**	5	3	3	25	75
SEC II	Choose any one from the list III	4	2	3	25	75
	Internship / Field Visit / Industrial Visit/ Research Knowledge Updating Activity	-	2		50	50
		30	26			

SEMESTER - IV

COURSE COMPONENTS	NAME OF THE COURSE	Hours	Credits	Exam Hrs	MAX MARKS	
					CIA	EXT
Core-XI	Nuclear and Particle Physics	6	5	3	25	75
Core-XII	Electromagnetic Theory	6	5	3	25	75
Elective- VI	Practical – IV: Advanced Physics Experiments - II and Numerical Methods in C++	6	3	6	50	50
SEC III	Choose any one from the list III	5	2	3	25	75
Core	Project with viva voce	7	7		50	50
	Extension Activity: Choose any one from LIST IV	-	1		50	50
		30	23			

ELECTIVE PAPERS

List 1

1. Energy Physics
2. Crystal Growth and Thin films
3. Analysis of Crystal Structures
4. Materials Science
5. Physics of Nano Science and Technology
6. Digital Communication
7. Communication Electronics

LIST 2

8. Plasma Physics
9. Bio Physics
10. Non-linear Dynamics
11. Quantum Field Theory
12. General Relativity and Cosmology
13. Advanced Optics
14. Advanced Mathematical Physics

LIST 3 - INDUSTRY ORIENTED SKILL ENHANCEMENT PAPERS

15. Advanced Spectroscopy
16. Microprocessor 8085 and Microcontroller 8051
17. Characterization of Materials
18. Medical Physics
19. Solid Waste Management (SWM)
20. Sewage and Waste Water Treatment and Reuse
21. Solar Energy Utilization

LIST - 4 - ACADEMIC EXTENSION ACTIVITY

1. **Entrepreneurship and Innovation Workshop Series**
   Empowering students to develop entrepreneurial skills and explore opportunities for commercializing physics-related technologies or starting their ventures.

2. **Computational Physics Hackathon**
   Organizing hackathons or coding competitions focused on solving physics problems using computational techniques, fostering collaboration and innovation among students

3. **Science Education Outreach Program**
   Involving students in educational outreach activities, such as designing and delivering physics workshops for schools or mentoring undergraduate students in projects.

4. **Physics in Your Pocket**
   An interactive workshop series exploring the physics concepts and experiments that can be conducted using sensors available in mobile phones, covering topics such as motion, sound, light & magnetism and monitoring air quality, temperature, humidity, and pollution levels in various locations (student residence)

5. **Conduct Virtual Experiments and Prepare Reports**
   a) Conduct the diffraction at a slit experiment virtually using the following link
   https://www.walter-fendt.de/html5/phen/singleslit_en.htm
   i) Measure the angular spread (Θ) for different slit widths (Δx) for given wavelength of the incident photon. ii). Determine the momentum of the incident photon using, p=h/λ iii) . Create a line of best fit through the points in the plot 1 Δpx against $\Delta x$and find its slope. How this exercise is related to Heisenberg Uncertainty principle Make a report of the observations
   b) Virtual lab - Photoelectric effect using Value@Amritha: link
   https://vlab.amrita.edu/?sub=1&brch=195&sim=840&cnt=1
   i) Determine the minimum frequency required to have Photoelectric effect for an EM radiation, when incident on a zinc metal surface. ii) . Determine the target material if the threshold frequency of EM radiation is$5.5 x 10^{15}$ Hz in a particular photoelectric experimental set up.
   iii) Determine the maximum kinetic energy of photo-electrons emitted from a Zinc metal surface, if the incident frequency is $3 x 10^{15}$Hz. Make a report of the calculations
   c) Visualization of wave packets using Physlet@Quantum Physics:
   https://www.compadre.org/PQP/quantum-need/prob5_11.cfm
   Six different classical wave packets are shown in the animations. Which of the wave packets have a phase velocity that is: greater than / less than / equal to the group velocity? Make a report of the observations.

6. **Construction of physics Models**
7. **Science Club Activities**
   (Report for the Extension activity shall be submitted by the students individually)

Field Visit/WORK

Fieldwork, as a derived concept, is the practical work carried out by students outside the classroom or laboratory in order to acquire hands-on experience, handle data, make observations, and interact with areas that are actual, involving the subject of their studies or professional practices. Practical field work includes having an interaction with nature, field sites, fancy tools, instruments, and local communities for discussion of the specific topics and studies to collect, investigate and analyze or for the utilization in disciplines of natural sciences, social sciences, humanities, engineering and other professional fields.

Following are some of the fieldwork activities a student or group of students may undertake.

(Not only restricted to the following activities)

Atmospheric Physics Measurements: Perform atmospheric physics measurements, such as temperature, humidity, and pressure, using weather stations or handheld instruments. Study atmospheric phenomena, weather patterns, and climate change indicators.

Water Quality Analysis: Collect water samples from lakes, rivers, or oceans to analyze water quality parameters, such as pH, salinity, and dissolved oxygen. Investigate water pollution sources, ecological impacts, and aquatic ecosystems.

Wind Energy Measurements: Conduct wind speed and direction measurements using anemometers and wind vanes at potential wind farm sites.

Study wind energy potential, turbine design, and wind farm optimization.

Thermal Power Plant Tour and Operation Overview: Organize a guided tour of a thermal power station to study the overall operation, energy generation processes, and power plant components, such as boilers, turbines, and generators. Learn about thermal power generation principles, steam cycles, and energy conversion efficiency.

Nuclear Power Plant Tour: Organize a guided tour of a nuclear power plant to study nuclear reactor design, operation, and safety measures.

Learn about nuclear fuel cycles, reactor control systems, and radiation monitoring.

Observational Astronomy: Organize a field trip to an observatory or a dark sky site for astronomical observations using telescopes. Study celestial objects, such as planets and stars.

Solar Observations: Conduct solar observations using solar telescopes or solar filters or collect data from solar observatories to study sunspots, solar flares, and solar prominences. Analyze solar activity and its impact on space weather.

Space Observatory Field Trip: Visit space observatories, astronomical research facilities, or satellite ground stations to study space exploration missions, astronomical observations, and satellite communications. Explore telescope technologies, observational techniques, and data acquisition systems.

Rocket Launch and Space Mission Observation: Attend rocket launch events, space mission launches, or spacecraft test flights to observe space launch operations, rocket propulsion systems, and aerospace technologies. Explore launch vehicle designs, mission profiles, and space exploration advancements.

Geomagnetic Field Measurements: Conduct geomagnetic field measurements using magnetometers at different locations to study Earth's magnetic field variations. Investigate geomagnetic storms, magnetic anomalies, and their effects on Earth's environment.

Data Science and Machine Learning Workshop: Attend workshops or training sessions on data science, machine learning, and artificial intelligence applications in physics research. Explore data analytics, pattern recognition, and predictive modeling techniques.

(Report for the Internship/ Field visit/ Industrial Visit/ Research Knowledge Updating Activity shall be submitted by the students individually)

PROJECT WORK

Rules and Regulations for PG Physics Project

Individual Project	Each candidate must undertake an individual project. Group projects are not permitted
Project Types	Projects must be based on one or more of the following areas: • Theoretical Physics • Experimental Physics • Computational Physics • Scientific Data Analysis
Prohibited Projects	• Readymade projects are not recommended • Electronic construction projects, IOT projects are not allowed unless they are the original idea of the student and approved by the project supervisor.
Project Report	• Students must adhere to the template provided by the university for the preparation of their project reports. • The report should include an abstract, introduction, literature review, methodology, results, discussion, conclusion, and references.
Originality and Plagiarism	• Projects must be original work by the student. • Plagiarism in any form is strictly prohibited and will result in disqualification.
Supervision	• Each project must be supervised by a faculty member. • Regular updates and consultations with the supervisor are mandatory
Safety and Ethics	• Students conducting experimental projects must follow all laboratory safety protocols. • Ethical guidelines in research must be strictly followed
Evaluation	• Projects will be evaluated by the external examiners based on originality, methodology, analysis, and adherence to the provided template. • Both a written report and an oral presentation may be required as part of the evaluation process.
Students are encouraged to consult their supervisors and the department for any clarifications regarding these rules and regulations	
Internal : 50 Marks and External : 50 Marks	

Core Paper VII - QUANTUM MECHANICS – II		II YEAR - THIRD SEMESTER						
Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
	QUANTUM MECHANICS – II	Core				5	5	75

Pre-Requisites
Knowledge of postulates of Quantum mechanics, properties of Hermitian operators, ladder operators, degeneracy, angular momentum techniques and commutation rules
Learning Objectives
➢ Formal development of the theory and the properties of angular momenta, both orbital and spin ➢ To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Barn approximation. ➢ Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field ➢ To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts ➢ To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions

UNIT I: SCATTERING THEORY

Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for S wave – Optical theorem – Transformation from centre of mass to laboratory frame.

UNIT II: PERTURBATION THEORY

Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability - Einstein‘s A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation .

UNIT III: RELATIVISTIC QUANTUM MECHANICS

Klein – Gordon Equation – Charge and Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation of Negative Energy States – Antiparticles – Spin of Electron - Magnetic Moment of an Electron Due to Spin.

UNIT IV: DIRAC EQUATION

Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman ‘s theory of positron (Elementary ideas only without propagation formalism)

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION

Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether‘s theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics,2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. Nouredine Zettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017.

REFERENCE BOOKS

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition, Oxford University Press, London, 1973.
2. B. K. Agarwal&HariPrakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics, 1st edition,I.K.International Publishing house Pvt. Ltd., 2006
4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi.
5. E. Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970.

WEB SOURCES

1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture notes/MIT8_05F13_Chap_09.pdf
2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf
3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf
4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notes-gk.pdf
5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation	**K1**
CO2	Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts	**K2**
CO3	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment	**K1, K4**
CO4	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions	**K1, K3**
CO5	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

Core Paper VIII - CONDENSED MATTER PHYSICS	II YEAR - THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	CONDENSED MATTER PHYSICS	Core				5	5	75

Pre-Requisites
Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.
Learning Objectives
➢ To describe various crystal structures, symmetry and to differentiate different types of bonding. ➢ To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat. ➢ To critically assess various theories of electrons in solids and their impact in distinguishing solids. ➢ Outline different types of magnetic materials and explain the underlying phenomena. ➢ Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

UNIT I: CRYSTAL PHYSICS

Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (SC,BCC, FCC). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).

UNIT II: LATTICE DYNAMICS

Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye‘s theory of lattice heat capacity - Thermal Conductivity - Umklapp processes.

UNIT III: THEORY OF METALS AND SEMICONDUCTORS

Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz Law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - De Hass-van Alphen effect.

UNIT IV: MAGNETISM

Diamagnetism - Quantum theory of Para-magnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferromagnetic material - Neel temperature.

UNIT V: SUPERCONDUCTIVITY

Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Type I and II Superconductors. Theoretical Explanation: Thermodynamics of super conducting transition - London equations - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory - Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High Temperature Superconductors – SQUIDS.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. C. Kittel, 1996, *Introduction to Solid State Physics,* 7th Edition, Wiley, New York.
2. Rita John, Solid State Physics, Tata Mc-Graw Hill Publication.
3. A. J. Dekker, *Solid State Physics*, Macmillan India, New Delhi.
4. M. Ali Omar, 1974, *Elementary Solid State Physics – Principle and Applications,* Addison - Wesley
5. H. P. Myers, 1998, *Introductory Solid State Physics,* 2nd Edition Viva Book, New Delhi.

REFERENCE BOOKS

1. J. S. Blakemore, 1974 , *Solid state Physics,* 2nd Edition, W.B. Saunder, Philadelphia
2. H. M. Rosenburg, 1993, *The Solid State,* 3rd Edition, Oxford University Press, Oxford.
3. J. M. Ziman, 1971, Principles *of the Theory of Solids*, Cambridge University Press, London.
4. C. Ross-Innes and E. H. Rhoderick, 1976, *Introduction to Superconductivity,* Pergamon, Oxford.
5. J. P. Srivastava, 2001, *Elements of Solid State Physics,* Prentice-Hall of India, New Delhi.

WEB SOURCES

1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html
2. http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html
3. https://www.britannica.com/science/crystal
4. https://www.nationalgeographic.org/encyclopedia/magnetism/
5. https://www.brainkart.com/article/Super-Conductors_6824/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	**K1**
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	**K1, K2**
CO3	Student will be able to comprehend the heat conduction in solids	**K3**
CO4	Student will be able to generalize the electronic nature of solids from band theories.	**K3, K4**
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

Core Paper IX - NUMERICAL METHODS AND PROGRAMMING IN C++	II YEAR – THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	NUMERICAL METHODS AND PROGRAMMING IN C++	Core				5	5	75

Pre-Requisites
Prior knowledge on computer and basic mathematics
Learning Objectives
➢ To make students to understand different numerical approaches to solve a problem. ➢ To understand the basics of programming and its application to solve physical problems

UNIT I -ROOTS OF EQUATION

Roots of equation: Bisection method – False position method – Newton Raphson method – Secant method – Order of convergence. Simultaneous Equations: Existence of solutions- Basic Gauss elimination method – Gauss Jacobi iteration method – Gauss Seidal iteration method – Inverse of a matrix using Gauss elimination method .

UNIT II - CURVE FITTING – INTERPOLATION

Curve fitting: Method of least squares – straight line, fitting a parabola, fitting $y = ax^n$, $y = ae^{bx}$ type curves – **Interpolation:** Polynomial Interpolation – Lagrange polynomial – Newton polynomial - Forward and Backward differences – Gregory Newton forward and backward interpolation formula for equal intervals – Divided difference – properties of divided differences – Newton's divided differences formula – Lagrange's interpolation formula for unequal interval

UNIT III – EIGEN VALUES, DIFFERENTIATION AND INTEGRATION

Eigenvalues: Power method to find dominant Eigenvalue - Jacobi method

Numerical differentiation: Numerical differentiation – Formulae for derivatives – Taylors Series Method - Forward backward differences and central difference formula **Numerical Integration** : Newton – cotes formula – Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, – Error estimates in trapezoidal and Simpson's rule – Monte Carlo Method.

UNIT IV - DIFFERENTIAL EQUATIONS

Ordinary differential equation: Solution by Taylor's series –- Basic Euler method –Improved and Modified Euler method – Runge Kutta fourth order method – solution of simultaneous first order differential equations and second order differential equations by RK fourth order Method

Partial differential equation: Introduction- Classification of partial differential equation of the 2nd order – Finite Difference approximations - Solution of Laplace's equation – Solution of Poisson's Equation –standard five point formula and diagonal five point formula (Jacobi and Gauss Seidal Methods).

UNIT V : PROGRAMMING IN C++

Program structure and header files - Basic data types- operators - Control Structures: decision making and looping statements. Arrays, Strings, Structures, Pointers and File handling. Application programs – Solution to Algebraic and transcendental equations by Newton Raphson Method - Charging and discharging of a condenser by Euler's Method – Radioactive Decay by Runge Kutta fourth order method - Currents in Wheatstone's bridge by Gauss elimination method - Cauchy's constant by least square method - Evaluation of integral by Simpson's and Monte-Carlo methods - Newton's Law of cooling by Numerical differentiation.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Books for Study

1. Introductory methods of numerical analysis, S. S. Sastry, Prentice Hall of India, 2010
2. Numerical methods for mathematics, science and engineering, John H. Matthews, Prentice Hall of India, 2nd Edition, 2000
3. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering computation, 3 rd edition, New age international (P) Ltd, Chennai , 1998.
4. Object Oriented Programming with C++ by E. Balagurusamy, Tata McGraw-Hill , India, 4th Edition

Books for Reference

1. Computer Applications in Physics, S. Chandra, M.K. Sharma, Narosa, 3rd Edition,2014
2. M. K. Venketraman, Numerical Methods in Science and Engineering 2nd Ed., National Publishing Co., Chennai (2010).
3. E. Balagurusamy, Computer Oriented Statistical and Numerical Methods, Macmillan India Ltd, New Delhi (2000).

Related online resources:

1. https://youtu.be/LbKKzMag5Rc
2. https://youtu.be/Xb9Ypn77LBo
3. https://youtu.be/FfqAIlOxkoY

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Recall the transcendental equations and analyze the different root finding methods. Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	**K1, K2**
CO2	Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.	**K5**
CO3	Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation	**K2, K3**
CO4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simpson's method of numerical integration.	**K3, K4**
CO5	Understand the basics of C++-programming and conditional statements.	**K2**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

(PSO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

CORE PAPER X: PRACTICAL III	II YEAR – THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	Advanced Physics Experiments – I and Microprocessor 8085 & Microcontroller 8051 Programming	CORE				4	6	50

PRACTICAL – III (Semester – III)

Pre-Requisites
Prior knowledge of basic physics and programming skills.
Learning Objectives
➢ To make students to understand different concepts of physics ➢ To understand the basics of microprocessor and microcontroller programming

Advanced Physics Experiments – I and Microprocessor 8085 & Microcontroller 8051 Programming

Section A (Any 6 Experiments)

1. Determination of Cauchy's Constant of the given prism – material. Obtain data by doing the Cauchy's Experiment and fitting a straight line using any software.
2. Determination Rydberg constant using Hydrogen Vapor lamp source.
3. Determination of Magnetoresistance of the given material.
4. Determination of Dielectric constant of the given liquid medium using Colpitt's oscillator or LCR circuit.
5. Photo Transistor Characteristics.
6. Temperature measurement using Si Diode as a Temperature Sensor (Calibrate the sensor using LM35)
7. Analysis of rotation and vibration spectrum /Interpretation of vibrational spectra of a given material
8. Determination of e/k using Transistors
9. Temperature coefficient of a Thermistor using 555 timer or any other method.
10. To study I-V Characteristics, Load Response, and Spectral Response of Photovoltaic Solar Cell
11. Pspice Simulation: Designing and simulating an Astable Multivibrator using a 555 Timer for the given frequency.
12. Pspice Simulation: Simulation of a Zener diode characteristics and voltage regulator.

Section B : Microprocessor 8085 and Microcontroller 8051 Programming

(Any 6 Experiments)
All Programs should contain Algorithms and Flowcharts

8085 Microprocessor Programs

1. Arithmetic Operations
a) Addition of two 8 bit and two 16 bit numbers
b) Subtraction of two 8 bit and 16 bit numbers
c) Multiplication of two 8 bit numbers –16-bit result.

2. Data Manipulation
a) Arrange the given data items in Ascending or Descending order
b) Finding the Minimum or Maximum value in the given data set.
c) Search of a given character/number in the given data set.

3. **System Call and Rolling character**
a) Calculation of time delay for a given interval.
b) Roll a given character from Left to Right / Right to Left on the 7 segment displays with the specified time interval.

4. **ADC Interfacing and Conversion**
a) Interfacing ADC with 8085 – ADC chip Block diagram – 8085 - ADC interfacing diagram
b) Conversion of analog input to digital – Resolution – Graph between input and output.

5. **DAC interfacing and Wave form generation**.
Interfacing DAC with 8085 – DAC Chip Block diagram – 8085 - DAC - 8085 interfacing diagram
Wave Form Generation using DAC
a) Square wave with the specified period T
b) Rectangular Wave with Specified T_H and T_L
d) Ramp Wave

8051 Programs using Simulator - MCU8051 IDE (Freeware)

6. Data Transfer Programming
a) Write an assembly language program to transfer N bytes of data from location A: XX H to location B: YYH in the internal RAM
b)Write an assembly language program to exchange N bytes of data at location A: XX h and at location B:YY H.

7. **Data Manipulation**
a) Write an assembly language program to find the largest element in a given array of N =___ h bytes at location 4000h. Store the largest element at location 4062h.

b) Write an assembly language program to count number of ones and zeros in an eight bit number.

8**. Arithmetic Programming**

a) Write an assembly language program to perform the addition of two 16-bit numbers.
b) Write an assembly language program to perform the subtraction of two 16-bit numbers.
c) Write an assembly language program to perform the multiplication of two 8-bit numbers.
d) Write an assembly language program to find the square of a given number N.

9. **Code Conversion**

a) Write an assembly language program to convert a BCD number into ASCII.
b) Write an assembly language program to convert a ASCII number into Decimal.
c) Write an assembly language program to convert a decimal number into ASCII.
d) Write an assembly language program to convert a binary (hex) number into decimal.
e) BCD to 7 Segment Code

10. Counter

Write an assembly language program to implement a decimal counter and show the count on the 7segment display virtual hardware available in the simulator. Write and use a proper delay routine.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Determination of some physical constants using specialized instruments	**K1, K2**
CO2	Spectral data analysis techniques and interpretation	**K5**
CO3	Simulation of some physical experiments using specialized software	**K2, K3**
CO4	Hands on experience with microprocessor Programming	**K3 ,**
CO5	Hands on experience with Microcontroller Programming	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2

Discipline Centric Elective – SPECTROSCOPY

ELECTIVE Paper- V: (A) SPECTROSCOPY		II YEAR – THIRD SEMESTER						
Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
	SPECTROSCOPY	ELECTIVE				3	5	75

Pre-Requisites
Thorough understanding of electromagnetic spectrum, mathematical abilities, knowledge of molecules, their structure, bond nature, physical and chemical behaviour
Learning Objectives
➢ To comprehend the theory behind different spectroscopic methods ➢ To know the working principles along with an overview of construction of different types of spectrometers involved ➢ To explore various applications of these techniques in R &D. ➢ Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds. ➢ Understand this important analytical tool

UNIT I: MICROWAVE SPECTROSCOPY

Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra - Problems.

UNIT II: INFRA-RED SPECTROSCOPY

Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra – Simple applications.

UNIT III: RAMAN SPECTROSCOPY

Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle- determination of N_2O structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- Surface Enhanced Raman Spectroscopy.

UNIT IV: RESONANCE SPECTROSCOPY

Nuclear and Electron spin- Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan

Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR

UNIT V: UV SPECTROSCOPY

Origin of UV spectra - Laws of absorption – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer -Simple applications

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Knowledge about sample preparations and equipment – cells and cuvettes – sample holders - software and computational tools for spectroscopic data analysis and interpreting spectroscopic data.

TEXT BOOKS

1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
2. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K. Sharma, 2015, *Spectroscopy*, Goel Publishing House Meerut.
5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7^{th} Edition), New Age International Publishers

REFERENCE BOOKS

1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
   K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi
4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.
5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer Link

WEB SOURCES

1. https://www.youtube.com/watch?v=0iQhirTf2PI
2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5
3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee
4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.	**K2**
CO2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.	**K2, K3**
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	**K5**
CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	**K4**
CO5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	**K1, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

ELECTIVE PAPER V: (B) RESEARCH METHODOLOGY IN PHYSICS		II YEAR – THIRD SEMESTER						
Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
	RESEARCH METHODOLOGY IN PHYSICS	ELECTIVE				4	5	75

RESEARCH METHODOLOGY

The course aims to introduce basic concepts of research methods, covering the preparation of research plans, data collection and analysis, understanding scientific papers, scientific writing, research proposal writing, ethics, plagiarism, laboratory safety issues

UNIT I: RESEARCH THEORY

Definition and importance of research in physics - Types of research: Theoretical, Experimental, and Computational Physics Research - Key concepts and theoretical frameworks - The role of theory in guiding physics research - Steps in planning a physics research project - Creating a research timeline specific to physics experiments - Importance of literature review - Sources of physics literature (journals, conference proceedings, preprints) - Techniques for effective literature review in physics- Defining the Research Problem in Physics- Steps and methods - Criteria for selecting a research problem - Identifying gaps in existing physics research - Formulating a clear and focused physics research question.

UNIT II: RESEARCH DESIGN IN PHYSICS: Definition and purpose of research design in physics - Key characteristics of an effective research design in physics- Balancing flexibility and rigor in physics experiments - Variables, hypotheses, and operational definitions in physics - Control and manipulation of variables in physics experiments -**Types:** Descriptive, correlational, experimental, and quasi-experimental designs in physics - Definition and significance of citation indices -Using citation indices to evaluate the impact of physics research - Impact Factor in the context of physics journals - Its role in academic publishing in physics - h-index and i10-index

UNIT III: DATA COLLECTION AND ANALYSIS: Measurement in research: Measurement scales, Sources of error in measurement, Tests of sound measurement, Scaling: Meaning of Scaling Classification Bases, Important Scaling Techniques- Methods of Data Collection: Collection of primary data, observation Method, Collection of data through schedules, Some other methods of data collection. Data Analysis Processing and Analysis of Data: Processing Operations, Elements/Types of Analysis: Basic statistics for experimental physics: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation.

UNIT IV TECHNICAL & SCIENTIFIC WRITING

Technical & Scientific writing - Technical papers, reviews, electronic communication, Research papers, etc., Poster preparation and Presentation and Dissertation. Reference Management using various software's such as

Endnote, reference manager, Refworks, etc. Report Writing: Technique of Interpretation, Precaution in Interpretation. Significance of report Writing, Different Steps in Writing Report, Layout of the Research Report Types of Reports, Precautions for Writing Research Reports.

UNIT V: ETHICAL ISSUES

Understanding research ethics - Significance of ethics in scientific research - Plagiarism ,definition of direct plagiarism, self-plagiarism, mosaic plagiarism , accidental plagiarism -, Tools and techniques to detect and avoiding plagiarism in scientific writing - Ethical issues in collaborative research – Case Studies in Research: Famous case studies in physics research: Successes and failures - Analysis of landmark research papers - Lessons learned from historical research projects.

UNIT VI: PROFESSIONAL COMPONENT

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Text Books:

1. S.Gupta, *Research Methodology and Statistical techniques* (Deep and Deep Publications (P) Ltd. New Delhi, India) 2005.
2. C. R. Kothari, *Research Methodology* (New Age International, New Delhi, India) 2008.
3. Research Methods the Basics by Nicholas Walliaman, Taylor and Francis London& New York 2011.
4. Research Methodology A Step-By-Step Guide for Beginners 3rd Edition by Ranjit Kumar, Sage Publications
5. Data Reduction and Error Analysis for the Physical Sciences 3rd Ed by Philip R Bevington & D Keith Robinson, McGraw – Hill (2003)
6. Numerical Methods by Balagurusamy, Tata McGraw – Hill(2000)
7. Numerical Analysis, 2nd Ed. by Francis Scheid, McGraw-Hill(2009)

Books for Reference

1. Research Methodology: Methods and Techniques" by C.R. Kothari and Gaurav Garg
2. Scientific Research Methodology" by P.N. Mukherjee
3. Research Methodology in Science and Technology" by M. Subbiah
4. Research Methodology: Concepts and Cases" by Deepak Chawla and Neena Sondhi
5. Research Methodology in Physical Sciences" by D. K. Bhattacharyya
6. Experimental Physics: Principles and Practice" by R.K. Shukla and Anchal Srivastava
7. Research Methodology for Scientists and Engineers" by Rajat Acharyya and Nandan Bhattacharya
8. Writing and Publishing in Scientific Journals: A Comprehensive Guide" by G. N. Ramachandran
9. Ethics in Science Education, Research and Governance" by Krishna Mani Pathak
10. Responsible Conduct of Research: An Indian Perspective" by P. A. K. Kumara

Web resources

1. www.aip.org www.aps.org for reference styles.
2. www.nature.com, www.sciencemag.org, www.springer.com, www.pnas.org, www.tandf.co.uk, www.opticsinfobase.org for research updates
3. Office of Research Integrity (ORI) – https://ori.hhs.gov

4. The National Center for Professional & Research Ethics – https://nationalethicscenter.org
5. Committee on Publication Ethics (COPE) – https://publicationethics.org

COURSE OUTCOME

CO1	Develop the ability to understand and apply fundamental research methodologies specific to theoretical, experimental, and computational physics.	K1,K2
CO2	Gain proficiency in designing robust research projects and experiments in physics, balancing flexibility with scientific rigor.	K1,K2
CO3	Master various data collection methods and statistical analysis techniques relevant to experimental physics to ensure accurate and reliable results.	K3,K4
CO4	Acquire advanced skills in technical and scientific writing, enabling the effective communication of research findings through various formats such as papers, posters, and reports.	K1,K2
CO5	Understand and apply ethical principles in scientific research, with the ability to identify and address ethical issues and avoid plagiarism.	K3
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Core Paper XI - NUCLEAR AND PARTICLE PHYSICS	II YEAR - FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	NUCLEAR AND PARTICLE PHYSICS	Core				5	6	75

Pre-Requisites
Knowledge of basic structure of atom and nucleus.
Learning Objectives
➢ Introduces students to the different models of the nucleus in a chronological order ➢ Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles ➢ Provides students with details of nuclear decay with relevant theories ➢ Exposes students to the Standard Model of Elementary Particles and Higgs boson

UNIT I: NUCLEAR MODELS

Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrupole moment - Bohr and Mottelson collective model – rotational and vibrational bands.

UNIT II: NUCLEAR FORCES

Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon- nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism.

UNIT III: NUCLEAR REACTIONS

Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.

UNIT IV: NUCLEAR DECAY

Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life – Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.

UNIT V: ELEMENTARY PARTICLES

Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-Gell Mann matrices– Gell Mann Okuba Mass formula- Quark Model. Standard model of particle physics – Higgs boson.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011).
2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008).
3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996).
4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011).
5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.- 3rd Revised edition (1968).

REFERENCE BOOKS

1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973).
2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).
3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002).
4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001).
5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.

WEB SOURCES

1. http://bubl.ac.uk/link/n/nuclearphysics.html
2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdfhttp://www.scholarpedia .org/article/Nuclear_Forces
3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/
4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html
5. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedec ay.html

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	**K1, K5**
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	**K2, K3**
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	**K3**
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	**K3, K4**
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

Core Paper XII - ELECTROMAGNETIC THEORY	**II YEAR - FOURTH SEMESTER**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
	ELECTROMAGNETIC THEORY	Core				5	6	75

Pre-Requisites
Knowledge of different coordinate systems, Laplace's equation, conducting & non-conducting medium, basic definitions in magnetism, propagation of electromagnetic waves, plasma
Learning Objectives
➢ To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables ➢ To understand Biot – Savart's law and Ampere's circuital law ➢ To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws ➢ To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves ➢ To grasp the concept of plasma as the fourth state of matter

UNIT I: ELECTROSTATICS

Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems. Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.

UNIT II: MAGNETOSTATICS

Biot-Savart‘s Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.

UNIT III: MAXWELL EQUATIONS

Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution- Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.

UNIT IV: WAVE PROPAGATION

Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide. Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole

UNIT V: ELEMENTARY PLASMA PHYSICS

The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto- hydrodynamic waves - Alfven waves and magneto sonic waves.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. D. J.Griffiths , 2002, Introductionto Electrodynamics, 3rd Edition, Prentice-Hall of India, New Delhi.
2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd edition, Narosa Publishing House, New Delhi.
3. J. D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd. New Delhi.
4. J. A. Bittencourt, 1988, Fundamentals of Plasma Physics, Pergamon Press, Oxford.
5. Gupta, Kumar and Singh, Electrodynamics, S. Chand & Co., New Delhi

REFERENCE BOOKS

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2. J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications,* 5th Edition, WCB McGraw-Hill, New York.
3. B. Chakraborty, 2002, *Principles of Electrodynamics,* Books and Allied, Kolkata.
4. P. Feynman, R. B. Leighton and M. Sands, 1998, *The Feynman Lectures on Physics*, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA

WEB SOURCES

1. http://www.plasma.uu.se/CED/Book/index.html
2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html
3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html
4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/
5. https://www.cliffsnotes.com/study-guides/physics/electricity-and-magnetism/electrostatics

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	**K1, K5**
CO2	Use Biot-Savart's law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems	**K2, K3**
CO3	Apply Maxwell's equations to describe how electromagnetic field behaves in different media	**K3**
CO4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	**K3, K4**
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

Elective Paper - VI -Practical – IV **ADVANCED PHYSICS EXPERIMENTS – II AND NUMERICAL METHODS IN C++**	**II YEAR – FOURTH SEMESTER**

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	Advanced Physics Experiments – II and Numerical Methods in C++	Elective				3	6	50

Pre-Requisites
Basic knowledge in principles of Physics, Circuit theory, Digital electronics, Scilab software Basic knowledge of Numerical Methods and Programming skills
Learning Objectives
➢ To apply theoretical knowledge through hands-on experiments in order to analyze and understand the characteristics and behaviors of various physical and electronic systems, while developing practical skills in measurement, data analysis, and circuit design. ➢ To familiarize the students with numerical methods used in problem-solving by writing programs using the high level language C++

Advanced Physics Experiments – II and Numerical Methods in C++

Section A : Advanced Physics Experiments – II

(Any 6 Experiments)

1. Investigate the equilibrium points of the logistic map equation $X_{n+1} = aX_{n\ (1-}\ X_{n)}$ for various parameter values and initial conditions:
   a) Determine the equilibrium points for 'a' ranging from 0.5 to 2.5 with a step size of 0.1 considering x0=0.1.
   b) Explore the behavior of the logistic map for 'a' values between 3.5 and 4.0 with a step size of 0.05 for x0=0.2.
   c) Analyze the dynamics near the period-doubling bifurcation point at a≈3.828, considering x0=0.3.
   d) Plot x_n versus n for each scenario and generate bifurcation diagrams to visualize the system's behavior.

2. Determination resistivity of a semiconductor by Four Probe Method
3. Examine the input-output characteristics of analog-to-digital converter ADC 0804 or any ADC IC. The characteristics may include parameters such as linearity, accuracy, resolution, and dynamic range.
4. Photo Conductivity Experiment:
   a) To plot the current-voltage characteristics of a CdS Photo Resistor (LDR) at constant irradiance.
   b) To measure the Photo current as a function of irradiance at constant voltage
5. Determination of the distance between two tracks of a CD and a DVD using a Solid state laser
6. Verification of Thevenin's and Max power theorems
7. Study the Characteristics of a Load cell
8. Design of a Serial Shift Registers using necessary Flip-Flop ICs
9. Design of Encoder and Decoder Circuits using necessary ICs
10. Study of a quartz crystal (1 MHz) and construction of a Pierce crystal Oscillator using digital inverters
11. UV spectral data analysis for the given spectrum
12. Simulation of satellite orbit around the earth using the universal law of gravitation in Scilab

Section – B : Numerical Methods in C++
(Any SIX programs with Algorithm and Flow chart)

1 Algebraic and Transcendental equation.
a) Solution of the given equations using Newton Raphson Method – manual calculation.
b) C++ program to find the solution using N-R method and verification.

2. Algebraic and Transcendental equations.
a) Solution of the given equations using Bisection Method – manual calculation.
b) C++ program to find the solution using Bisection method and verification.

3. Curve Fitting – Linear Fit
a) Principle of least square and fitting a straight line.
b) C++ program to fit a straight line using the given data related with any physics experiment.

4. Curve Fitting – Non Linear Fit
a) Principle of fitting a second degree polynomial using method of least square
b) C++ program to fit a polynomial using the given data related with any physics experiment.

5. Interpolation
a) Derive Lagrangian interpolation formula.
b) C++ program to interpolate using the given data related with any physics experiment by Lagrangian Method.

6. Solution of simultaneous equations -Gauss Elimination method.
a) Procedure to solve Simultaneous equations using Gauss Elimination (GE) Method
b) C++ program for solving unknown branch currents in Wheatstone's bridge using GE method.

7. Numerical solution of ordinary Differential Equations.
   a) Derivation of Exponential law of Radioactive decay.
   b) RK 4th order method of solving a given 1st order differential equation.
   c) C++ program using RK method to solve radioactive problem – Compare output with the analytical result.
8. Area under the Curve - Numerical integration
   a) Derivation of Trapezoidal and Simpson's rule
   b) C++ programs for Trapezoidal and Simpson 1/3 rule
   c) Comparison of the program output with direct integration.

9. Random Number Generation and Montecarlo Method
   a) Generate and scale the random numbers using the C++ library functions.
   b) Evaluate the given integral using Montecarlo method.

10. Matrix Multiplication
   a) Multiplication of given matrices
   b) Rotation matrix definition.
   c) C++ program to rotate the given 2D- object about the origin using rotation matrix through the given angle.

11. Inverse of a Matrix

   a) Procedure to determine the Inverse of a Matrix using Gauss elimination Method.

   b) C++ Program to find the Inverse of the Matrix using Gauss Elimination Method.

12. Numerical Differentiation

   a) Numerical differentiation – related to any physical problem
   b) Derivation of Newton's law of cooling –equation
   c) C++ program to verify the Newton's law of cooling from the given experimental data.

Course Outcomes: Section –A

CO1	Students will be able to evaluate the efficiency and performance of solar cells by analyzing their spectral response to different wavelengths of light.
CO2	Students will understand the functional characteristics of ADCs, including linearity, accuracy, resolution, and dynamic range, through practical examination of the ADC 0804.
CO3	Students will be able to characterize the current-voltage relationship of a CdS photoresistor under constant irradiance conditions.
CO4	Students will be able to determine and analyze the temperature coefficient of resistance for a thermistor using the Carey Foster Bridge method.
CO5	Students will be able to measure and interpret the spacing between tracks on optical discs using diffraction patterns generated by a solid-state laser.

CO6	Students will gain practical experience in verifying and applying Norton's, Thevenin's, and Maximum Power Transfer theorems in electrical circuits.
CO7	Students will understand and evaluate the performance characteristics of load cells, including their response to varying loads.
CO8	Students will acquire the ability to design, implement, and test serial shift registers using flip-flops and integrated circuits.
CO9	Students will learn to design and construct encoder and decoder circuits, understanding their principles and applications in digital systems.
CO10	Students will be able to analyze the properties of a quartz crystal and construct a Pierce crystal oscillator, understanding its operation and applications.
CO11	Students will develop skills in using simulation software to model and analyze satellite orbits based on the universal law of gravitation.

Course Outcomes: Section -B

CO1	Students will be able to apply the Newton Raphson method manually to solve given equations and implement it in C++ for verification.
CO2	Students will demonstrate proficiency in applying the Bisection method manually and implementing it in C++ to find solutions, ensuring accuracy through verification.
CO3	Learners will understand the principle of least squares and successfully fit a straight line to given data using C++, applying it to physics experiments.
CO4	Students will grasp the principle of least squares for nonlinear fits and implement it in C++ to fit a polynomial to experimental data, specifically exploring physics-related datasets.
CO5	Students will derive the Lagrangian interpolation formula and apply it in C++ to interpolate data from physics experiments, gaining practical experience in numerical methods.
CO6	Students will comprehend the Gauss Elimination method for solving simultaneous equations and implement it in C++ to find unknown branch currents in a Wheatstone bridge, linking numerical methods to circuit analysis.
CO7	Learners will derive the exponential law of radioactive decay and employ the RK 4th order method in C++ to solve differential equations, comparing results to analytical solutions in a radioactive decay scenario.
CO8	Students will understand and derive the Trapezoidal and Simpson's rules for numerical integration and implement corresponding C++ programs, validating their accuracy through comparison with direct integration methods.
CO9	Students will be proficient in generating and scaling random numbers in C++ using library functions and applying the Monte Carlo method to evaluate integrals, integrating randomness into numerical methods.
CO10	Students will demonstrate competence in matrix multiplication, comprehend rotation matrix concepts, and implement a C++ program to rotate 2D objects about the origin, emphasizing practical applications in computer graphics or physics simulations.
CO11	Students will apply numerical differentiation to solve physical problems, derive Newton's law of cooling equation, and validate it through a C++ program analyzing experimental data, connecting mathematical modeling to real-world phenomena.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) and program specific outcomes (PSO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1
CO11	2	2	2	3	3	1	1	1	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1
CO11	2	2	2	3	3	1	1	1	3	3

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