

Punyashlok Ahilyadevi Holkar

Solapur University, Solapur



पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ

॥ विद्यया संपन्नता ॥

NAAC Accredited-2022
'B++' Grade (CGPA-2.96)

Name of the Faculty: Science & Technology

NEP 2020

Syllabus: Physics

Name of the Course: B. Sc. III (Sem V & VI)

(Syllabus to be implemented from June 2026)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Three Majors in First Year structure as per NEP-2020 Approved in For AC Meeting on 18/04/2024

4- Year Multidisciplinary UG Program with DSC as a Major (4 -Year Bachelor of Science (Honors)/(Honors with Research)

Level/ Difficulty	Sem.	Faculty			Generic/ Open Elective GE/ OE	Vocational and Skill Enhancement Courses (SEC/VSC)	Ability Enhancement Course (AEC), IKS, VEC	Field Project/ RP/CC/Internship/Appre nticeship/ Community Engagement & Services	Credits	Cumulati ve Credits
		Major		Minor						
		DSC	DSE							
4.5 100-200	I	DSC1-1 (2+2)#	--		GE1/ OE1(2)	SEC1 (2)	L1-1(2) IKS (2) VEC1(2) <small>(Indian Constitution And Democracy)</small>	--	22	44 UG Certificate (44)
		DSC2-1 (2+2)#	--							
		DSC3-1 (2+2)#	--							
	II	DSC1-2 (2+2)#	--		GE2/ OE2(2)	SEC 2 (2)	L1-2(2) VEC2(2) <small>(Environmental Studies)</small>	CC1 (2)	22	
		DSC2-2 (2+2)#	--							
		DSC3-2 (2+2)#	--							
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										
5.0/20 0	III	DSC1-3 (2+1)	---	DSC2-3 (2+1)	GE3 / OE3(2)	VSC1 (2) (DSC1) VSC2(2) (DSC2)	L2-1 (2)	CC2 (2)	22	44 UG Diploma (88)
		DSC1-4 (2+1)	---	DSC-2-4 (2+1)						
	IV	DSC1-5 (2+1)	---	DSC2-5 (2+1)	GE4/ OE4 (2)	VSC3 (2) (DSC1) VSC4(2) (DSC2)	L2 -2(2)	FP1/CEP1(2)	22	
		DSC1-6 (2+1)	--	DSC2-6 (2+1)						
Exit option: Award of UG Diploma in Major with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major										

5.5/300	V	DSC1-7 (3+2)	DSE1-1 (2+1) or	----	----	VSC3 (2) (Hands on Training related to DSE)	IKS 2 (2) (related to major subject)	--	22	44 UG degree (132)
		DSC1-8 (3+2)								
		DSC1-9 (3+2)	DSE1-2 (2+1)							
	VI	DSC1-10 (3+2)	DSE1-3 (2+1) or DSE1-4 (2+1)	----	---	VSC4 (2) (Hands on Training related to DSE)		FP2/CEP2/OJT1 (2)	22	
		DSC1-11 (3+2)								
		DSC1-12 (3+2)								
Total Credits 3 Yrs	66-8#	6	12 +8# 20	08	16	16	16	08	132	
Exit option: Award of UG degree in Major with 132 Credits OR Continue with Major										
6.0/40 0	VII	DSC1-13 (4+2)	DSE1-5 (4+2)	Research Methodology (4)	-----	----	----	---	22	44 UG Honours Degree in Main faculty (176)
		DSC1-14 (4+2)								
	VIII	DSC1-15 (4+2)	DSE1-6 (4+2)	----	-----	----	OJT/In-house Project/ Internship/ Apprenticeship (4)	22		
		DSC1-16 (4+2)								
Total 4 Yrs	90-8#	18	16+8#	08	16	16	16	12	176	
Award of Bachelor of Science Honors., (B.Sc. Honors.) degree with Major and Minor (176 credits)										

OR

6.0/40 0	VII	DSC1-13 (4)	DSE1-5 (4)	Research Methodology (4)	-----	----	----	Research Project (6)	22	44 UG Honours with research Degree in Main faculty (176)
		DSC1-14 (4)			----	-----	----			
	VIII	DSC1-15 (4+2)	DSE1-6 (4)	----	-----	----	Research Project (6)	22		
		DSC1-16 (4+2)		----	-----	----				
	Total 4 Yrs	86-8#	14	16+8#	08	16	16	20	176	

#Out of the three major courses in the first year, one major (comprising 4 credits for the 1st semester and 4 credits for the 2nd semester) will transition into a minor starting from the second year. Consequently, 8 credits will be reallocated from the major course credit count and added to the minor credit count, thereby meeting the requisite credit criteria for the minor as stipulated in the guidelines.

B.Sc. Part- III Subject: Physics

[According to NEP 2020 wef June 2026]

Sem	Paper	Credits		Marks				Total Credits
		T	PR	T-CA	PR-CA	T-UA	PR-UA	
V	DSC 1-7	3	2	30	20	45	30	22
	DSC 1-8	3	2	30	20	45	30	
	DSC 1-9	3	2	30	20	45	30	
	DSE 1-1	2	1	20	10	30	15	
	DSE 1-2	2	1	20	10	30	15	
	VSC 5	---	2	--	20	--	30	
	IKS 2	2	---	20	---	30	---	
VI	DSC 1-10	3	2	30	20	45	30	22
	DSC 1-11	3	2	30	20	45	30	
	DSC 1-12	3	2	30	20	45	30	
	DSE 1-3	2	1	20	10	30	15	
	DSE 1-4	2	1	20	10	30	15	
	VSC 6	---	2	--	20	--	30	
	FP2/CEP2/OJT1	---	2	--	20	--	30	



Program Preamble

The Bachelor of Science (B.Sc.) in Physics program at Punyashlok Ahilyadevi Holkar Solapur University is meticulously designed in alignment with the visionary framework of the National Education Policy (NEP) 2020. This program offers a holistic, multi-dimensional approach to undergraduate physics education, seamlessly bridging scientific foundations with contemporary theoretical and technological advancements.

Theoretical Rigor and Analytical Depth

At its core, the program is engineered to transition students from fundamental physical concepts to advanced analytical frameworks. In the final year (Semesters V and VI), the curriculum challenges students with the sophisticated mathematics and theories that govern the universe. Students explore the rigorous formulations of Classical Mechanics and Electrodynamics, while simultaneously diving into the probabilistic and microscopic realms of Statistical Physics, Quantum Mechanics, Nuclear Physics, and Atomic and Molecular Physics. This comprehensive theoretical grounding ensures students can articulate and model complex physical phenomena from the subatomic to the macroscopic scale.

Applied Sciences and Modern Technologies

Complementing its theoretical depth, the program places a strong emphasis on applied physics and material innovation. Through dedicated Discipline Specific Electives (DSE) in Materials Science, and Electronics, students investigate the underlying physics of modern semiconductors, advanced composite and nano-materials, and sophisticated power and display electronics. These subjects form the critical bridge between pure physics and the cutting-edge engineering driving today's technological landscape.

Integration of Heritage and Modernity

A unique and vital hallmark of this curriculum is the incorporation of Indian Knowledge Systems (IKS). By exploring ancient Indian frameworks of matter, historical metallurgical triumphs like Wootz steel, and classical kinematics, the program fosters a deep appreciation for India's scientific heritage, critically connecting ancient methodologies with modern materials science.

Experiential Learning and Vocational Skill Development

True to the spirit of NEP 2020, the B.Sc. Physics program places unprecedented focus on experiential learning and employability. Through intensive Practical Courses and Vocational Skill Courses (VSC), students transition from theoretical learners to active practitioners. They acquire hands-on training in fabricating composite and nano-materials, designing operational



Program Outcomes (POs)

Program Outcomes represent the broad graduate attributes and skills that students will develop by the time they complete their B.Sc. degree.

- **PO1: Disciplinary Knowledge:** Demonstrate a comprehensive understanding of the fundamental principles, theories, and laws governing the natural world across various scientific disciplines.
 - **PO2: Critical Thinking & Problem Solving:** Apply analytical, logical, and critical thinking to identify, formulate, and solve complex, unstructured physical and mathematical problems.
 - **PO3: Experimental & Quantitative Skills:** Design and safely execute laboratory experiments, meticulously record observations, and apply rigorous statistical and computational methods to analyze and interpret quantitative data.
 - **PO4: Modern Tool Usage:** Select and integrate appropriate analog instruments, digital technologies, and computational software (e.g., MS Excel, ImageJ, VESTA) to model, visualize, and analyze scientific phenomena.
 - **PO5: Communication Skills:** Effectively communicate complex scientific concepts, experimental methodologies, and analytical results clearly and concisely through formal lab reports, technical writing, and multimedia presentations.
 - **PO6: Environment, Sustainability, and Ethics:** Understand the impact of scientific and technological solutions on society and the environment, applying ethical principles to research, data integrity, and the development of sustainable materials.
 - **PO7: Lifelong Learning:** Recognize the rapid evolution of technology and scientific knowledge, demonstrating the ability to engage in independent, self-directed learning to adapt to future professional and academic demands.
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Program Specific Outcomes (PSOs)

Program Specific Outcomes describe the specific competencies and specialized knowledge that graduates of the **B.Sc. Physics** program will acquire.

- **PSO1 (Core Theoretical Physics):** Master the advanced theoretical frameworks of physics, demonstrating proficiency in Classical Mechanics, Electrodynamics, Quantum Mechanics, Statistical Physics, and Nuclear Physics.
- **PSO2 (Materials Science & Solid State Physics):** Analyze the microscopic and crystallographic structures of matter to predict and evaluate the macroscopic physical properties of metals, semiconductors, superconductors, composites, biomaterials, and nanomaterials.
- **PSO3 (Electronic Systems & Device Physics):** Design, construct, and analyze low-power analog circuits and high-power control systems utilizing modern electronic components such as Operational Amplifiers, 555 Timers, SCRs, Diacs, Triacs, and MOSFETs.
- **PSO4 (Mathematical & Computational Modeling):** Apply advanced mathematical techniques (such as vector calculus, differential equations, and the calculus of variations) alongside numerical methods to model physical systems and solve complex electrodynamic and quantum boundary-value problems.
- **PSO5 (Indian Knowledge Systems Integration):** Critically evaluate India's historical and cultural contributions to physics and metallurgy, correlating ancient materials science techniques (such as Wootz steel and Rasashastra) with modern scientific and engineering principles.
- **PSO6 (Vocational & Experiential Competence):** Transition theoretical knowledge into practical industrial and research skills through hands-on fabrication, testing, and characterization of polymers, ceramics, and electronic circuits, ensuring readiness for advanced research or technical careers.



Semester V



B.Sc. III Sem.- V

Physics

DSC 1-7

Paper Number – Physics-VII; Paper Code – G04-DSC1-0501

Mathematical Physics and Statistical Physics

Credits: 03

Course Preamble

This course bridges the gap between advanced mathematical frameworks and the foundational principles of statistical mechanics. The first half of the curriculum is dedicated to Mathematical Physics, equipping students with rigorous analytical tools—such as vector calculus, curvilinear coordinates, and series solutions to differential equations—which are indispensable for formulating and solving complex physical problems. The second half transitions into Statistical Physics, exploring how the microscopic properties of large particle assemblies dictate the macroscopic thermodynamic behavior of physical systems. By progressing from classical Maxwell-Boltzmann statistics to the quantum realms of Bose-Einstein and Fermi-Dirac statistics, students will gain a comprehensive understanding of the probabilistic nature of the universe, from classical gas dynamics to the quantum behavior of photons and electrons.

Course Objectives

The primary objectives of this course are:

- **To introduce advanced mathematical methods:** Familiarize students with key vector theorems (Gauss, Green, Stokes) and the mechanics of orthogonal curvilinear coordinate systems.
- **To develop mathematical problem-solving skills:** Train students in solving second-order linear differential equations using the Frobenius method and introduce the associated special mathematical functions.
- **To establish the foundations of statistical mechanics:** Introduce fundamental concepts such as microstates, macrostates, ensembles, phase space, and the vital link between probability and entropy.
- **To explore classical statistical distribution:** Teach the Maxwell-Boltzmann distribution law and its application to calculating molecular speeds and thermodynamic functions.



- **To transition to quantum statistics:** Provide a detailed framework for Bose-Einstein and Fermi-Dirac statistics, demonstrating their necessity in explaining phenomena like black body radiation and the behavior of free electrons in metals.

Course Outcomes (COs)

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

- **CO1 (Mathematical Tools):** Apply Gauss's, Green's, and Stoke's theorems to physical systems, and confidently compute gradient, divergence, curl, and the Laplacian in Cartesian, spherical, and cylindrical coordinate systems.
- **CO2 (Differential Equations):** Identify the order, degree, and singular points of differential equations, and apply the Frobenius method to find solutions for complex equations like the Hermite differential equation.
- **CO3 (Statistical Foundations):** Analyze the statistical behavior of thermodynamic systems by utilizing concepts of phase space, a priori probability, accessible microstates, and different statistical ensembles.
- **CO4 (Classical Statistics):** Apply the Maxwell-Boltzmann distribution law to derive thermodynamic functions from partition functions and evaluate molecular speeds in a classical gas.
- **CO5 (Bose-Einstein Applications):** Formulate the laws of black body radiation (Planck's, Wien's, Rayleigh-Jeans, and Stefan's laws) using the principles of Bose-Einstein statistics.
- **CO6 (Fermi-Dirac Applications & Comparison):** Utilize Fermi-Dirac statistics to explain the distribution of free electrons and Fermi energy in metals, and critically compare the applications and limits of MB, BE, and FD statistics.

Unit 1 Vector Theorems and Partial Differential Equation

(Lectures= 08; Weightage= 13 M)

- 1.1 Gauss's theorem
- 1.2 Green's theorem
- 1.3 Stoke's theorem
- 1.4 Differential equation
 - 1.4.1 Types of differential equation
 - 1.4.2 Degree, order, linearity, homogeneity of differential equation
 - 1.4.3 Concept of singular points of differential equation
- 1.5 Frobenius method of solving differential equation
 - 1.5.1 Legendre differential equation (without solution)



1.5.2 Bessel differential equation (without solution)

1.5.3 Hermite differential equation (without solution)

Unit 2 Orthogonal Curvilinear Coordinates

(Lectures= 08; Weightage= 13 M)

2.1 Introduction to cartesian, spherical polar and cylindrical coordinate system

2.2 Concept of orthogonal coordinate system

2.3 Gradient in orthogonal coordinate system

2.4 Divergence in orthogonal coordinate system

2.5 Curl in orthogonal coordinate system

2.6 Laplacian operator in orthogonal coordinate system

2.7 Extension of orthogonal coordinate system in cartesian, spherical polar and cylindrical coordinate system

Unit 3 Basic Concept in Statistical Physics

(Lectures= 08; Weightage= 13 M)

3.1 Micro and macro states

3.2 Micro canonical and canonical ensemble

3.3 Phase space

3.4 Accessible microstates

3.5 A priory probability

3.6 Thermodynamic probability

3.7 Probability distribution

3.8 Entropy and probability

Unit 4 Maxwell Boltzmann Statistics

(Lectures= 07; Weightage= 12 M)

4.1 Maxwell Boltzmann distribution law

4.2 Evaluation of constants α and β

4.3 Molecular speeds

4.4 Thermodynamic functions in terms of partition function

Unit 5 Quantum Statistics – I

(Lectures= 07; Weightage= 12 M)

5.1 Bose- Einstein statistics

5.2 Bose- Einstein distribution law

5.3 Experimental study of black body radiation



- 5.4 Derivation of Planck's radiation formula
- 5.5 Deduction of Wein's formula from Planck's radiation formula
- 5.6 Deduction of Rayleigh- Jean's law from Planck's radiation formula
- 5.7 Deduction of Wein's displacement law from Planck's radiation formula
- 5.8 Stefan's law from Planck's radiation formula

Unit 6 Quantum Statistics – II **(Lectures= 07; Weightage= 12 M)**

- 6.1 Fermi- Dirac distribution law
- 6.2 Application to free electrons in metals
- 6.3 Electron energy distribution
- 6.4 Fermi energy
- 6.5 Comparison of M.B., F.D. and B.E. statistics

Reference Books:

1. Theory and problems of vector analysis- Schaum outline series- Murray R, Spiegel
 2. Mathematical methods for physics – George Arfken
 3. Thermodynamics and statistical physics – Sharma, Sarkar
 4. Statistical Mechanics –B.B. Laud
 5. Statistical and thermal physics – S. Loknathan
 6. Statistical Mechanics – SatyaPrakash, J.P. Agrawal
 7. Elementary Statistical Mechanics – Kumar, Gupta
 8. An approach to Statistical Physics – Debi Prasad Ray
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B.Sc. III Sem.- V

Physics

DSC1-7 Practical Course

Paper Number – Physics-VII-Practical Lab-VII

Paper Code – G04-DSC1-0501-P

Credits: 02

Course Preamble

The Physics-VII Practical Lab (DSC1-7) is designed to develop computational and mathematical skills essential for physics. This course introduces students to fundamental concepts of linear algebra, vector spaces, matrices, and probability theory, along with their applications in solving physical problems. It also emphasizes numerical methods such as root finding and solving differential equations using Euler's and Runge-Kutta methods. The course bridges theoretical mathematics and practical implementation, enabling students to model and analyze physical systems effectively using computational techniques.

Course Objectives

1. To understand concepts of vector spaces, linear algebra, and matrix operations.
2. To apply eigenvalues and eigenvectors in physical and engineering problems.
3. To study probability theory and random variables for data analysis.
4. To implement numerical methods for solving equations and differential equations.
5. To develop computational and analytical problem-solving skills.

Course Outcomes (COs)

CO1: Apply concepts of vector spaces, linear independence, and basis in problem-solving.

CO2: Analyze matrices, eigenvalues, and eigenvectors in physical systems.

CO3: Use probability concepts and random variables for statistical analysis.

CO4: Solve algebraic and differential equations using numerical methods.

CO5: Develop computational approaches to model and analyze physical problems.

List of Experiments

1. [Euclidean Space as a Vector Space](#)
2. [Linear Combination and Span](#)
3. [Linear Independence, Basis, Dimension and Coordinates](#)
4. [Linear Transformations and Their Connection with Matrices](#)



5. [Eigen Values, Eigen Vectors and Diagonalization](#)
6. [Application to Ordinary Linear Differential Equations and Engineering Problems](#)
7. [Discrete and Continuous Type Random Variables](#)
8. [Cumulative Distribution Function](#)
9. [Moments of the Random Variable](#)
10. [Finding Roots of Algebraic and Transcendental Equations](#)
11. [Ordinary Differential Equations \(ODEs\) using Euler's and Runge-Kutta Methods](#)
12. [Finding Eigen-Values and Eigen-Vectors of Matrices](#)

Reference Books

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley.
 2. Gilbert Strang, *Linear Algebra and Its Applications*, Cengage Learning.
 3. K. F. Riley, M. P. Hobson, and S. J. Bence, *Mathematical Methods for Physics and Engineering*, Cambridge University Press.
 4. S. H. Ross, *Introduction to Probability Models*, Academic Press.
 5. S. S. Sastry, *Introductory Methods of Numerical Analysis*, PHI Learning.
 6. John R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. Python/Matlab Documentation for Numerical Computation.
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B.Sc. III Sem.- V

Physics

DSC 1-8

Paper Number – Physics-VIII; Paper Code – G04-DSC1-0502

Solid State Physics

Credits: 03

Course Preamble

This course provides a comprehensive and rigorous foundation in Solid State Physics, exploring the vital relationship between the microscopic structure of solids and their macroscopic physical properties. Beginning with the geometric elegance of crystallography and the analytical power of X-ray diffraction, the curriculum systematically progresses through the foundational theories governing electron behavior in metals. Crucially, the exploration of band theory establishes the essential framework for understanding the fundamental distinctions between metals, insulators, and semiconductors—serving as a critical stepping stone for advanced study in semiconductor physics and the development of modern electronic or energy-storage materials. The course culminates in the study of specialized states of matter, specifically magnetic phenomena and superconductivity, equipping students with the theoretical background required to engage with contemporary materials science and solid-state device physics.

Course Objectives

The primary objectives of this course are:

- **To introduce structural crystallography:** Familiarize students with lattice structures, unit cells, Miller indices, and the packing characteristics of various crystal systems.
- **To examine X-ray diffraction techniques:** Explain the principles of reciprocal lattices and Bragg's Law to analyze crystal structures using X-ray powder diffraction.
- **To explore Free Electron Theory:** Detail the Drude, Lorentz, and Sommerfeld models to explain the thermal and electrical conductivities of metals, incorporating Fermi-Dirac distribution.
- **To establish the Band Theory of Solids:** Introduce the Kronig-Penney model and the concept of effective mass to explain the formation of energy bands and the Hall Effect.



- **To analyze magnetic properties:** Categorize magnetic materials (diamagnetic, paramagnetic, ferromagnetic, anti-ferromagnetic, and ferrimagnetic) and explain hysteresis energy losses.
- **To introduce superconductivity:** Provide a fundamental understanding of superconductors, including critical temperature, the Meissner effect, Type I and II classifications, and the Josephson effect.

Course Outcomes (COs)

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

- **CO1 (Crystal Structures):** Define foundational crystallographic terms, calculate inter-planar spacing, determine Miller indices, and evaluate the packing fraction and coordination numbers for SC, BCC, FCC, and HCP structures.
- **CO2 (Diffraction Analysis):** Apply the concepts of reciprocal lattices and Bragg's law to interpret X-ray diffraction patterns and determine crystal structures using the powder method.
- **CO3 (Electron Dynamics in Metals):** Utilize the free electron model and Fermi-Dirac statistics to explain the electrical and thermal conductivity of metals, evaluating concepts like Fermi energy and the Wiedemann-Franz relation.
- **CO4 (Band Theory & Semiconductors):** Differentiate between metals, semiconductors, and insulators using energy band diagrams, and apply the Hall Effect to determine charge carrier properties in periodic potentials.
- **CO5 (Magnetic Materials):** Classify various magnetic materials based on their atomic and macroscopic properties, and analyze energy dissipation through hysteresis loops.
- **CO6 (Superconductivity Physics):** Explain the defining characteristics of superconductors, distinguish between Type I and Type II behaviors under magnetic fields, and identify practical applications of the Meissner and Josephson effects.

Unit 1 Crystallography

(Lectures= 10; Weightage= 15 M)

- 1.1 Lattice and basis
- 1.2 Unit cell
- 1.3 Bravais lattices (2D, 3D)
- 1.4 Inter-planer spacing
- 1.5 Miller indices
- 1.6 Packing fraction and co-ordination number for SC, BCC, FCC & HCP structures



Unit 2 X-ray Diffraction by Crystals

(Lectures= 05; Weightage= 12 M)

- 2.1 Production of X-rays and its properties
- 2.2 Reciprocal lattice and its properties
- 2.3 Bragg's law in reciprocal lattice
- 2.4 Powder method of X-ray diffraction for crystal structure

Unit 3 Free Electron Theory

(Lectures= 08; Weightage= 12 M)

- 3.1 Properties of metals
- 3.2 Free electron model (Drude and Lorentz model)
- 3.3 Electrical, thermal conductivity of metals and Wiedemann-Franz relation
- 3.4 Sommerfeld's theory
- 3.5 Fermi-Dirac distribution
- 3.6 Fermi energy, degeneracy and non-degeneracy of metals

Unit 4 Band Theory of Solids

(Lectures= 08; Weightage= 12 M)

- 4.1 Formation of bands in solids (PE, KE and total energy of electron in an isolated atom)
- 4.2 Formation of energy bands (valence band, conduction band and forbidden energy gap)
- 4.3 Motion of electron in one-dimensional periodic potential (Kronig-Penney model)
- 4.4 Effective mass of electron
- 4.5 Difference between metals, semiconductors and insulators
- 4.6 Hall Effect and its applications

Unit 5 Magnetic Materials

(Lectures= 07; Weightage= 12 M)

- 5.1 Magnetic terminology
- 5.2 Classification of magnetic materials
 - 5.2.1 Diamagnetic materials
 - 5.2.2 Paramagnetic materials
 - 5.2.3 Ferromagnetic materials
 - 5.2.4 Anti-ferromagnetic materials
 - 5.2.5 Ferri-magnetic material and ferrites
- 5.3 Energy loss in the hysteresis



Unit 6 Superconductivity (Lectures= 07; Weightage= 12 M)

- 6.1 Superconductor
- 6.2 Type I and type II superconductors
- 6.3 Critical temperature
- 6.4 Effect of magnetic field
- 6.5 Meissner effect
- 6.6 Josephson effect
- 6.7 Applications of superconductors

Reference Books:

1. Introduction to Solid State Physics – Charles Kittel (Wiley)
2. Solid State Physics – S. O. Pillai (NEW AGE INTERNATIONAL PUBLISHERS)
3. Solid State Physics – A. J. Dekker (Laxmi Publications)
4. Solid State Physics – R. K. Puri, V.K. Babbar (S. Chand)
5. Solid State Physics – R. L. Singhal (K
NRN Publication)
6. Fundamentals of Solid-State Physics – Saxena B. S. and Gupta R.C. (Pragati Prakashan)



B.Sc. III Sem.- V

Physics

DSC1-8 Practical Course

Paper Number – Physics-VIII-Practical Lab-VIII

Paper Code – G04-DSC1-0502-P

Credits: 02

Course Preamble

The Physics-VIII Practical Lab (DSC1-8) is designed to provide experimental understanding of surface tension, viscosity, thermal radiation, electrical properties, and crystallography. The course includes experiments related to fluid mechanics, heat transfer, and solid-state physics concepts such as lattice structures, Miller indices, and symmetry. Students gain hands-on experience in measuring physical properties using different methods and develop skills in experimental techniques, data analysis, and interpretation. This course strengthens the connection between theoretical concepts and real-world physical phenomena.

Course Objectives

1. To study surface tension and viscosity using different experimental methods.
2. To understand thermal radiation laws such as Stefan's law.
3. To measure electrical properties like resistivity using advanced techniques.
4. To explore crystallography concepts such as unit cells, lattices, and symmetry.
5. To develop experimental skills and analytical abilities in physical measurements.

Course Outcomes (COs)

CO1: Measure and analyze surface tension and viscosity using various methods.

CO2: Understand and verify thermal radiation laws experimentally.

CO3: Determine electrical properties such as resistivity using appropriate techniques.

CO4: Analyze crystal structures using lattice concepts, Miller indices, and symmetry.

CO5: Interpret experimental data and apply concepts to real-world physical systems.

List of Experiments

1. S.T. of a soap film
2. S.T. by Ferguson's modified method
3. S.T. by ripple method
4. Stefan's fourth power law



5. Viscosity of a given liquid by logarithmic decrement
6. [Resistivity by Four Probe Method](#)
7. [Cornu's Method](#)
8. [Unit Cells](#)
9. [Construct Lattice](#)
10. [Reciprocal Lattices](#)
11. [Miller Indices](#)
12. [Symmetries](#)

Reference Books

1. D. Chattopadhyay and P. C. Rakshit, *Advanced Practical Physics*, New Central Book Agency.
 2. B. L. Worsnop and H. T. Flint, *Advanced Practical Physics*, Asia Publishing House.
 3. S. O. Kasap, *Principles of Electronic Materials and Devices*, McGraw-Hill.
 4. Charles Kittel, *Introduction to Solid State Physics*, Wiley.
 5. B. D. Cullity and S. R. Stock, *Elements of X-Ray Diffraction*, Pearson.
 6. J. R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. Standard Laboratory Manuals for Physics Experiments.
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B.Sc. III Sem.- V

Physics

DSC 1-9

Paper Number – Physics-IX; Paper Code – G04-DSC1-0503

Classical Mechanics

Credits: 03

Course Preamble

This course represents a fundamental shift from the force-based Newtonian perspective to the elegant, energy-based analytical methods of Classical Mechanics. By transitioning to the Lagrangian and Hamiltonian formulations, students will learn how to solve complex physical problems—such as constrained motion and multi-particle systems—where traditional Newtonian methods become mathematically cumbersome. The curriculum explores the profound connection between symmetries and conservation laws, the dynamics of non-inertial reference frames, and the beautiful mathematics of the calculus of variations. Finally, the course extends these principles to analyze coupled oscillatory systems and the rotational dynamics of rigid bodies in space. This advanced framework is not only the pinnacle of classical physics but also the essential mathematical language required for transitioning into Quantum Mechanics and Statistical Mechanics.

Course Objectives

The primary objectives of this course are:

- **To review and extend Newtonian mechanics:** Solidify concepts of vector algebra, centre of mass, and conservation theorems for both single particles and multi-particle systems.
- **To introduce Analytical Mechanics:** Teach the Lagrangian formulation, concepts of constraints, degrees of freedom, and D'Alembert's principle to bypass the limitations of Newtonian mechanics.
- **To analyze non-inertial frames of reference:** Explore the effects of moving and rotating coordinate systems, focusing on pseudo forces like the Coriolis and centrifugal forces.
- **To apply the Calculus of Variations:** Introduce Hamilton's Principle of least action and use it to derive Lagrange's equations and solve classic optimization problems like the Brachistochrone.



- **To study complex periodic motion:** Analyze coupled oscillatory systems, determine their normal modes, and understand energy transfer between coupled oscillators.
- **To examine rigid body dynamics:** Provide a comprehensive understanding of rigid body motion in three dimensions using Euler's theorem and Euler's equations of motion.

Course Outcomes (COs)

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

- **CO1 (Particle System Dynamics):** Apply Newton's laws and conservation theorems of linear momentum, angular momentum, and energy to analyze the mechanics of individual particles and complex systems of particles.
- **CO2 (Lagrangian Formulation):** Construct Lagrange's equations of motion using generalized coordinates and D'Alembert's Principle to solve constrained mechanical systems, such as Atwood's machine, simple pendulums, and beads on rotating wires.
- **CO3 (Rotating Coordinate Systems):** Evaluate the physical implications of pseudo forces in moving reference frames, specifically analyzing the impact of the Coriolis force on freely falling bodies and terrestrial phenomena like Foucault's pendulum.
- **CO4 (Variational Principles):** Apply the techniques of the calculus of variations and Hamilton's Principle to solve classical optimization problems, including finding the shortest path, the minimum surface of revolution, and the Brachistochrone curve.
- **CO5 (Coupled Oscillations):** Calculate the frequencies of normal modes, define normal coordinates, and quantify energy transfer in coupled oscillatory systems.
- **CO6 (Rigid Body Mechanics):** Formulate and solve Euler's equations of motion to describe the angular momentum, energy, and complex rotational behavior of rigid bodies in three-dimensional space.

Unit 1 Mechanics of a Particle and System of Particles

(Lectures= 08; Weightage= 15 M)

- 1.1 Mechanics of a particle using vector algebra and vector calculus
- 1.2 Conservation theorems for linear momentum, angular momentum and energy of a particle
- 1.3 Mechanics of a system of particles, concept of centre of mass
- 1.4 Conservation theorems for linear momentum, angular momentum and energy of a system of particles
- 1.5 Application of Newton's law of motion - Projectile motion in resistive medium



Unit 2 Lagrangian Formulation (Lectures= 07; Weightage= 15 M)

- 2.1 Limitations of Newtonian Formulation
- 2.2 Introduction of Lagrangian Formulation
- 2.3 Constraints
- 2.4 Degrees of freedom
- 2.5 Generalized coordinates
- 2.6 Principle of virtual work
- 2.7 D' Alembert's principle
- 2.8 Lagrange's equation from D' Alembert's principle
- 2.9 Applications of Lagrange's equation
 - 2.9.1 A particle in space (cartesian coordinates)
 - 2.9.2 Atwood's machine
 - 2.9.3 A bead sliding on uniformly rotating wire
 - 2.9.4 Simple pendulum
 - 2.9.5 Simple harmonic oscillator

Unit 3 Moving Coordinate Systems (Lectures= 08; Weightage= 12 M)

- 3.1 Origin of moving coordinates
- 3.2 Pseudo forces
- 3.3 Rotating coordinate systems
- 3.4 Coriolis force
- 3.5 Foucault's pendulum
- 3.6 Effects of Coriolis force in nature
- 3.7 Effect of Coriolis force on freely falling body

Unit 4 Techniques of Calculus of Variation (Lectures= 07; Weightage= 12 M)

- 4.1 Hamilton's principle
- 4.2 Deduction of Lagrange's equations from Hamilton's principle
- 4.3 Applications of Hamilton's principle
 - 4.3.1 Shortest distance between two points in a plane
 - 4.3.2 Brachistochrone problem
 - 4.3.3 Minimum surface of revolution



Unit 5 Coupled Oscillations (Lectures= 08; Weightage= 10 M)

- 5.1 Frequencies of coupled oscillatory system
- 5.2 Normal modes and normal coordinates
- 5.3 Energy of coupled oscillations
- 5.4 Energy transfer in coupled oscillatory system

Unit 6 Motion of rigid body (Lectures= 07; Weightage= 11 M)

- 6.1 Motion of rigid body in space
- 6.2 Euler's theorem
- 6.3 Angular momentum and energy
- 6.4 Euler's equations of motion

Reference Books:

1. Classical Mechanics: Herbert Goldstein
2. Classical Mechanics: N. C. Rana and P.S. Joag
3. Introduction to classical Mechanics: R. G. Takawale and P.S. Puranic
4. Classical Mechanical: Gupta, Kumar and Sharma
5. Classical Mechanics: P.V. Panat



B.Sc. III Sem.- V

Physics

DSC1-9 Practical Course

Paper Number – Physics-IX-Practical Lab-IX

Paper Code – G04-DSC1-0503-P

Credits: 02

Course Preamble

The Physics-IX Practical Lab (DSC1-9) is designed to provide comprehensive experimental training in classical mechanics and properties of matter. The course includes experiments related to elasticity, rigidity, oscillations, and rotational dynamics using various methods such as bending, torsion, and pendulum techniques. It also covers fundamental laws of motion, collisions, and projectile motion. Students gain hands-on experience in determining mechanical properties, moments of inertia, and dynamic parameters of physical systems. This course enhances experimental precision, analytical thinking, and understanding of core principles of mechanics.

Course Objectives

1. To study elastic properties such as Young's modulus and rigidity modulus using different methods.
2. To analyze oscillatory systems including pendulums and torsional systems.
3. To understand rotational dynamics and determine moment of inertia of bodies.
4. To verify laws of motion, collisions, and projectile motion experimentally.
5. To develop experimental skills, accuracy in measurement, and data analysis techniques.

Course Outcomes (COs)

CO1: Determine elastic constants such as Young's modulus and rigidity modulus using experimental methods.

CO2: Analyze oscillations in pendulum and torsional systems.

CO3: Evaluate moment of inertia and rotational parameters of physical systems.

CO4: Verify Newton's laws, projectile motion, and collision principles experimentally.

CO5: Interpret experimental data and apply concepts of mechanics to real-world systems.

List of Experiments

1. Modulus of rigidity of a wire by Maxwell's needle



2. Y and η using flat spiral spring
3. Y by Koenig's method
4. Y by Cornu's method
5. Resonating pendulum
6. [Rigidity Modulus of The Suspension Wire of a Torsion Pendulum](#)
7. [Young's Modulus Non-Uniform Bending](#)
8. [Compound Pendulum Symmetric](#)
9. [Kater's pendulum](#)
10. [Young's Modulus Uniform Bending](#)
11. [Moment of inertia of a Torsion Pendulum](#)
12. [Rigidity Modulus Static Torsion](#)
13. [Torque and angular acceleration of a fly wheel](#)
14. [Moment of Inertia of Flywheel](#)
15. [Newton's Second Law of Motion](#)
16. [Ballistic Pendulum](#)
17. [Collision balls](#)
18. [Projectile Motion](#)
19. [Elastic and Inelastic Collision](#)
20. [Torsional Oscillations in Different Liquids](#)

Reference Books

1. D. Chattopadhyay and P. C. Rakshit, *Advanced Practical Physics*, New Central Book Agency.
 2. B. L. Worsnop and H. T. Flint, *Advanced Practical Physics*, Asia Publishing House.
 3. S. L. Gupta and V. Kumar, *Practical Physics*, Pragati Prakashan.
 4. J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publishing House.
 5. H. Goldstein, *Classical Mechanics*, Pearson.
 6. John R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. Standard Laboratory Manuals for Mechanics Experiments.
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B.Sc. III Sem.- V

Physics

DSE1-1

Paper Number – Physics-DSE1; Paper Code – G04-DSE1-501

Materials Science

Credits: 02

Course Preamble

Materials Science is a highly interdisciplinary field that lies at the heart of modern engineering and technological advancement. This introductory course provides a fundamental understanding of how the internal structure of a material dictates its macroscopic properties. Students will begin by exploring the broad classification of materials—spanning organic, inorganic, and biological domains—and analyzing their mechanical, thermal, optical, electrical, and magnetic characteristics. The curriculum then dives into two critical classes of modern materials: Polymers and Ceramics. By studying the synthesis mechanisms, structural defects, and mechanical behaviors of polymers, alongside the crystalline structures, processing techniques, and high-performance applications of ceramics, students will build a robust foundation for selecting, analyzing, and developing materials for real-world applications.

Course Objectives

The primary objectives of this course are:

- **To introduce material classifications:** Provide a comprehensive overview of how materials are categorized into organic, inorganic, and biological groups.
- **To examine fundamental material properties:** Detail the mechanical, thermal, optical, electrical, and magnetic properties that govern how materials behave under various physical conditions.
- **To explore polymer synthesis:** Teach the chemical mechanisms of addition and condensation polymerization, and differentiate between homopolymers and copolymers.
- **To analyze polymer mechanics:** Investigate the degree of polymerization, structural defects, and the deformation mechanisms of standard and reinforced polymers.
- **To study ceramic structures:** Introduce the classification and atomic/molecular structures of ceramic materials.



- **To understand ceramic processing and utility:** Explain the specialized processing techniques used for ceramics and correlate their unique thermal and mechanical properties to industrial applications.

Course Outcomes (COs)

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

- **CO1 (Material Classification):** Categorize various materials into organic, inorganic, and biological classes, recognizing their foundational differences and uses.
- **CO2 (Property Analysis):** Evaluate and articulate the physical properties of materials (mechanical, thermal, optical, electrical, and magnetic) to determine their suitability for specific applications.
- **CO3 (Polymer Chemistry):** Distinguish between different polymerization mechanisms and classify polymers based on their structural composition (e.g., homopolymers vs. copolymers).
- **CO4 (Polymer Characteristics):** Calculate the degree of polymerization, identify common structural defects, and analyze the mechanical deformation processes in pure and reinforced polymers.
- **CO5 (Ceramic Foundations):** Classify advanced ceramic materials and describe their distinct structural geometries.
- **CO6 (Ceramic Applications):** Outline the standard stages of ceramic processing and critically assess the properties of ceramics that make them ideal for high-temperature and structural applications.

Unit 1 Materials and their Properties

(Lectures= 07; Weightage= 11 M)

- 1.1 Classification of materials
- 1.2 Organic, inorganic and biological materials
- 1.3 Properties of materials
 - 1.3.1 Mechanical properties
 - 1.3.2 Thermal properties
 - 1.3.3 Optical properties
 - 1.3.4 Electrical properties
 - 1.3.5 Magnetic properties



Unit 2 Polymer Materials

(Lectures= 07; Weightage= 11 M)

- 2.1 Polymers
- 2.2 Polymerization mechanism
 - 2.2.1 Additional polymerization
 - 2.2.2 Condensation polymerization
 - 2.2.3 Homo-polymer
 - 2.2.4 Co-polymer
- 2.3 Degree of polymerization
- 2.4 Defects in the polymers
- 2.5 Mechanical properties of polymers, deformation, reinforced polymers
- 2.6 Applications of polymers

Unit 3 Ceramic and Composite Materials

(Lectures= 08; Weightage= 12 M)

- 3.1 Classification of ceramic materials
- 3.2 Structure of ceramics
- 3.3 Ceramic possessing
- 3.4 Properties of ceramics
- 3.5 Applications of ceramics
- 3.6 Fabrication of composites
- 3.7 Mechanical properties of composites
- 3.8 Particle-reinforced composites
- 3.9 Fiber-reinforced composites
- 3.10 Applications of composites

Unit 4 Biomaterials and Nanomaterials

(Lectures= 08; Weightage= 12 M)

- 4.1 Bio-mechanism
- 4.2 Classification of biomaterials
- 4.3 Processing of biomaterials
- 4.4 Properties of biomaterials
- 4.5 Applications of biomaterials
- 4.6 Introduction to nano-sized materials and structures
- 4.7 Brief history of nanomaterials and challenges in nanotechnology



4.8 Significance of nano-sized materials and properties

4.9 Classification of nano structured materials

4.10 Methods of synthesis of nanomaterials

4.10.1 Bottom-up and top-down approaches

4.10.2 Physical methods

4.10.3 Chemical methods

4.10.4 Hybrid methods

Reference Books:

1. Materials science by S.L. Kakani, Amit Kakani, New age international publishers.
 2. Materials science and engineering, V. Raghavan, 5th edition, PHI
 3. Materials science by R.S. Khurmi, S. Chand
 4. Materials science, G.K. Narula, K.S. Narula, V.K. Gupta, Tata McGraw-Hill.
 5. Semiconductor physics and devices by S.S. Islam, Oxford university press, 1st edition
 6. Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, by Thomas Varghese & K.M. Balakrishna, Atlantic publication
 7. Introduction to nanoscience and nanotechnology, by Chattopadhyay K.K., Banerjee A.N., PHI
 8. Materials science – V. Rajendran & A. Marikani (TMHI).
 9. Elements of materials Science & engineering.- I.H. Van Vlack (4th Edition.).
 10. Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
 11. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
 12. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
 13. Nanostructure and nanomaterials synthesis, Properties and applications, by G. Cao, Imperials College Press, London.
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B.Sc. III Sem.- V

Physics

DSE1-1 Practical Course

Paper Number – Physics-DSE1-Practical

Paper Code – G04-DSE1-501-P

Credits: 01

Course Preamble

The Physics-DSE1 Practical Course is designed to provide students with advanced experimental exposure in thermal physics, solid-state physics, electromagnetism, and materials characterization techniques. The course integrates traditional experimental methods with modern computational tools such as ImageJ and VESTA for analysis of particle size, surface morphology, and crystal structures. Students gain practical knowledge of techniques like Hall effect, X-ray diffraction analysis, and magnetic and dielectric measurements. This course enhances experimental skills, data interpretation abilities, and familiarity with contemporary research tools, preparing students for higher studies and research in physics and materials science.

Course Objectives

1. To perform experiments related to thermal conductivity, Hall effect, and e/m determination.
2. To understand crystallographic concepts and analyze XRD patterns.
3. To develop skills in image analysis for particle size and surface morphology using ImageJ.
4. To visualize and interpret crystal structures and lattice parameters using VESTA.
5. To study magnetic and dielectric properties of materials through experimental methods.

Course Outcomes (COs)

CO1: Conduct experiments to measure thermal, electrical, and magnetic properties of materials.

CO2: Analyze crystal structures and interpret XRD patterns effectively.

CO3: Use ImageJ software for particle size distribution and surface morphology analysis.

CO4: Apply VESTA for visualization of crystal systems and determination of lattice parameters.

CO5: Interpret experimental data and relate material properties to physical concepts.



List of Experiments

1. Measurement of thermal conductivity of a wire
2. Crystallography and study of XRD pattern
3. Hall effect
4. e/m by Thomson method
5. Measurement of particle size and size distribution using ImageJ
6. Analysis of surface morphology and grain size using ImageJ
7. Visualization of crystal structures and unit cells using VESTA
8. Identification of crystal systems and lattice parameters using VESTA
9. [Hall effect experiment - Determination of charge carrier density](#)
10. [Crystal Structure](#)
11. [Primitive Vectors](#)
12. [Measurement of Magnetic Susceptibility by Gouy's Method](#)
13. [Dielectric Constant and Curie Temperature Measurement](#)

Reference Books

1. Charles Kittel, *Introduction to Solid State Physics*, Wiley.
 2. B. D. Cullity and S. R. Stock, *Elements of X-Ray Diffraction*, Pearson.
 3. S. O. Kasap, *Principles of Electronic Materials and Devices*, McGraw-Hill.
 4. Donald A. Neamen, *Semiconductor Physics and Devices*, McGraw-Hill.
 5. William D. Callister Jr., *Materials Science and Engineering*, Wiley.
 6. John R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. Software Documentation for ImageJ and VESTA.
 8. Standard Laboratory Manuals for Materials Characterization.
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B.Sc. III Sem.- V

Physics

DSE1-2

Paper Number – Physics-DSE2; Paper Code – G04-DSE2-501

Artificial Intelligence

Credits: 02

Course Preamble

Artificial Intelligence (AI) and Machine Learning (ML) have emerged as transformative tools across scientific disciplines, offering powerful new ways to analyze complex data, model physical systems, and automate research workflows. This 2-credit Discipline Specific Elective (DSE) provides a comprehensive introduction to the foundational concepts and practical paradigms of AI.

The course is structured to take students on a logical journey from the historical roots and overarching taxonomy of AI to the modern data-driven approaches of machine learning. Students will explore how raw data is acquired, wrangled, and analyzed, followed by a conceptual deep dive into supervised and unsupervised learning techniques. Finally, the course addresses the critical ethical, regulatory, and societal implications of deploying AI systems. By the end of this course, students will possess a strong conceptual framework of AI, enabling them to understand and critically evaluate the integration of these technologies in both everyday life and scientific research.

Course Objectives

The primary objectives of this course are to:

- Introduce the historical background, core taxonomy, and diverse paradigms of Artificial Intelligence (from Symbolic to Connectionist AI).
- Familiarize students with the machine learning workflow, emphasizing the critical role of data modalities, data wrangling, and exploratory data analysis.
- Establish a clear understanding of the core mechanisms and distinctions between supervised and unsupervised machine learning techniques.
- Cultivate an awareness of the ethical challenges, algorithmic biases, and regulatory governance surrounding the development and deployment of AI technologies.



Course Outcomes (COs)

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

- **CO1:** Outline AI Fundamentals: Describe the foundational history, landscape, and distinct computational paradigms of Artificial Intelligence.
- **CO2:** Process and Explore Data: Identify different data formats and modalities, and explain the procedures for data wrangling and exploratory data analysis (EDA) within a machine learning workflow.
- **CO3:** Distinguish Learning Models: Differentiate between supervised and unsupervised machine learning methods and identify the appropriate components and types for specific problem-solving scenarios.
- **CO4:** Evaluate AI Ethics: Critically analyze the ethical implications of AI, recognize sources of algorithmic bias, and understand the importance of governance and mitigation strategies.

Unit 1 Introduction to Artificial Intelligence and Paradigms

(Lectures= 10; Weightage= 12 M)

- 1.1 Introduction to artificial intelligence
- 1.2 Foundations and history of artificial intelligence
- 1.3 Mapping the landscape of AI: Taxonomy and types
- 1.4 Artificial intelligence paradigms
- 1.5 Symbolic AI
- 1.6 Connectionist AI
- 1.7 Evolutionary AI
- 1.8 Agent-based AI
- 1.9 Neuro-symbolic AI

Unit 2 Machine Learning Paradigms, Data and Exploration

(Lectures= 10; Weightage= 12 M)

- 2.1 Introduction to machine learning
- 2.2 Paradigms of machine learning
- 2.3 Machine learning workflow
- 2.4 Introduction to data in AI
- 2.5 Source of data and data modalities
- 2.6 Structured and unstructured data
- 2.7 Quantitative and qualitative data



2.8 Understanding data formats

2.9 Data wrangling and exploratory data analysis

Unit 3 Supervised and Unsupervised Learning

(Lectures= 06; Weightage= 11 M)

3.1 Introduction to supervised learning

3.2 Components of supervised learning

3.3 Types of supervised learning

3.4 Introduction to unsupervised learning

3.5 Types of unsupervised learning

Unit 4 Ethics in AI

(Lectures= 04; Weightage= 11 M)

4.1 Introduction to AI ethics

4.2 Ethical challenges in AI

4.3 Biases in AI and how to mitigate it

4.4 Regulation and governance

Reference Books:

1. <https://artint.info/3e/html/ArtInt3e.html>
 2. [https:// Artificial-Intelligence-final-PDF-for-Print-1.pdf](https://Artificial-Intelligence-final-PDF-for-Print-1.pdf)
 3. <https://people.engr.tamu.edu/guni/csce625/slides/AI.pdf>
 4. <https://courses.csail.mit.edu/6.034f/ai3/rest.pdf>
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B.Sc. III Sem.- V

Physics

DSE1-2 Practical Course

Paper Number – Physics-DSE2-Practical

Paper Code – G04-DSE2-501-P

Credits: 01

Course Preamble

The Physics-DSE2 Practical Course is designed to introduce students to the principles and applications of Artificial Intelligence (AI) through hands-on activities and computational experiments. The course covers fundamental AI techniques such as search algorithms, heuristic optimization, and decision-making models, along with practical exposure to modern AI tools and platforms. Students will explore real-world applications, including problem-solving, automation, and content generation, while also examining ethical issues, data privacy, and future trends in AI. This course enhances computational thinking, digital literacy, and interdisciplinary skills relevant to modern scientific and technological environments.

Course Objectives

1. To understand and implement fundamental AI search algorithms such as DFS, BFS, A*, and heuristic methods.
2. To apply AI techniques for solving optimization and decision-making problems.
3. To explore and utilize AI tools for practical and educational applications.
4. To study ethical, privacy, and security issues associated with Artificial Intelligence.
5. To develop awareness of AI applications, emerging trends, and career opportunities.

Course Outcomes (COs)

CO1: Implement and analyze basic AI search algorithms and problem-solving strategies.

CO2: Apply heuristic methods to solve optimization problems like TSP.

CO3: Use AI tools effectively for academic and real-world tasks.

CO4: Evaluate ethical concerns, data privacy, and security issues in AI systems.

CO5: Understand AI applications, compare AI tools, and identify future career opportunities.

List of Experiments

1. [Perform and visualize Random Search](#)
2. [Search With Open and Closed List](#)



3. [Perform and visualize Depth First Search](#)
4. [Perform and Visualize Breadth First Traversal](#)
5. [Travelling Salesman Problem \(TSP\) Using Heuristic Search](#)
6. [Best First Search](#)
7. [Perform and visualize A* Search](#)
8. [Mini-Max Algorithm](#)
9. Study of Artificial Intelligence Applications in Daily Life.
10. Comparison Study of Types of Artificial Intelligence (Weak AI and Strong AI).
11. Exploration and Study of Common Artificial Intelligence Tools.
12. Basic Interaction with AI Chatbot using ChatGPT.
13. Study of Prompt Writing Techniques and Their Effect on AI Responses.
14. Use of AI Tools for Educational Purposes (Notes, Summaries, and Quiz Generation).
15. Introduction and Feature Study of Google Gemini.
16. Performing Real-World Tasks using AI Tools (Email Writing, Timetable Generation, Report Preparation).
17. Comparative Study between ChatGPT and Google Gemini Based on Performance and Output Quality.
18. Study of Ethical Issues in Artificial Intelligence (Bias, Privacy, Security).
19. Study of Data Privacy and Cybersecurity Awareness in Artificial Intelligence Applications.
20. Study of Future Trends and Career Opportunities in Artificial Intelligence.

Reference Books

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson.
 2. Elaine Rich and Kevin Knight, *Artificial Intelligence*, McGraw-Hill.
 3. Dan W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, PHI.
 4. S. Kaushik, *Artificial Intelligence*, Cengage Learning India.
 5. Ivan Bratko, *Prolog Programming for Artificial Intelligence*, Addison-Wesley.
 6. Michael Negnevitsky, *Artificial Intelligence: A Guide to Intelligent Systems*, Pearson.
 7. Tom Mitchell, *Machine Learning*, McGraw-Hill.
 8. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press.
 9. Margaret A. Boden, *AI: Its Nature and Future*, Oxford University Press.
 10. Online Documentation and User Guides for AI tools (e.g., ChatGPT, Google Gemini, Image-based AI platforms).
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B.Sc. III Sem.- V

Physics

VSC3

Paper Number – Physics-VSC-III; Paper Code – G04-VSC-501

Vocational Skill Course (VSC)

(Hands on Training related to DSE)

Credit: 02

Course Preamble

The Physics VSC5 (Vocational Skill Course) is designed to provide hands-on training in experimental techniques and instrumentation related to materials science and applied physics. This course emphasizes practical skills in sample preparation, thin film characterization, nanomaterial analysis, and measurement of physical properties such as electrical resistivity, thermoelectric power, and optical band gap. Students are also introduced to essential laboratory equipment and data analysis using modern software tools. The course aims to enhance employability by developing technical competencies, analytical skills, and familiarity with real-world laboratory practices relevant to research and industry.

Course Objectives

1. To provide hands-on training in laboratory instruments and experimental techniques.
2. To understand preparation and characterization of thin films and nanomaterials.
3. To measure physical properties such as electrical, thermal, and optical parameters.
4. To develop skills in data analysis and interpretation using software tools.
5. To enhance practical knowledge relevant to research laboratories and industry applications.

Course Outcomes (COs)

CO1: Operate laboratory instruments such as micro-balance, furnace, and distillation units effectively.

CO2: Perform sample preparation and thin film thickness measurements accurately.

CO3: Analyze nanomaterials using SEM/TEM images and XRD data.

CO4: Measure and interpret electrical, thermoelectric, and optical properties of materials.

CO5: Process and analyze experimental data using appropriate software tools.



List of Experiments

1. Study of water distillation plant
2. Study of analytical micro-balance
3. Substrate cleaning process (glass/ stainless steel)
4. Thickness measurement of thin/thick film (gravimetric method)
5. Calculation of size of nanomaterial (SEM/TEM micrographs)
6. Calculation of crystallite size using the Debye–Scherrer equation
7. Measurement of electrical resistivity of materials
8. Measurement of thermoelectric power of materials
9. Measurement of optical band gap using Tauc's relation
10. Data analysis of XRD using software tool
11. Plotting and analysis of experimental data
12. Study of heating furnace

Reference Books

1. Donald A. Neamen, *Semiconductor Physics and Devices*, McGraw-Hill.
 2. Charles Kittel, *Introduction to Solid State Physics*, Wiley.
 3. B. D. Cullity and S. R. Stock, *Elements of X-Ray Diffraction*, Pearson.
 4. S. O. Kasap, *Principles of Electronic Materials and Devices*, McGraw-Hill.
 5. William D. Callister Jr., *Materials Science and Engineering*, Wiley.
 6. John R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. A. J. Dekker, *Solid State Physics*, Macmillan.
 8. User Manuals of SEM, TEM, XRD, and relevant software tools.
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B.Sc. III Sem.- V

Physics

IKS 2

Paper Number – Physics-IKS-II; Paper Code – G04-IKS-501

Indian Knowledge Systems (IKS)

(Physics & Materials Science)

Credits: 02

Course Preamble

This course offers a fascinating exploration into the rich scientific heritage of India, bridging ancient philosophical frameworks with the principles of modern physics and material science. It systematically unpacks how early Indian scholars conceptualized the physical universe, from the fundamental building blocks of matter (*Anu* and *Paramanu*) and the *Panchabhuta* classification system to early understandings of kinematics (*Gati*) and causality. Moving from theoretical physics to applied materials science, the curriculum highlights India's historical mastery over metallurgy, ceramics, and alchemy (*Rasashastra*). By studying legendary achievements such as the corrosion-resistant Iron Pillar of Delhi and the advanced alloy of Wootz steel, students will gain a profound appreciation for traditional technologies and learn how these ancient methodologies continue to hold relevance in contemporary materials engineering.

Course Objectives

The primary objectives of this course are:

- **To introduce ancient frameworks of matter:** Explore the concept of *Dravya* (matter), its properties (*Guna*), and the *Panchabhuta* theory as an early system of material classification.
- **To examine early atomic and measurement theories:** Detail the ancient Indian atomic concepts of *Anu* and *Paramanu*, alongside traditional systems and tools for measuring length, mass, and time.
- **To understand classical Indian kinematics:** Analyze the ancient perspectives on motion (*Gati*), rest (*Sthiti*), and the cause-and-effect relationships governing physical processes.



- **To study historical metallurgical triumphs:** Investigate ancient Indian techniques for extracting and alloying iron, copper, and gold, with a specific focus on the remarkable corrosion resistance of the Iron Pillar of Delhi.
- **To explore advanced ancient alloys and ceramics:** Detail the preparation of Wootz steel and uncover the traditional techniques used in early ceramic and glass-making.
- **To analyze *Rasashastra* as early materials science:** Introduce the foundational processes of *Shodhana* (purification) and *Marana* (calcination) to evaluate the durability and modern relevance of traditional materials.

Course Outcomes (COs)

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

- **CO1 (Foundations of Indian Physics):** Articulate the classical Indian concepts of *Dravya* and *Guna*, and evaluate the *Panchabhuta* theory as a logical precursor to modern material classification.
- **CO2 (Ancient Metrology & Atomic Theory):** Compare the ancient Indian atomic models (*Anu* and *Paramanu*) and historical measurement standards with contemporary physical units and models.
- **CO3 (Kinematics & Causality):** Explain the traditional understanding of motion (*Gati*) and rest (*Sthiti*), and critically compare these ancient physical concepts with modern Newtonian mechanics.
- **CO4 (Archaeometallurgy):** Analyze the chemical and metallurgical properties that contribute to the exceptional durability of historical Indian artifacts, particularly the Iron Pillar of Delhi and Wootz steel blades.
- **CO5 (Traditional Materials Processing):** Describe the methodologies of traditional ceramic making, glass-making, and the specific physicochemical treatments (*Shodhana* and *Marana*) employed in *Rasashastra*.
- **CO6 (Modern Relevance):** Critically evaluate ancient Indian materials science techniques and assess how traditional knowledge can inform or inspire modern sustainable materials engineering.

Unit 1 Concepts of Matter in IKS

(Lectures= 07; Weightage= 11 M)

- 1.1 Concept of Dravya (matter) in Indian knowledge systems
- 1.2 Panchabhuta theory as early material classification
- 1.3 Properties of matter (guna)



1.4 Concept of anu and paramanu (atomic ideas)

Unit 2 Measurement and Motion in IKS

(Lectures= 08; Weightage= 12 M)

- 2.1 Indian units of length, mass, and time
- 2.2 Measurement tools in ancient India
- 2.3 Concept of motion (Gati) and rest (Sthiti)
- 2.4 Cause–effect relation in physical processes
- 2.5 Comparison of ancient and modern physical concepts

Unit 3 Ancient Indian Metallurgy

(Lectures= 07; Weightage= 11 M)

- 3.1 Ancient Indian metallurgy: iron, copper, gold
- 3.2 Iron pillar of Delhi – corrosion resistance
- 3.3 Wootz steel and alloy preparation
- 3.4 Traditional ceramic and glass-making techniques

Unit 4 Materials Science and Technology in Ancient India

(Lectures= 08; Weightage= 12 M)

- 4.1 Rasashastra as early materials science
- 4.2 Purification (Shodhana) and calcination (Marana) processes
- 4.3 Traditional materials and their durability
- 4.4 Relevance of ancient materials to modern materials science

Reference Books

1. Introduction to Indian Knowledge System: Concepts and Applications – B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R. N.
 2. Indian Knowledge System: Integrating Heritage with Engineering – Gagan Bansal
 3. Science and Technology in Ancient India – Debiprasad Chattopadhyaya
 4. The History and Culture of Science in Bhārata – B. C. Chauhan (Ed.)
 5. Ancient Metal Technology and Archaeology of South Asia – D. P. Agrawal
 6. India’s Legendary Wootz Steel: An Advanced Material of the Ancient World – Sharada Srinivasan and Srinivasa Ranganathan
 7. The Rustless Wonder: A Study of the Iron Pillar at Delhi – T. R. Anantharaman
 8. Mathematics in India: 500 BCE–1800 CE – Kim Plofker
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Semester VI



B.Sc. III Sem.- VI

Physics

DSC 1-10

Paper Number – Physics-X; Paper Code – G04-DSC1-0601

Nuclear Physics

Credits: 03

Course Preamble

This course offers a profound journey into the heart of matter, exploring the fundamental constituents and forces that govern the atomic nucleus and the subatomic world. The curriculum begins with the static properties of the nucleus, utilizing frameworks like the liquid drop model to explain binding energy and mass defect. It then transitions into the dynamic realm of nuclear reactions and radioactive decay, unraveling the mysteries of alpha and beta particle emissions. To bridge theory with experimental physics, students will investigate the complex machinery used to probe these microscopic scales, including particle accelerators and radiation detectors. Ultimately, the course scales down to the most fundamental level of reality, introducing the Standard Model of elementary particles and quarks, providing a comprehensive understanding of the universe's ultimate building blocks.

Course Objectives

The primary objectives of this course are:

- **To explore nuclear structure and stability:** Define foundational nuclear properties—such as spin, magnetic moment, and mass defect—and introduce the liquid drop model and semi-empirical mass formula to explain nuclear binding energy.
- **To analyze nuclear dynamics:** Teach the mechanics of nuclear reactions, focusing on calculating Q-values, threshold energies, and understanding the concepts of cross-sections and stripping/pick-up reactions.
- **To study particle accelerators:** Explain the necessity, operational principles, and limitations of high-energy particle accelerators, specifically the Cyclotron and Betatron.
- **To examine radiation detection methods:** Detail the construction, working principles, and internal mechanisms (like self-quenching and dead time) of essential nuclear detectors, including the Geiger-Muller counter, Wilson cloud chamber, and Scintillation counters.



- **To understand nuclear decay processes:** Investigate nuclear energy levels through the lens of alpha and beta decay, highlighting continuous beta spectra and the historical necessity of Pauli's neutrino hypothesis.
- **To introduce high-energy particle physics:** Classify elementary particles, describe the four fundamental interactions of nature, and introduce the quark model.

Course Outcomes (COs)

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

- **CO1 (Nuclear Architecture):** Calculate mass defect, packing fraction, and binding energy for various isotopes, and apply the semi-empirical mass formula to predict nuclear stability.
- **CO2 (Reaction Energetics):** Evaluate nuclear equations to determine the Q-value and threshold energy of specific reactions, differentiating between exoergic and endoergic processes.
- **CO3 (Accelerator Physics):** Articulate the phase stability principles and magnetic/electric field configurations required to accelerate charged particles in Cyclotrons and Betatrons.
- **CO4 (Radiation Instrumentation):** Compare the operational advantages and resolving times of various nuclear detectors, and explain the physical mechanisms of gas ionization and scintillation used to track radiation.
- **CO5 (Decay Mechanisms):** Analyze alpha and beta disintegration energy spectra, using Pauli's neutrino hypothesis to resolve the apparent violation of conservation laws in continuous beta decay.
- **CO6 (Subatomic Classification):** Categorize elementary particles based on their fundamental properties (e.g., mass, spin, interaction type) and describe the quark composition of hadrons and mesons.

Unit 1 Nuclear Structure and Properties

(Lectures= 10; Weightage= 13 M)

- 1.1 Composition of nucleus
- 1.2 Nuclear radius
- 1.3 Nuclear spin
- 1.4 Nuclear magnetic moment
- 1.5 Electric quadrupole moment
- 1.6 Mass defect
- 1.7 Binding energy



- 1.8 Packing fraction
- 1.9 Liquid drop model of nucleus
- 1.10 Semi-empirical mass formula

Unit 2 Nuclear Reactions
(Lectures= 05; Weightage= 12 M)

- 2.1 General scheme of nuclear reactions
- 2.2 Q-value of nuclear reactions
- 2.3 Threshold energy
- 2.4 Cross-section of nuclear reactions (Qualitative)
- 2.5 Stripping reactions
- 2.6 Pick-up reactions

Unit 3 Particle Accelerators
(Lectures= 08; Weightage= 13 M)

- 3.1 Need of accelerator
- 3.2 Cyclotron
- 3.3 Limitations of cyclotron
- 3.4 Phase stable orbit
- 3.5 Betatron

Unit 4 Nuclear Radiation Detectors
(Lectures= 07; Weightage= 13 M)

- 4.1 Classification of detectors
- 4.2 Geiger-Muller counter
 - 4.2.1 Construction and working
 - 4.2.2 Dead time, recovery time and resolving time
 - 4.2.3 Self-quenching mechanism
- 4.3 Wilson cloud chamber
- 4.4 Scintillation counter

Unit 5 Nuclear Energy Levels
(Lectures= 08; Weightage= 12 M)

- 5.1 Alpha decay- α disintegration energy
- 5.2 α particle spectra
- 5.3 Nuclear energy levels
- 5.4 Beta decay- Experimental study of β decay



- 5.5 Continuous β - ray spectrum
- 5.6 Pauli's neutrino hypothesis
- 5.7 Nuclear energy levels from β decay

Unit 6 Elementary Particles
(Lectures= 07; Weightage= 12 M)

- 6.1 Introduction of elementary particles
- 6.2 Types of interactions
- 6.3 Classification of elementary particles
- 6.4 Properties of particles
- 6.5 Introduction of quarks
- 6.6 Different types of quarks

Reference Books:

1. Nuclear Physics: Irving Kaplan (Addison Wesley)
 2. Nuclear Physics: S.N. Ghoshal (S. Chand Publishing Co.)
 3. Nuclear Physics: D.C. Tayal (Himalayan Publishing House)
 4. Nuclear Physics: J.B. Rajam (S. Chand Publishing Co.)
 5. Concepts of Modern Physics: Arthur Beiser (Tata McGraw Hill Publishing)
 6. Atomic and Nuclear Physics: N. Subramanyam & Brijlal (S. Chand Pub. Co.)
 7. Concepts of Nuclear Physics: B.L. Cohen (Tata McGraw Hill Publishing)
 8. Nuclear Physics- an Introduction: W.E. Barcham
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B.Sc. III Sem.- VI

Physics

DSC1-10 Practical Course

Paper Number – Physics-X-Practical Lab-X

Paper Code – G04-DSC1-0601-P

Credits: 02

Course Preamble

The Physics-X Practical Lab (DSC1-10) is designed to provide experimental and analytical understanding of nuclear physics and atomic physics concepts. The course focuses on radiation detection techniques, nuclear properties, and fundamental particle parameters through experiments involving the Geiger-Müller counter, radioactive decay, and energy calculations. Students will gain hands-on experience in determining nuclear parameters such as binding energy, Q-value, decay energy, and charge-to-mass ratio of electrons. This practical course enhances experimental skills, data interpretation, and understanding of nuclear phenomena relevant to modern physics and research applications.

Course Objectives

1. To understand the working and applications of radiation detectors like the Geiger-Müller counter.
2. To study nuclear properties such as binding energy, nuclear radius, and decay processes.
3. To determine parameters related to radioactive decay and particle energy.
4. To calculate important physical quantities like Q-value and cyclotron frequency.
5. To develop experimental skills and data analysis in nuclear and atomic physics.

Course Outcomes (COs)

CO1: Operate and analyze the performance of radiation detectors like GM counter.

CO2: Determine nuclear properties such as binding energy and nuclear radius.

CO3: Analyze radioactive decay processes and calculate particle energies.

CO4: Evaluate physical parameters like Q-value, cyclotron frequency, and charge-to-mass ratio.

CO5: Interpret experimental data and draw meaningful conclusions in nuclear physics experiments.



List of Experiments

1. Estimation of efficiency of GM counter
2. Determination of Beta particle range and maximum energy
3. Plot of binding energy per nucleon curve
4. Verification of nuclear radius relation
5. Q-value of nuclear reaction
6. Cyclotron frequency calculation
7. Alpha decay energy calculation
8. [Geiger Muller counter: To determine the optimum operating voltage and dead time of Geiger Muller tube](#)
9. [Charge to Mass Ratio of Electrons](#)

Reference Books

1. Kenneth S. Krane, *Introductory Nuclear Physics*, Wiley.
 2. S. N. Ghoshal, *Nuclear Physics*, S. Chand.
 3. Irving Kaplan, *Nuclear Physics*, Narosa Publishing.
 4. Arthur Beiser, *Concepts of Modern Physics*, McGraw-Hill.
 5. H. Semat and J. R. Albright, *Introduction to Atomic and Nuclear Physics*, CBS Publishers.
 6. John R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. Laboratory Manuals and Instrumentation Guides for GM Counter and Radiation Detection.
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B.Sc. III Sem.- VI

Physics

DSC 1-11

Paper Number – Physics-XI; Paper Code – G04-DSC1-0602

Electrodynamics

Credits: 03

Course Preamble

This course provides an advanced, mathematically rigorous study of Electrodynamics, bridging the foundational principles of electricity and magnetism with the complex dynamics of electromagnetic wave propagation. Beginning with the analytical treatment of electrostatics via Poisson's and Laplace's equations, the curriculum progresses to the behavior of charged particles in constant and crossed fields. A central focus of the course is the elegant formulation of Maxwell's equations, introducing the critical concept of displacement current to unify time-varying electric and magnetic fields. From this theoretical framework, students will derive the electromagnetic wave equations, exploring how these waves propagate, attenuate, reflect, and refract across different media. The course culminates in the study of retarded potentials and radiation, giving students a complete picture of how accelerating charges generate electromagnetic waves.

Course Objectives

The primary objectives of this course are:

- **To analyze electrostatic fields mathematically:** Apply Coulomb's and Gauss's laws, and utilize Poisson's and Laplace's equations to solve for electric potentials in spherical systems.
- **To study charged particle dynamics:** Investigate the precise motion and trajectories of charged particles subjected to constant electric fields, magnetic fields, and crossed \vec{E} and \vec{B} fields.
- **To understand time-varying fields:** Formulate the integral and differential forms of Faraday's laws of induction, and explore the physical applications of self and mutual inductance.



- **To establish Maxwell's Equations:** Derive the four Maxwell equations, specifically examining the theoretical necessity of the displacement current density to correct Ampere's law for time-dependent fields.
- **To explore Electromagnetic (EM) Waves:** Derive the wave equations in a vacuum to prove the transverse and orthogonal nature of EM waves, and analyze energy conservation using Poynting's theorem.
- **To analyze wave interactions and radiation:** Apply boundary conditions to study wave reflection and refraction at dielectric and conducting interfaces, and model the emission of EM waves using retarded potentials and oscillating electric dipoles.

Course Outcomes (COs)

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

- **CO1 (Electrostatics & Dynamics):** Solve boundary-value problems using Poisson's and Laplace's equations, and mathematically predict the paths of charged particles moving through uniform and orthogonal E^{\rightarrow} and B^{\rightarrow} fields.
- **CO2 (Electromagnetic Induction):** Apply Faraday's and Lenz's laws to time-varying magnetic systems, calculating the electromotive force and inductance in practical devices like solenoids and transformers.
- **CO3 (Maxwell's Formalism):** Derive and interpret the differential forms of Maxwell's equations (such as $\nabla \cdot B^{\rightarrow} = 0$ and $\nabla \times B^{\rightarrow} = \mu_0 J^{\rightarrow}$ incorporating displacement current), validating their physical significance in both vacuum and material media.
- **CO4 (Wave Propagation):** Formulate the wave equation to prove that E^{\rightarrow} , B^{\rightarrow} , and the propagation vector k^{\rightarrow} are mutually orthogonal, and calculate the attenuation (skin depth) of plane EM waves traversing conducting media.
- **CO5 (Boundary Physics):** Utilize electromagnetic boundary conditions to quantify the reflection and refraction of EM waves at the interfaces of two dielectrics or a dielectric and a conductor under normal incidence.
- **CO6 (Radiation Theory):** Apply the concepts of retarded time and retarded potential to derive and explain the radiation fields and power radiated by an electric dipole.

Unit 1 Electrostatics and Charged Particle Dynamics

(Lectures= 08; Weightage= 13 M)

1.1 Coulomb's law

1.2 Gauss law in differential form

1.3 Poisson's and Laplace's equations



- 1.4 Applications of Poisson's and Laplace's equation to spherical systems
- 1.5 Motion of charged particle in constant electric field
- 1.6 Motion of charged particle in constant magnetic field
- 1.7 Motion of charged particle in constant crossed uniform electric and magnetic fields

Unit 2 Time Varying Fields
(Lectures= 07; Weightage= 12 M)

- 2.1 Electromotive force
- 2.2 Electromagnetic induction-Faraday's laws
- 2.3 Lenz's law
- 2.4 Integral & differential forms of Faraday's laws
- 2.5 Self inductance
- 2.6 Application of self-inductance to solenoid
- 2.7 Mutual inductance
- 2.8 Application of mutual inductance to transformer

Unit 3 Maxwell's Equations
(Lectures= 08; Weightage= 13 M)

- 3.1 Magnetic susceptibility and permeability
- 3.2 Biot - Savart law
- 3.3 Derivation of $\nabla \cdot \vec{B} = 0$
- 3.4 Ampere's law
- 3.5 Derivation of $\nabla \times \vec{B} = \mu_0 \vec{J}$ or Differential form of Ampere's law
- 3.6 Equation of continuity
- 3.7 Displacement current density
- 3.8 Maxwell's correction to Ampere's law
- 3.9 Maxwell's equations for time dependent electric and magnetic fields in vacuum
- 3.10 Maxwell's equations for time dependent electric and magnetic fields in material medium
- 3.11 Physical significance (integral form) of Maxwell's Equations

Unit 4 Electromagnetic Waves
(Lectures= 07; Weightage= 12 M)

- 4.1 Conservation of energy in electromagnetic fields and Poynting's theorem
- 4.2 Conservation of momentum in electromagnetic fields
- 4.3 Wave equations for electric and magnetic fields in vacuum
- 4.4 Plane wave solutions, orthogonality of E, B and propagation vector k



4.5 Plane E. M. waves in dielectric

4.6 Plane E. M. waves in conductors, attenuation of wave in metal (skin depth)

Unit 5 Reflection and Refraction of E.M. Waves

(Lectures= 08; Weightage= 13 M)

5.1 Boundary conditions for E. M. field vectors (D, B, E & H)

5.2 Reflection and refraction of E. M. waves at a boundary of two dielectrics
(normal incidence only)

5.3 Reflection from a conducting plane – Normal incidence

5.4 Total internal reflection

Unit 6 Radiation from Electric Dipole

(Lectures= 07; Weightage= 12 M)

6.1 Electric dipole

6.2 Retarded time and retarded potential

6.3 Electric dipole radiation

6.4 Radiation reaction for electric dipole

Reference Books:

1. Introduction to Electrodynamics (second edition) – David J. Griffiths
2. Introduction to Electrodynamics (third edition) – David J. Griffiths
3. Classical Electrodynamics – J. D. Jackson
4. Classical Electrodynamics – S. P. Puri
5. Electrodynamics – B. B. Laud
6. Foundations of Electromagnetic theory – Reitz and Milford



B.Sc. III Sem.- VI

Physics

DSC1-11 Practical Course

Paper Number – Physics-XI-Practical Lab-XI

Paper Code – G04-DSC1-0602-P

Credits: 02

Course Preamble

The Physics-XI Practical Lab (DSC1-11) is designed to provide experimental understanding of electromagnetism, electrical measurements, and magnetic properties of materials. The course emphasizes precise measurement techniques using bridge circuits, inductance and capacitance determination, and analysis of magnetic fields and hysteresis phenomena. Students gain hands-on experience with instruments such as galvanometers, Earth inductors, and Van de Graaff generators. The course also covers AC circuit analysis through LCR circuits and explores magnetic behavior through B-H curves and related effects. This practical training enhances experimental accuracy, analytical skills, and understanding of electrical and magnetic systems.

Course Objectives

1. To study electrical measurement techniques using bridge circuits for resistance, inductance, and capacitance.
2. To analyze magnetic properties such as hysteresis, magnetic fields, and Earth's magnetic components.
3. To understand the working of instruments like galvanometers and electrostatic generators.
4. To investigate AC circuit behavior using series and parallel LCR circuits.
5. To develop experimental skills, precision in measurements, and data analysis techniques.

Course Outcomes (COs)

CO1: Perform accurate measurements of resistance, inductance, and capacitance using bridge methods.

CO2: Analyze magnetic properties including hysteresis and Earth's magnetic field components.

CO3: Operate and understand instruments like tangent galvanometer and Van de Graaff generator.



CO4: Study and interpret behavior of AC circuits using LCR configurations.

CO5: Analyze experimental data, estimate errors, and draw meaningful physical conclusions.

List of Experiments

1. High resistance by leakage method
2. Self-inductance by Owen's bridge
3. Measurement of B_H , B_V and Q using Earth inductor
4. Calibration of bridge wire by Carey Foster's bridge method
5. Absolute capacitance of condenser by BG method
6. Hysteresis (B-H curve)
7. [Tangent Galvanometer](#)
8. [Magnetic Field Along The Axis of A Circular Coil Carrying Current](#)
9. [Deflection Magnetometer](#)
10. [Van De Graaff Generator](#)
11. [Barkhausen Effect](#)
12. [Anderson's Bridge](#)
13. [Quincke's Method](#)
14. [Parallel LCR Circuits](#)
15. [Series LCR Circuits](#)
16. [To draw hysteresis \(B-H curve\) of a specimen in the form of a transformer and to determine its hysteresis loss](#)

Reference Books

1. H. S. Kalsi, *Electronic Instrumentation*, McGraw-Hill.
 2. D. Chattopadhyay and P. C. Rakshit, *Advanced Practical Physics*, New Central Book Agency.
 3. B. L. Theraja and A. K. Theraja, *Electrical Technology*, S. Chand.
 4. J. B. Gupta, *Electrical Measurements and Measuring Instruments*, S. K. Kataria & Sons.
 5. David J. Griffiths, *Introduction to Electrodynamics*, Pearson.
 6. John R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. Standard Laboratory Manuals for Electrical and Magnetic Measurements.
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B.Sc. III Sem.- VI

Physics

DSC 1-12

Paper Number – Physics-XII; Paper Code – G04-DSC1-0603

Atomic Physics, Molecular Physics and Quantum Mechanics

Credits: 03

Course Preamble

This course provides a comprehensive exploration of the microscopic universe, transitioning from the empirical observations of atomic and molecular spectra to the rigorous mathematical framework of Quantum Mechanics. Students will begin by analyzing the fine structure of alkali metals and discovering how atoms behave under the influence of external magnetic and electric fields. The curriculum then scales up to diatomic molecules, exploring rotational, vibrational, and electronic transitions, alongside the classical theory of the Raman effect. In the second half, the course delves into the fundamental postulates of Quantum Mechanics. By establishing the operator formalism and utilizing the Schrödinger wave equation, students will solve classic quantum boundary-value problems—from the particle in a box to the hydrogen atom—unveiling the probabilistic nature of matter at the atomic level.

Course Objectives

The primary objectives of this course are:

- **To analyze atomic spectra:** Review quantum numbers and examine the electronic configurations, spectral notations, and doublet fine structure of alkali metals, with a specific focus on the sodium spectrum.
- **To explore field effects on atoms:** Explain the splitting of atomic spectral lines in external magnetic and electric fields through the anomalous Zeeman, Paschen-Back, and Stark effects using the vector atom model.
- **To study molecular dynamics:** Detail the rotational, vibrational, and electronic spectra of diatomic molecules, introduce the Franck-Condon principle, and explain the characteristic properties of Raman lines.
- **To establish quantum foundations:** Introduce Heisenberg's uncertainty principle, interpret the physical significance of the wave function (ψ), and formulate the time-dependent and time-independent Schrödinger wave equations.



- **To solve quantum boundary problems:** Apply the Schrödinger equation to fundamental 1D and 3D systems, including the particle in a box, step potentials, potential barriers, potential wells, and the linear harmonic oscillator.
- **To develop operator formalism:** Teach the mathematics of quantum operators, expectation values, and angular momentum commutation relations, culminating in the formulation of the Schrödinger equation for the hydrogen atom.

Course Outcomes (COs)

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

- **CO1 (Atomic Transitions):** Determine spectral terms for many-electron atoms and apply strict selection and intensity rules to predict and explain the emission spectra of alkali metals.
- **CO2 (Field Interactions):** Predict the spectral behavior of atoms subjected to external fields, differentiating between the anomalous Zeeman effect, the Paschen-Back effect, and the weak/strong field Stark effects in hydrogen.
- **CO3 (Molecular Spectroscopy):** Differentiate between pure rotational, vibrational, and vibration-rotation spectra, and physically interpret the origins of Rayleigh, Stokes, and Anti-Stokes lines in Raman scattering.
- **CO4 (Wave Mechanics):** Construct the Schrödinger wave equations for various physical systems and extract meaningful physical information by calculating eigenvalues, eigenfunctions, and probability current density.
- **CO5 (Quantum Systems):** Solve the time-independent Schrödinger equation to determine the quantized energy states and zero-point energy of a linear harmonic oscillator, and mathematically describe quantum tunneling through a potential barrier.
- **CO6 (Quantum Operators & Hydrogen Atom):** Evaluate expectation values, prove the commutation relations for angular momentum operators (L_x, L_y, L_z, L^2), and successfully separate the radial and angular components of the hydrogen atom wave equation.

Unit 1 Atomic Spectra (Lectures= 08; Weightage= 13 M)

- 1.1 Review of quantum numbers
- 1.2 Electronic configuration of alkali metals
- 1.3 Spectral notations with examples
- 1.4 Alkali spectra
- 1.5 Doublet fine structure of alkali metals



1.6 Spectrum of sodium

1.7 Selection rules

1.8 Intensity rules

Unit 2 Effects of Magnetic and Electric fields on Atomic Spectra

(Lectures= 07; Weightage= 12 M)

2.1 Anomalous Zeeman effect and its explanation from vector atom model

2.2 Paschen Back effect

2.3 Paschen Back effect in principal series doublet

2.4 Selection rules for Paschen Back effect

2.5 Stark effect of hydrogen

2.6 Weak field Stark effect in hydrogen

2.7 Strong field Stark effect in hydrogen

Unit 3 Molecular Spectra and Raman Effect

(Lectures= 08; Weightage= 13 M)

3.1 Molecular bond

3.2 Rotational energy levels and rotational spectra

3.3 Vibrational energy levels and vibrational spectra

3.4 Vibration-rotation spectra

3.5 Electronic spectra of a diatomic molecule

3.6 Franck-Condon principle

3.7 Raman effect

3.8 Characteristic properties of Raman lines

3.9 Classical theory of Raman effect

Unit 4 Quantum Mechanics

(Lectures= 07; Weightage= 12 M)

4.1 Heisenberg's uncertainty principle (statement) and its similarity with concept of matter waves

4.2 Physical significance of ψ

4.3 Time dependent and time independent Schrödinger wave equations

4.4 Eigen values and eigen functions

4.5 Probability current density



Unit 5 Application of Schrodinger's Time Independent Wave Equation

(Lectures= 08; Weightage= 13 M)

- 5.1 Particle in a box (one- and three-dimensional cases), its eigen values and eigen functions
- 5.2 Step potential
- 5.3 Potential barrier
- 5.4 Potential well
- 5.5 Linear harmonics oscillator – Eigen values and eigen functions
- 5.6 Zero-point energy

Unit 6 Operators

(Lectures= 07; Weightage= 12 M)

- 6.1 Operators in quantum mechanics
- 6.2 Expectation values and properties
- 6.3 Angular momentum operators
- 6.4 Commutation properties for components L_x , L_y , L_z
- 6.5 Commutation for L^2 and L_z operators and their Eigen values
- 6.6 Schrodinger's equation for hydrogen atom
- 6.7 Radial and angular parts of Schrodinger's equation for hydrogen atom

Reference Books:

1. Atomic Spectra – H.E. White
2. Molecular Spectroscopy - Banwell
3. Molecular Spectroscopy – Hertzberg
4. Quantum Mechanics – Mathews and Venkateshan
5. Introduction to Quantum Mechanics - Pauling and Wilson
6. Elements of Quantum Mechanics - Kamal Singh and S.P. Singh.
7. Perspectives of Modern Physics – Arthur Beiser
8. Quantum Mechanics – Chatwal Anand



B.Sc. III Sem.- VI

Physics

DSC1-12 Practical Course

Paper Number – Physics-XII-Practical Lab-XII

Paper Code – G04-DSC1-0603-P

Credits: 02

Course Preamble

The Physics-XII Practical Lab (DSC1-12) is designed to provide experimental and theoretical insights into atomic and quantum physics. This course covers fundamental concepts such as quantum numbers, atomic spectra, and quantum mechanical models, along with important experiments like the photoelectric effect, Franck-Hertz experiment, and Millikan's oil drop experiment. Students explore phenomena such as Zeeman and Stark effects, Raman scattering, and rotational energy levels, bridging the gap between classical and quantum physics. The course enhances understanding of microscopic systems, experimental techniques, and data interpretation relevant to modern physics.

Course Objectives

1. To understand fundamental concepts of atomic structure and quantum mechanics.
2. To study atomic spectra and related phenomena such as Zeeman, Stark, and Raman effects.
3. To perform experiments related to quantum behavior like photoelectric effect and Franck-Hertz experiment.
4. To apply quantum mechanical models such as particle in a box and uncertainty principle.
5. To develop experimental skills and analytical ability in atomic and quantum physics.

Course Outcomes (COs)

CO1: Understand quantum numbers, atomic structure, and electronic configurations.

CO2: Analyze atomic spectra and explain effects like Zeeman, Stark, and Raman.

CO3: Perform and interpret experiments demonstrating quantum phenomena.

CO4: Apply quantum mechanical principles such as uncertainty and energy quantization.

CO5: Analyze experimental data and draw conclusions related to atomic and quantum systems.

List of Experiments

1. Quantum numbers



2. Electronic configuration of alkali metals
3. Hydrogen spectral series
4. Zeeman effect
5. Stark effect
6. Rotational energy levels
7. Raman effect
8. Particle in a box
9. Uncertainty principle
10. Expectation value
11. [Franck-Hertz experiment](#)
12. [Photoelectric effect](#)
13. [Determination of Planck's constant](#)
14. [Abbe's refractometer](#)
15. [Emission spectra](#)
16. [Millikan's oil drop experiment](#)
17. [Zeeman effect](#)

Reference Books

1. H. E. White, *Introduction to Atomic Spectra*, McGraw-Hill.
 2. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, Tata McGraw-Hill.
 3. Arthur Beiser, *Concepts of Modern Physics*, McGraw-Hill.
 4. Eisberg and Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles*, Wiley.
 5. B. H. Bransden and C. J. Joachain, *Quantum Mechanics*, Pearson.
 6. John R. Taylor, *An Introduction to Error Analysis*, University Science Books.
 7. Standard Laboratory Manuals for Atomic and Quantum Physics Experiments.
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B.Sc. III Sem.- VI

Physics

DSE1-3

Paper Number – Physics-DSE3; Paper Code – G04-DSE3-601

Electronics

Credits: 02

Course Preamble

This course provides a vital foundation in analog signal processing and power electronics by focusing on three indispensable components of modern electronic systems: the Operational Amplifier (Op-Amp), the 555 Timer IC, and the Silicon Controlled Rectifier (SCR). The curriculum begins with a deep dive into Op-Amps, exploring their internal architecture and demonstrating their immense versatility in mathematical operations, signal conditioning, and waveform shaping. Transitioning from continuous linear signals to timing and pulse generation, students will study the ubiquitous IC 555, analyzing its fundamental operating modes. Finally, the course enters the realm of power electronics, examining the solid-state physics of the SCR, its high-power switching characteristics, and its practical implementation in industrial control systems. This progression equips students with the essential skills to design and analyze both low-power analog circuits and high-power control systems.

Course Objectives

The primary objectives of this course are:

- **To introduce Operational Amplifiers:** Familiarize students with the internal block diagram, ideal characteristics, and practical parameters of Op-Amps.
- **To explore Op-Amp applications:** Demonstrate how Op-Amps are configured as inverting and non-inverting amplifiers, and how they execute mathematical operations (addition, subtraction, integration, differentiation) and logic functions (comparators, Schmitt triggers).
- **To analyze the 555 Timer:** Explain the functional block diagram, pin connections, and internal architecture of the IC 555 timer.
- **To apply timing circuits:** Detail the operation of the IC 555 in monostable and astable modes, and its use in generating linear ramps, square waves, and voltage-to-frequency conversions.



- **To study semiconductor power devices:** Introduce the construction, working principle, and four-layer (PNPN) physics of the Silicon Controlled Rectifier (SCR).
- **To analyze SCR operation and control:** Examine the V-I characteristics of the SCR, detail its specific turn-on and turn-off (commutation) methods, and explore its application in controlling the speed of DC motors.

Course Outcomes (COs)

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

- **CO1 (Op-Amp Fundamentals):** Define the core parameters of an operational amplifier and differentiate between its ideal and practical operating characteristics.
- **CO2 (Op-Amp Circuit Design):** Design and mathematically analyze analog circuits using Op-Amps to perform specific signal-conditioning operations, such as integration and differentiation.
- **CO3 (Timer Architecture):** Identify the internal components of the IC 555 timer and thoroughly explain the function and utility of each pin.
- **CO4 (Waveform Generation):** Configure the IC 555 timer to operate in monostable and astable modes to design precise pulse generators and frequency converters.
- **CO5 (SCR Physics):** Explain the regenerative latching action within the four-layer PNPN structure of an SCR and describe its physical construction.
- **CO6 (Power Electronics Application):** Interpret the V-I characteristics of an SCR, evaluate proper triggering and commutation techniques, and implement an SCR-based circuit for DC motor speed control.

Unit 1 Operational Amplifier (Lectures= 08; Weightage= 12 M)

- 1.1 Block diagram of Op-Amp
- 1.2 Characteristics of Op-Amp
- 1.3 Op-Amp parameters
- 1.4 Op-Amp as inverting amplifier
- 1.5 Op- Amp as non- inverting amplifier
- 1.6 Applications of Op-Amp
 - 1.6.1 Adder
 - 1.6.2 Subtractor
 - 1.6.3 Differentiator
 - 1.6.4 Integrator



1.6.5 Comparator

1.6.6 Schmitt's trigger

Unit 2 Timer

(Lectures= 07; Weightage= 11 M)

2.1 Functional block diagram of IC 555 and pin configuration

2.2 Operating modes

2.2.1 Monostable

2.2.2 Astable

2.3 Applications of timer IC 555

2.3.1 Linear ramp generator

2.3.2 Square wave generator

2.3.3 Voltage to frequency converter

Unit 3 Power Electronics

(Lectures= 08; Weightage= 12 M)

3.1 Four-layer PNP diode: Construction, working and characteristics

3.2 SCR: Construction, working and characteristics

3.3 Diac: Construction, working and characteristics

3.4 Triac: Construction, working and characteristics

Unit 4 Metal Oxide Semiconductor Field Effect Transistor

(Lectures= 07; Weightage= 11 M)

4.1 Review of JFET

4.2 Metal oxide semiconductor FET (MOSFET)

4.2.1 Schematic symbols and types of MOSFET-a) D-MOSFET and b) E-MOSFET

4.3 D-MOSFET

4.3.1 Circuit operation

4.3.2 Transfer characteristic

4.3.3 Transconductance and input impedance

4.4 E-MOSFET

4.4.1 Circuit operation

4.4.2 Transfer characteristic

4.4.3 Transconductance and input impedance

Reference Books:

1. Electronic Principles – Malvino & Leech



2. Basic Electronic – Grob
 3. Electronic Circuits and Devices – Allan Mottershed
 4. Linear Op-Amp – Ramakanth Gaikwad
 5. Principles of Electronics (Eleventh Edition)– V. K. Mehta (S Chand and Co. Ltd.)
 6. Basic Electronics Solid State – B. L. Thereja. (S Chand and Co. Ltd.)
 7. Electronic Instrumentation – H. S. Kalsi
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B.Sc. III Sem.- VI

Physics

DSE1-3 Practical Course

Paper Number – Physics-DSE3-Practical

Paper Code – G04-DSE3-601-P

Credits: 01

Course Preamble

The Physics-DSE2-1 Practical Course (Electronics Lab) is designed to provide hands-on experience in analog electronics and semiconductor devices. This course focuses on the study and application of operational amplifiers, timer circuits, and semiconductor components such as SCR, Zener diode, and thermistors. Students will construct and analyze electronic circuits, verify theoretical concepts, and understand the practical behavior of devices used in modern electronic systems. The course enhances circuit design skills, measurement techniques, and understanding of electronic instrumentation, preparing students for applications in research, industry, and technology development.

Course Objectives

1. To study the operation and applications of operational amplifiers in various configurations.
2. To understand the working of IC 555 timer in monostable and astable modes.
3. To analyze characteristics of semiconductor devices such as SCR, Zener diode, and thermistor.
4. To design and verify electronic circuits for signal generation and processing.
5. To develop practical skills in circuit construction, measurement, and analysis.

Course Outcomes (COs)

CO1: Construct and analyze Op-Amp circuits such as amplifiers, integrators, and differentiators.

CO2: Understand and implement IC 555 timer circuits for pulse and waveform generation.

CO3: Analyze V-I characteristics of semiconductor devices like SCR, Zener diode, and thermistor.

CO4: Design basic electronic circuits for mathematical operations and signal processing.

CO5: Develop skills in circuit debugging, measurement, and interpretation of experimental results.



List of Experiments

1. Op-Amp as inverting amplifier
2. Op-Amp as non-inverting amplifier
3. Op-Amp applications – Adder and subtractor circuits
4. Op-Amp applications – Integrator and differentiator circuits
5. IC 555 in monostable mode – Measurement of pulse width
6. IC 555 in astable mode – Square wave generation and frequency calculation
7. Characteristics of SCR
8. [Characteristics of Zener diode](#)
9. [Characteristics of thermistor](#)
10. [Zener diode as voltage regulator](#)
11. [Characteristic parameters of Op-Amp](#)
12. [Mathematical operations using Op-Amp](#)
13. [Generation of sawtooth wave using Op-Amp](#)

Reference Books

1. Ramakant A. Gayakwad, *Op-Amps and Linear Integrated Circuits*, Pearson.
 2. Sedra and Smith, *Microelectronic Circuits*, Oxford University Press.
 3. V. K. Mehta and Rohit Mehta, *Principles of Electronics*, S. Chand.
 4. Robert L. Boylestad and Louis Nashelsky, *Electronic Devices and Circuit Theory*, Pearson.
 5. Malvino and Bates, *Electronic Principles*, McGraw-Hill.
 6. H. S. Kalsi, *Electronic Instrumentation*, McGraw-Hill.
 7. Data Sheets and Manuals of IC 741, IC 555, SCR, Zener Diode, and other components.
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B.Sc. III Sem.- VI

Physics

DSE1-4

Paper Number – Physics-DSE4; Paper Code – G04-DSE4-601

Applied Physics for Space Science and ISRO Applications

Credits: 02

Course Preamble

The course Applied Physics for Space Science and ISRO Applications is designed to provide B.Sc. III Physics students with a comprehensive understanding of the application of physics principles in space science and technology. With the remarkable progress of Indian Space Research Organisation, India has emerged as a global leader in space exploration, making this field highly relevant for physics graduates.

This course integrates core physics concepts such as mechanics, electromagnetism, materials science, and energy systems with their applications in rocket propulsion, satellite technology, and space instrumentation. It also introduces students to the space environment and its influence on materials and systems used in spacecraft.

Special emphasis is given to real-world applications including communication systems, navigation, weather forecasting, disaster management, and environmental monitoring. The course highlights important Indian space missions such as Chandrayaan-3 and Mangalyaan, encouraging students to explore research and career opportunities in space science.

Aligned with NEP 2020, this course promotes experiential learning, analytical thinking, and skill development through practical activities, simulations, and case studies.

Course Objectives

1. To introduce the fundamentals of space science and the contributions of Indian Space Research Organisation.
2. To understand the principles governing rocket motion and propulsion systems.
3. To develop knowledge of satellite technology, orbital mechanics, and remote sensing.
4. To study space instrumentation, sensors, and advanced materials used in spacecraft.
5. To explore the applications of space science in communication, navigation, and environmental monitoring.
6. To enhance analytical and computational skills in solving space physics problems.



7. To inspire students towards research, innovation, and careers in space science and technology.

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Describe the fundamentals of space science and the role of Indian Space Research Organisation in space missions.

CO2: Apply physical laws to analyze rocket motion, escape velocity, and orbital parameters.

CO3: Explain the working and classification of satellites along with orbital mechanics (LEO, MEO, GEO).

CO4: Understand space instrumentation, sensors, and material properties under space conditions.

CO5: Analyze applications of space technology in communication systems, GPS, weather forecasting, and disaster management.

CO6: Interpret remote sensing data for applications in agriculture and environmental studies.

CO7: Solve numerical problems and perform basic simulations related to space physics.

CO8: Demonstrate awareness of major Indian space missions such as Chandrayaan-3 and Mangalyaan.

Unit 1 Introduction to Space Science & ISRO

(Lectures= 07; Weightage= 11 M)

- 1.1 Overview of Indian Space Research Organisation
- 1.2 Major milestones (e.g., Chandrayaan-1, Chandrayaan-3, Mangalyaan)
- 1.3 Basics of space physics
- 1.4 Structure of atmosphere and space environment
- 1.5 Applications of physics in space missions

Unit 2 Rocket Physics & Propulsion

(Lectures= 07; Weightage= 11 M)

- 2.1 Newton's laws in rocket motion
- 2.2 Escape velocity and orbital velocity
- 2.3 Rocket propulsion principles
- 2.4 Types of rockets: solid, liquid, cryogenic
- 2.5 Launch vehicles: PSLV and GSLV (overview)
- 2.6 Basic thrust equation



Unit 3 Satellite Technology **(Lectures= 07; Weightage= 11 M)**

- 3.1 Types of satellites: Communication, weather, navigation
- 3.2 Working of artificial satellites
- 3.3 Orbital mechanics (LEO, MEO, GEO)
- 3.4 Satellite subsystems: Power, thermal, communication
- 3.5 Remote sensing basics

Unit 4 Space Instrumentation, Materials and Applications of Space Science **(Lectures= 09; Weightage= 13 M)**

- 4.1 Sensors and detectors used in space
- 4.2 Solar panels and energy systems
- 4.3 Materials used in spacecraft (lightweight, heat-resistant)
- 4.4 Basics of nanomaterials in space
- 4.5 Radiation effects on materials
- 4.6 Communication systems (INSAT, GSAT)
- 4.7 Weather forecasting and disaster management
- 4.8 GPS and navigation systems
- 4.9 Space applications in agriculture and environment

Reference Books

1. <https://www.isro.gov.in/Science.html>
2. <https://www.isro.gov.in/FishingHamlet.html>
3. <https://www.issdc.gov.in/>
4. <https://www.isro.gov.in/SpaceApplications.html>



B.Sc. III Sem.- VI

Physics

DSE1-4 Practical Course

Paper Number – Physics-DSE4-Practical

Paper Code – G04-DSE4-601-P

Credits: 01

Course Preamble

The Physics-DSE2-2 Practical Course (Astrophysics and Space Science Lab) is designed to provide practical exposure to fundamental concepts of astronomy, astrophysics, and space science through simulations, data analysis, and observational techniques. The course integrates computational methods, case studies of space missions, and hands-on activities related to celestial objects, orbital mechanics, and stellar properties. Students gain experience in analyzing astronomical data, understanding satellite motion, and exploring space technology developments. This course enhances analytical, computational, and observational skills, preparing students for careers and higher studies in astrophysics and space science.

Course Objectives

1. To understand orbital mechanics, satellite motion, and space mission concepts.
2. To analyze real-world space missions and remote sensing data.
3. To develop computational skills using software and Python for space-related calculations.
4. To study astronomical objects, constellations, and observational techniques.
5. To enhance understanding of stellar properties and astronomical measurements.

Course Outcomes (COs)

- CO1:** Analyze satellite motion, orbital parameters, and space mission data.
- CO2:** Apply computational tools and programming for solving astrophysical problems.
- CO3:** Identify celestial objects, constellations, and astronomical phenomena.
- CO4:** Interpret astronomical data such as spectra, star coordinates, and distance measurements.
- CO5:** Understand space technology, ISRO missions, and future trends in space science.

List of Experiments

1. Study of satellite orbit simulation (using software)
2. Calculation of escape velocity and orbital period
3. Model making: rocket or satellite



4. Case study on Chandrayaan-3
5. Data analysis from remote sensing images
6. Case study on Mangalyaan
7. Study of PSLV vs GSLV launch vehicles
8. Report on future ISRO missions
9. Python program to calculate escape velocity
10. Poster making on space technology
11. To become familiar with the astronomical objects. [Go For The Experiment](#)
12. To become familiar with the Constellations. [Go For The Experiment](#)
13. To identify the retrograde motion of Mars. [Go For The Experiment](#)
14. To identify spectral lines in the spectrum of sun. [Go For The Experiment](#)
15. To get familiar with the spectra of different stars. [Go For The Experiment](#)
16. To extract coordinates of a star. [Go For The Experiment](#)
17. To measure astronomical distances using Cepheid variables. [Go For The Experiment](#)
18. To measure the Proper Motion of Barnard's Star. [Go For The Experiment](#)
19. To identify a Circumpolar Star. [Go For The Experiment](#)
20. To determine the distance and age of cluster using Colour Magnitude Diagram. [Go For The Experiment](#)
21. To determine Orbital Inclination of the planet Mars. [Go For The Experiment](#)
22. To measure planetary distances [Go For The Experiment](#)
23. To measure distance to the Moon [Go For The Experiment](#)
24. To determine observer's location by means of the stars [Go For The Experiment](#)

Reference Books

1. B. W. Carroll and D. A. Ostlie, *An Introduction to Modern Astrophysics*, Pearson.
 2. H. Karttunen et al., *Fundamental Astronomy*, Springer.
 3. Michael Zeilik and Stephen A. Gregory, *Introductory Astronomy & Astrophysics*, Brooks/Cole.
 4. K. D. Abhyankar, *Astrophysics: Stars and Galaxies*, Universities Press.
 5. Jayant V. Narlikar, *An Introduction to Cosmology*, Cambridge University Press.
 6. Arnold Hanslmeier, *The Sun and Space Weather*, Springer.
 7. ISRO Publications, Reports, and Official Resources on Space Missions.
 8. Software Manuals and Python Documentation for Astronomical Simulations and Data Analysis.
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B.Sc. III Sem.- VI

Physics

VSC6

Paper Number – Physics-VSC-IV; Paper Code – G04-VSC-601

Vocational Skill Course

(Hands on Training related to DSE)

Credit: 2

Course Preamble

The Physics VSC6 (Vocational Skill Course) is designed to provide hands-on training in semiconductor physics, electronic devices, and circuit design. This course focuses on experimental techniques related to semiconductor characterization, thin film preparation, and analysis of electronic components such as diodes, transistors, and FET/MOSFET devices. Students also gain practical experience in digital electronics and circuit design, including logic gates, multivibrators, and regulated power supplies. The course aims to develop technical skills, experimental competence, and problem-solving ability relevant to electronics, materials science, and industry applications.

Course Objectives

1. To study the electrical properties of semiconductor materials using experimental methods.
2. To understand the characteristics and applications of diodes, transistors, and FET/MOSFET devices.
3. To gain practical knowledge of thin film preparation techniques.
4. To design and analyze basic electronic and digital circuits.
5. To develop hands-on skills relevant to electronics and applied physics industries.

Course Outcomes (COs)

CO1: Measure and analyze electrical properties such as resistivity and band gap of semiconductors.

CO2: Study and interpret V–I characteristics of diodes and transistor devices.

CO3: Fabricate and analyze thin films using chemical methods.

CO4: Design and implement digital circuits and timer-based applications.

CO5: Develop practical skills in circuit design, testing, and troubleshooting.

List of Experiments

1. Resistivity and band gap of semiconducting material by four probe method
2. Thin film preparation by any chemical method
3. V–I characteristics of PN junction diode in forward and reverse bias
4. V–I characteristics of Zener diode and voltage regulation
5. Study of BJT characteristics (CE configuration)
6. Study of FET / MOSFET characteristics
7. [Energy band gap of a semiconductor](#)
8. [Generation of clock using NAND and NOR gate](#)
9. [To study the bistable multivibrator using 555 Timer IC](#)
10. [To design a regulated power supply](#)

Reference Books

1. S. O. Kasap, *Principles of Electronic Materials and Devices*, McGraw-Hill.
 2. Donald A. Neamen, *Semiconductor Physics and Devices*, McGraw-Hill.
 3. Robert L. Boylestad and Louis Nashelsky, *Electronic Devices and Circuit Theory*, Pearson.
 4. Sedra and Smith, *Microelectronic Circuits*, Oxford University Press.
 5. V. K. Mehta and Rohit Mehta, *Principles of Electronics*, S. Chand.
 6. Malvino and Bates, *Electronic Principles*, McGraw-Hill.
 7. Data Sheets and Manuals of Semiconductor Devices and ICs (555 Timer, Logic Gates, etc.).
 8. Laboratory Manuals for Electronics and Semiconductor Experiments.
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B.Sc. III Sem.- VI

Physics

FP2/CEP2/OJT1

**Paper Number – Field Project/ Community Engagement Programme/
Field Project (FP)-2/ Community Engagement Program (CEP)-2/
On Job Training (OJT)-1**

Paper Code – G04-FP-601/ G04-CEP-601/ G04-OJT-601

Credit: 2

Class	: B.Sc. III Physics
Credits	2
Total Contact Hours	: 60 hours
Course Type	: Service Learning / Social Engagement
Nature	: Society–Science Interface
Total Marks	50

PREAMBLE:

The Field Project (FP)-2/ Community Engagement Program (CEP)-2/ On Job Training (OJT)-1 course is designed to introduce undergraduate physics students to real-world scientific and technological problems encountered in society through field-based investigations. The course emphasizes the application of physical principles to analyze environmental, energy, and technological issues.

It develops skills in measurement, data collection, instrumentation, analysis, and scientific reasoning by engaging students in real-life situations such as energy auditing, environmental monitoring, acoustics, optics, and applied electronics. This course bridges the gap between theoretical physics and its practical implementation in society, preparing students for higher studies, research, and industry-oriented careers.

Course Objectives – Students will be able to:

- Apply physical principles in real-life field situations.
- Develop experimental, observational, and measurement skills.
- Learn data collection techniques using scientific instruments.
- Understand environmental and technological applications of physics.
- Practice ethical scientific investigation and data handling.



f) Develop technical report writing and presentation skills.

Course Outcomes – After completion, students will be able to:

- CO-1: Conduct structured field investigations using physics concepts.
- CO-2: Collect, organize, and interpret experimental and field data.
- CO-3: Apply measurement techniques and instrumentation effectively.
- CO-4: Analyze data scientifically and correlate with physical laws.
- CO-5: Prepare and present a scientific field project report.

Expected Activities (Examples):

- Energy audit of homes, institutions, or industries
- Study of solar energy systems and efficiency analysis
- Environmental monitoring (air, water, noise pollution measurement)
- Acoustic analysis of auditoriums or public spaces
- Study of electrical energy consumption and conservation methods
- Optical studies (light intensity, illumination in working spaces)
- Weather parameter measurements (temperature, humidity, pressure)
- Any applied physics aspect such as renewable energy, electronics applications, or community-based technology solutions

Report Structure / Format:

Title Page

Certificate

Index

Introduction

Methodology:

Study area description

Instruments used

Experimental procedures

Data collection methods

Results:

Observations

Tables and graphs

Photographic evidence

Data interpretation

Discussion and Conclusion

References



Evaluation Methods:

College Assessment: Attendance and participation, Field diary and observations, and Practical involvement

University Assessment: Report submission, Presentation, and Viva-voce



B.Sc. III Sem.- V and VI

Physics

Pattern of Examination

Pattern of Examination:

For 3 credits (75 Marks)

UA + CA = 45 Marks + 30 Marks = 75 Marks

For 2 credits (50 Marks)

UA + CA = 30 Marks + 20 Marks = 50 Marks

Passing Criteria:

For 3 credits (75 Marks)

UA = 18 out of 45

CA = 12 out of 30

For 2 credits (50 Marks)

UA = 12 out of 30

CA = 08 out of 20

College Assessment (CA) System

For 3 credits (CA = 30 Marks)

Choose any two of the following:

Home Assignment/ Unit Test/ Tutorial/ Seminar/ Field Visit/ Educational Visit/ Project/ Workshop Participation/ Conference Participation/ Vigyan Vidhushi Participation/ Online Course Completion/ Online Internship/ Offline Internship/ Survey Report/ Case Study.

For 2 credits (CA = 20 Marks)

Choose any two of the following:

Home Assignment/ Unit Test/ Tutorial/ Seminar/ Field Visit/ Educational visit/ Project/ Workshop Participation/ Conference Participation



B.Sc. III Sem.- V and VI

Physics

University Assessment

Nature of Question Paper

Credit: 3

Duration: 2 hour

Total Marks: 45

- Instructions: 1) All questions are compulsory.
2) Figure to right indicate full marks.

Q.1 A) Choose correct alternative. (MCQ) 5 Marks

- i) a) b) c) d)
ii) a) b) c) d)
iii) a) b) c) d)
iv) a) b) c) d)
v) a) b) c) d)

Q.1 B) State true or false. 4 Marks

- i)
ii)
iii)
iv)

Q.2 Answer the following (Any Three). 9 Marks

- i)
ii)
iii)
iv)

Q.3 A) Answer the following (Any One). 5 Marks

- i)
ii)

Q.3 B) Answer the following (Any One). 4 Marks

- i)
ii)

Q.4 A) Answer the following (Any One). 5 Marks

- i)
ii)

Q.4 B) Answer the following (Any One). 4 Marks

- i)
ii)

Q.5 Answer the following (Any One). 9 Marks

- i)
ii)



B.Sc. III Sem.- V and VI

Physics

University Assessment

Nature of Question Paper

Credit: 2

Duration: 1.5 hour

Total Marks: 30

- Instructions: 1) All questions are compulsory.
2) Figure to right indicate full marks.

Q.1 Choose correct alternative. (MCQ)

6 Marks

- i) a) b) c) d)
ii) a) b) c) d)
iii) a) b) c) d)
iv) a) b) c) d)
v) a) b) c) d)
vi) a) b) c) d)

Q.2 Answer the following (Any Three).

6 Marks

- i)
ii)
iii)
iv)
v)

Q.3 Answer the following (Any Two).

6 Marks

- i)
ii)
iii)

Q.4 Answer the following (Any Two).

6 Marks

- i)
ii)
iii)

Q.5 Answer the following (Any One).

6 Marks

- i)
ii)