Re-Accredited B++ 2.86 CGPA by NAAC
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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-:પરિપત્ર:-

યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ અને યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓને જણાવવાનું કે, NEP-2020 અંતર્ગત શૈક્ષણિક વર્ષ ૨૦૨૬–૨૭ થી અમલમાં આવનાર 2 Year PG - M.Sc. Physics Sem.-1 & 2 નો પેટાસમિતિ દ્વારા તૈયાર કરવામાં આવેલ અભ્યાસક્રમ ભૌતિકશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૦૫/૦૫/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૦૩ થી ચેરમેનશ્રીને આપેલ સત્તા અંતર્ગત ચેરમેનશ્રીએ અભ્યાસક્રમ અભ્યાસ સમિતિવતી મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાની તા.૦૪/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૩૫ થી મંજૂર કરવા એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૧૮/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૨૩ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

(બિડાણઃઉપર મુજબ)

ક્રમાંકઃઓથો./પરિપત્ર/૧૩૬૫૧/૨૦૨૬
તા.૨૩/૦૬/૨૦૨૬

કુલસચિવ(છ)

પ્રતિ,

(૧) યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ.

(૨) યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓ.
... આપશ્રીના વિભાગ/કોલેજના સંબંધિત શિક્ષકો/વિદ્યાર્થીઓને જાણ કરી અમલ કરવા સારૂ.

(૩) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.

(૪) પરીક્ષા નિયામકશ્રી,પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારૂ.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT.

Syllabus

2 years PG Programme with Course work only

SEM - I

Program: M.Sc. Physics

Effective from: Academic Year: 2026-27

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT PROGRAM TITLE	
Name of Program	Master of Science in Physics (Course-work)
Program Abbreviation	M. Sc. -Physics(Course-work)
Duration	2 years
Eligibility Criteria	B.Sc. (Physics as major subject)
Pre-requisite	Aptitude for Physical Sciences.
Medium of Instruction	English
Objective of Program	**Main objectives are:** ➢ To build strong fundamentals in Physics ➢ To promote scientific thinking and problem-solving ability ➢ To develop laboratory and experimental skills ➢ To encourage research and innovation ➢ To improve employability and professional skills with multiple entry and exit options.
Program Outcome (PO)	**PO-01:** Scientific Knowledge & Conceptual Understanding: Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advance knowledge and problem-solving abilities. **PO-02:** Analytical & Critical Thinking: Apply critical thinking and analytical reasoning to evaluate scientific data, hypotheses and real-world problems, leading to evidence-based conclusions. **PO-03:** Research & Inquiry-based Learning: Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04:** Laboratory & Technical Skills: Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05:** Digital & Computational Literacy: Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving. **PO-06:** Environmental & Societal Responsibility: Understand the role of science in addressing environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07:** Effective Communication & Collaboration: Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08:** Innovation & Entrepreneurship: Foster an entrepreneurial mind-set by applying scientific knowledge for innovation, technology development, and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09:** Lifelong Learning & Professional Growth: Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research, and professional careers. **PO-10:** Ethical Leadership & Value-based Education: Develop leadership qualities, ethical Values, and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives.
Program Specific Outcomes (PSO)	Physics is the core of natural sciences. It explains how the universe works. In general, a M.Sc. (Physics) program holds great importance both academically and professionally. It aims to develop analytical thinking, mathematical skills and problem solving abilities. The program of M.Sc. Physics that includes theory and practical courses has been designed keeping in focus the below mentioned Program Specific Outcomes (PSOs): PSO1. Understanding Core Concepts of Physics: Students shall be able to inculcate in-depth knowledge of core areas of Physics such as classical mechanics, quantum mechanics, electromagnetism, statistical physics, optics, and thermodynamics through theory and practical courses. PSO2. Analytical and Problem-Solving Skills:

Apply the concepts of physics to analyse physical systems, solve problems, and interpret experimental data.

PSO3. Experimental and Laboratory Skills:
Develop the ability to design and conduct physics-based experiments, use scientific instruments, record precise measurements, and analyse results to draw Valid conclusion

PSO4.Computational Proficiency:
Use programming languages and computational tools (such as Python, C+, to model and solve physical problems.

PSO5. Multidisciplinary Skill:
Integrate knowledge from physics with related disciplines like mathematics, chemistry, environmental science, and emerging fields like nanotechnology and materials science.

PSO6.Ethics, Sustainability, and Societal Relevance:
Understand the ethical dimensions and environmental implications of scientific developments and apply physics knowledge for benefit of the society.

PSO7. Career Readiness:
Build the foundation for higher studies and competitive exams like JAM, NET, GATE, TIFR and BARCor employment in education, industry or scientific organizations such as ISRO, DRDO, BARC, CSIR etc.

Mapping between POs and PSOs

Correlation Level: 3 = High Correlation, 2 = Moderate Correlation, 1 = Low Correlation

PO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
PO1	3	3	2	2	2	1	2
PO2	2	3	2	2	1	1	2
PO3	2	3	3	2	1	1	2
PO4	2	2	3	2	1	1	2
PO5	1	2	2	3	2	1	2
PO6	1	1	1	1	2	3	1
PO7	1	2	2	1	2	2	2
PO8	1	2	1	2	2	2	3
PO9	2	2	2	2	2	2	3
PO10	1	1	1	1	2	3	2

Structure of a two-year PG with Course-work only Program (Semester-I) (22 Credits)

Course Category	Course Code	Course Title	Marksheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		TotalMarks	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
Major-1	PH-1001	Mathematical Methods and Solid-State Physics	Mathematical Methods and Solid-State Physics	400-499	2	--	1	--	2	--	25	--	25	--	50	--
	PHP-1001	Practical based on "Mathematical Methods and Solid-State Physics"	Mathematical Methods and Solid-State Physics practical		--	4	--	4	--	2	--	25	--	25	--	50
Major-2	PH-1002	Quantum Mechanics and Statistical Mechanics	Quantum Mechanics and Statistical Mechanics	400-499	2	--	1	--	2	--	25	--	25	--	50	--
	PHP-1002	Practical based on "Quantum Mechanics and Statistical Mechanics"	Quantum Mechanics and Statistical Mechanics practical		--	4	--	4	--	2	--	25	--	25	--	50
Major-3	PH-1003	Analog and Digital Electronics	Analog and Digital Electronics	400-499	2	--	1	--	2	--	25	--	25	--	50	--
	PHP-1003	Practical based on "Analog and Digital Electronics"	Analog and Digital Electronics practical		--	4	--	4	--	2	--	25	--	25	--	50
Major-4	PH-1004	Bhartiya Knowledge System	Bhartiya Knowledge System	400-499	4	--	2	--	4	--	50	--	50	--	100	--
Generic Elective	PH-1005	Elective 1-Physics of Semiconductor Devices **OR** Elective 2-Crystal Growth and Characterization **OR** Elective 3- Numerical Methods **OR** Elective 4-Basic Nuclear Properties and Radioactivity	Elective 1-Physics of Semiconductor Devices **OR** Elective 2-Crystal Growth and Characterization **OR** Elective 3- Numerical Methods **OR** Elective 4-Basic Nuclear Properties and Radioactivity	400-499	4	--	2	--	4	--	50	--	50	--	100	--
Skill Enhancement Course	PH-1006	Measurement and Industrial Instrumentation	Measurement and Industrial Instrumentation	400-499	2	--	1	_	2	_	25	_	25	_	50	_

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester I with Course-work)						
Program Name	M. Sc.					
Semester	I					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	PH-1001					
Course Level	400-499					
Course Title	Mathematical Methods and Solid-State Physics					
Credit	**Theory**	**02**	**Practical:**	**---**	**Total**	**02**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1:** To understand the concepts of vector spaces, basis, and inner products to solve problems in linear algebra. **CO2:** To understand basic operations on matrices including addition, multiplication, transpose, determinant, and inverse. **CO3:** Understanding of linear operators and their matrix representations in physical systems. **CO4:** To understand the concepts of determinants and inverses of matrices **CO5:** To understand the concepts of Fourier transforms and other transform pairs **CO6:** Understanding the concept of Laplace transforms to solve differential equations involving derivatives and integrals. **CO7:** Explain the concept of energy bands and band gap in semiconductor crystals. **CO8:**Analyse charge carrier dynamics using concepts of holes, effective mass, and equation of motion. **CO9:** Differentiate between donor and acceptor impurities and evaluate their role in semiconductor conductivity. **CO10:** Interpret thermal ionization processes and their effect on electrical properties of semiconductors. **CO11:** Describe the properties of semi-metals and advanced structures like superlattices.					
Course Content	**Unit – 1 Mathematical Methods** **Matrices and Vector Spaces:** Vector spaces, Basis vectors; inner product; some useful inequalities (8.1), Linear operators (8.2), Matrices (8.3), Basic matrix algebra (8.4), Matrix addition; multiplication by a scalar; matrix multiplication, Functions of matrices (8.5), The transpose of a matrix (8.6), The determinant of a matrix; Properties of determinants (8.9), The inverse of a matrix (8.10) Eigen Values and eigen vectors (8.13) Determination of Eigen Values and Eigen vectors (8.14) **Integral Transforms:** Fourier transforms: The uncertainty principle; Fraunhofer diffraction; the Dirac δ-function; relation of the δ-function to Fourier transforms; properties of Fourier transforms; odd and even functions (13.1), Laplace transforms, Laplace transforms of derivatives and integrals; other properties of Laplace					

<table>
<tr><td></td><td>Transforms (13.2).
Unit – 2 Solid State Physics
Semiconductor crystals:
Band Gap, Equation of motion: (a) Physical derivation of Force F. (b) Holes. (c) Effective mass (d) Effective masses in Semiconductor, Impurity Conductivity: (a) DonorStates (b) Acceptor States (c) Thermal ionization of donors and acceptors, Semi Metals., Superlattices. (a)Bloch Oscillator (b) Zener Tunnelling.</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table>
<tr><td>COs \ PSOs</td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
<tr><td>CO1</td><td>3</td><td>2</td><td>–</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>–</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO5</td><td>2</td><td>3</td><td>–</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>CO6</td><td>2</td><td>3</td><td>–</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>CO7</td><td>3</td><td>2</td><td>–</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO8</td><td>3</td><td>3</td><td>–</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO9</td><td>3</td><td>2</td><td>–</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO10</td><td>3</td><td>2</td><td>–</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO11</td><td>2</td><td>2</td><td>–</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
</table></td></tr>
<tr><td>Reference Books</td><td>1. Mathematical Methods for Physics and Engineering: K.F.Riley,M.P.Hobson,S.J.Bence,Third Edition Cambridge
2. Introduction to solid State Physics:By Charles kittel. Global Edition.</td></tr>
<tr><td>Teaching Methodology</td><td>Classroom Lecture, Problem Solving, Assignments,Tutorials</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 25 Marks
External Assessment: 25 Marks</td></tr>
</table>

<table>
<tr><td colspan="7">SYLLABUS (Semester 1 with Course-work)</td></tr>
<tr><td>Course Code</td><td colspan="6">PHP-1001</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on “Mathematical Methods and Solid-State Physics”</td></tr>
<tr><td>Course Type</td><td colspan="6">Major</td></tr>
<tr><td>Credit</td><td colspan="6">2</td></tr>
<tr><td>Course Level</td><td colspan="6">6</td></tr>
<tr><td>Teaching Hours/ Week</td><td colspan="6">4 Hours</td></tr>
<tr><td>Teaching Time</td><td colspan="6">15×4= 60 Hours</td></tr>
<tr><td>Credit</td><td>Theory</td><td>---</td><td>Practical:</td><td>02</td><td>Total</td><td>02</td></tr>
<tr><td>Course Outcome</td><td colspan="6">At the end of the course, the students will be able to
CO1: Apply the concepts of vector spaces, basis, and inner products to solve problems in linear algebra.
CO2: Analyze and perform operations on matrices including addition, multiplication, transpose, determinant, and inverse.
CO3: Demonstrate understanding of linear operators and their matrix representations in physical systems.
CO4: Evaluate determinants and inverses of matrices and apply them in solving systems of linear equations and finding eigen values.
CO5: Apply Fourier transforms to analyze functions and physical phenomena such as diffraction and signal behavior.
CO6: Use Laplace transforms to solve differential equations involving derivatives and integrals
CO7: Understand semiconductor properties and electronic behaviour through experiments related to conductivity, band gap determination, and Hall Effect.
CO8: Apply principles of solid-state physics and electronics in the design and analysis of semiconductor devices and regulated power supplies.
CO9: Develop experimental and measurement skills using modern laboratory instruments such as Hall probe setups, power supplies, and semiconductor devices.
CO10:Analyse and interpret experimental data using graphical, mathematical, and statistical methods.
CO11: Promote experiential, skill-oriented, and multidisciplinary learning in accordance with the objectives of NEP 2020.</td></tr>
<tr><td>Course Content</td><td colspan="6">Practical
Unit-1: Solve problems based on
1. Vector space verification
2. Determinant evaluation
3. Determinant equation solving
4. Matrix classification
5. Eigenvalues & eigenvectors
6. Fourier transform and its applications
7. Laplace transform and its applications
8. Solving differential equation using integral transforms.
Unit-2: Experiments:
9. To determine the band gap of a semiconductor using temperature dependence of conductivity.
10. Study of Hall Effect and Carrier Type Identification. (Hall probe setup)</td></tr>
</table>

	11. Design, built and test of zener based voltage regulated power supply. 12. Verification of Effective Mass (Simulation Based) 13. Bloch Oscillation (Simulation method using mathematical tools like Python) 14. **Project** (simulation or working model) based on unit-2 (equivalent to four experiments)
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	2	2	2	1	2
CO2	2	3	2	2	2	1	2
CO3	2	3	3	2	2	1	2
CO4	2	3	3	2	2	1	2
CO5	2	3	2	2	3	1	2
CO6	2	3	2	2	3	1	2
CO7	2	2	3	-	2	1	2
CO8	2	2	3	-	2	1	2
CO9	2	2	3	-	2	1	2
CO10	2	2	3	-	2	1	2
CO11	2	2	3	-	2	1	2

Reference Books	1. Mathematical Methods for Physics and Engineering: K.F.Riley,M.P.Hobson,S.J.Bence ,Third Edition Cambridge 2. Introduction to Solid State Physics: By Charles kittel. Global Edition
Teaching Methodology	Laboratory Work
Evaluation Method	1. Internal Assessment: 25Marks 2. External Assessment: 25 Marks

Instructions:

1. The duration of each experiment is of 2 hours.
2. There should not be more than 10 students per batch as per NEP 2020 guidelines.
3. In the external examination, a student will have to perform one experiment and there will be a Project viva also. The duration of external examination will be of 4 hours.
4. There should be two examiners per batch in the external examination.
5. There should not be more than 10 students per examiner per session in the external Examination.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 1 with Course-work)						
Program Name	M. Sc. Physics					
Semester	I					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	PH-1002					
Course Level	400-499					
Course Title	Quantum Mechanics and Statistical Mechanics					
Credit	**Theory**	**02**	**Practical**	**--**	**Total**	**02**
Effective Form	Academic Year: 2026-27					
Course Outcomes	**CO1** – Understand and explain the fundamental postulates of Quantum Mechanics and their significance in describing the physical state of a system. **CO2**–Apply the concepts of probability density, superposition principle, and operators to describe observables and measurement processes in quantum systems. **CO3**–Analyse the effect of measurement on quantum systems and evaluate expectation values using the formalism of operators and Complete Sets of Commuting Operators (CSCO). **CO4**– Examine the time evolution of quantum states through the Schrödinger equation, wave packets, and time evolution operators, ensuring comprehension of probability conservation. **CO5**– Relate symmetries and conservation laws in quantum mechanics to classical mechanics using unitary transformations, Poisson brackets, commutators, and the Ehrenfest theorem. **CO6**– Apply the concept of the partition function to determine thermodynamic quantities and understand the statistical behaviour of physical systems using the Darwin–Fowler method. **CO7**– Differentiate between classical and quantum regimes by analysing the classical limit of the partition function and recognizing the emergence of singularities associated with phase transitions. **CO8**– Explain magnetic properties of electron gases, including Landau diamagnetism and Pauli Para magnetism, through quantum statistical principles. **CO9**– Explore Boson systems by understanding photon gases, phonons in solids, and the phenomenon of Bose–Einstein condensation, extending to the behaviour of imperfect Bose gases in real systems.					
Course Content	**Unit – 1 Quantum Mechanics** Postulates of Quantum Mechanics: Introduction (3.1), The Basic Postulates of Quantum Mechanics (3.2), The State of a System (3.3), Probability Density (3.3.1) The Superposition Principle (3.3.2), Observables and Operators (3.4), Measurement in Quantum Mechanics (3.5), How Measurements Disturb Systems (3.5.1), Expectation Values (3.5.2), Complete Sets of Commuting Operators (CSCO) (3.5.3), Measurement and the Uncertainty Relations (3.5.4), Time Evolution of the System's State (3.6), Time Evolution Operator (3.6.1),					

<table>
<tr><td></td><td>Stationary States: Time-Independent Potentials (3.6.2), Schrödinger Equation and Wave Packets (3.6.3), The Conservation of Probability (3.6.4), Time Evolution of Expectation Values (3.6.5), Symmetries and Conservation Laws (3.7), Infinitesimal Unitary Transformations (3.7.1), Finite Unitary Transformations (3.7.2), Symmetries and Conservation Laws (3.7.3), Connecting Quantum to Classical Mechanics (3.8), Poisson Brackets and Commutators (3.8.1), The Ehrenfest Theorem (3.8.2), Quantum Mechanics and Classical Mechanics (3.8.3).
Unit – 2 Statistical Mechanics
General Properties of the Partition Function:
The Darwin-Fowler method (9.1), classical limit of the partition function (9.2), singularities and phase transitions (9.3).
Fermi Systems:
The equation of state of an ideal Fermi gas (11.1), the theory of white dwarf stars (11.2), Landau diamagnetism (11.3), Pauli Para magnetism (11.6).
Boson Systems:
Photons (12.1), Photons in solids (12.2), Bose-Einstein condensation (12.3), an imperfect ideal gas (12.4).</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>Mapping Key:
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<tr><td>CO2</td><td>3</td><td>3</td><td>–</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO5</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO6</td><td>2</td><td>3</td><td>–</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>CO7</td><td>2</td><td>3</td><td>–</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>CO8</td><td>2</td><td>2</td><td>–</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>CO9</td><td>2</td><td>2</td><td>–</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
</table></td></tr>
<tr><td>Reference Books</td><td>1. Quantum Mechanics: Concepts and Applications by NouredineZettili, 2nd Ed., A John Wiley and Sons, Ltd. Publication, 2013.
2. Statistical Mechanics by Kerson Huang, 2ndEd.John Wiley and Sons.</td></tr>
<tr><td>Teaching Methodology</td><td>Classroom lectures/Assignments/Problem Solving/Tutorials</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 25 Marks
External Assessment: 25 Marks</td></tr>
</table>

SYLLABUS (Semester 1 with Course-work)

Course Code	PHP-1002					
Course Title	Practical based on "Quantum Mechanics and Statistical Mechanics"					
Course Type	Major					
Credit	2					
Course Level	6					
Teaching Hour/ Week	4 Hours					
Teaching Time	15×4= 60 Hours					
Credit	**Theory**	**---**	**Practical**	**02**	**Total**	**02**
Course Outcome	At the end of the course, the students will be able to **CO1**-Explain the fundamental principles of quantum mechanics, wave functions, operators, observables, and probability interpretation. **CO2-**Solve Schrödinger equation problems for particles in one-dimensional potential wells, harmonic oscillators, and matrix mechanics systems. **CO3-**Analyze quantum states, eigenvalues, Eigen functions, commutators, angular momentum operators, and measurement postulates in quantum systems. **CO4-** Evaluate expectation values, probability densities, current densities, conservation laws, and time evolution of quantum mechanical systems. **CO5–** Apply concepts of Bose-Einstein and Fermi-Dirac statistics to derive thermodynamic quantities such as partition function, equation of state, pair correlation function, and Fermi energy. **CO6**–Develop mathematical and computational skills required for solving advanced problems in quantum mechanics and statistical physics relevant to modern physics research.						
Course Content	**Practical:** 1. A particle of mass m, which moves freely inside an infinite potential well of length a, is initially in the state $\psi(x,0) = \sqrt{\frac{3}{5a}}\sin\frac{3\pi x}{a} + \frac{1}{\sqrt{5a}}\sin\frac{5\pi x}{a}$. (a) Find $\psi(x,t)$ at any later time. (b) Calculate the probability density $\rho(x,t)$ and the current density $\vec{J}(x,t)$ and (c) verify that the probability is conserved, i.e. $\frac{\partial\rho}{\partial t} + \vec{\nabla}\cdot\vec{J}(x,t) = 0$. 2. Consider a one-dimensional particle which is confined within the region $0 \le x \le a$ and whose wave function is $\Psi(x,t) = \sin\left(\frac{\pi x}{a}\right) exp(-i\omega t)$. (a) Find the potential $V(x)$ and (b) calculate the probability of finding the particle in the interval $\frac{a}{4} \le x \le \frac{3a}{4}$. 3. A particle in an infinite potential box with walls at $x = 0$ and $x = a$ (i.e., the potential is infinite for $x < 0$ and $x > a$ and zero in between) has the following wave function at some initial time: $$\psi(x) = \frac{1}{\sqrt{5a}}\sin\frac{\pi x}{a} + \frac{2}{\sqrt{5a}}\sin\frac{3\pi x}{a}$$ (a) Find the possible results of the measurement of the system's energy and the corresponding probabilities. (b) Find the form of the wave function after such a measurement. (c) If the energy is measured again immediately afterwards, what are the relative probabilities of the possible outcomes? 4. Consider a physical system whose Hamiltonian H and initial state $\lfloor\psi_o\rangle$ are given						

by$H = \varepsilon \begin{pmatrix} 0 & i & 0 \\ -i & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$,$\lfloor\psi_o\rangle = \begin{pmatrix} 1-i \\ 1-i \\ 1 \end{pmatrix}$, where ε has the dimensions of energy. (a) What values will we obtain when measuring the energy and with what probabilities? (b) Calculate$\langle\hat{H}\rangle$, the expectation value of the Hamiltonian.

5. Consider a system whose state and two observables are given by

$$\lfloor\psi(t)\rangle = \begin{pmatrix} -1 \\ 2 \\ 1 \end{pmatrix}, A = \frac{1}{\sqrt{2}}\begin{pmatrix} 0\,1\,0 \\ 1\,0\,1 \\ 0\,1\,0 \end{pmatrix}, B = \begin{pmatrix} 1\,0\,0 \\ 0\,0\,0 \\ 0\,0-1 \end{pmatrix}$$

(a) What is the probability that a measurement of A at time t yields-1?
(b) Let us carry out a set of two measurements where $B$is measured first and then, immediately afterwards, A is measured. Find the probability of obtaining a value of 0 for B and value of 1 for$A$.
(c) Now we measure A first then, immediately afterwards,B. Find the probability of obtaininga value of 1 for A and a value of 0 for$B$.
(d) Compare the results of (b) and (c). Explain.
(e) Which among the sets of operatorsandform a complete set of commuting operators (CSCO)?

6. Consider a physical system which has a number of observables that are represented by the following matrices:

$$A = \begin{pmatrix} 5 & 0 & 0 \\ 0 & 1 & 2 \\ 0 & 2 & 1 \end{pmatrix}, B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 3 \\ 0 & 3 & 0 \end{pmatrix}, C = \begin{pmatrix} 0\,3 & 0 \\ 3\,0 & 2 \\ 0\;2 & 0 \end{pmatrix} \; D = \begin{pmatrix} 1 & 0\,0 \\ 0 & 0-i \\ & 0i0 \end{pmatrix}$$

(a) Find the results of the measurements of these observables.
(b) Which among these observables are compatible? Give a basis of eigenvectors common to these observables.
(c) Which among the sets of operators$\{\hat{A}\}, \{\hat{B}\}, \{\hat{C}\}, \{\hat{D}\}$and their various combinations, such as $\{\hat{A}, \hat{B}\}, \{\hat{B}, \hat{C}\}, \{\hat{A}, \hat{C}\}, \{\hat{A}, \hat{D}\}, \{\hat{A}, \hat{B}, \hat{C}\}$form a complete set of commuting operators (CSCO)?

7. (a) Calculate the Poisson bracket between the x and y components of the classical orbital angular momentum.
(b) Calculate the commutator between the x and y components of the orbital angular momentum operator.
(c) Compare the results obtained in (a) and (b).

8. Let$\psi_n(x)$denote the orthonormal stationary states of a system corresponding to the energyE_n. Suppose that the normalized wave function of the system at time $t = 0$is$\psi(x,0)$and supposethat a measurement of the energy yields the value E_1 with probability 1/2, E_2 with probability3/8, and E_3 with probability 1/8. (a) Write the most general expansion for$\psi(x,0)$consistent with this information. (b) What is the expansion for the wave function of the system at time$t$,$\psi(x,t)$? (c) Show that the expectation value of the Hamiltonian does not change with time.

9. Consider the dimensionless harmonic oscillator Hamiltonian
$\hat{H} = \frac{1}{2}\hat{P}^2 + \frac{1}{2}\hat{X}^2$, with $\hat{P} = -i\frac{d}{dx}$. (a) Show that the two wave functions$\psi_o(x) = e^{-x^2/2}$ and $\psi_1(x) = xe^{-x^2/2}$ are eigenfunctions of$\hat{H}$ with eigenvalues 1/2and3/2, respectively.(b) Find the value of the coefficientα
Such that$\psi_2(x) = (1+\alpha x^2)e^{-x^2/2}$ is orthogonal to$\psi_o(x)$. Then show that $\psi_2(x)$Is an eigenfunction of$\hat{H}$ with eigenvalue 5/2?

10. Consider a system whose initial state at $t = 0$ is given in terms of a complete and orthonormalset of three vectors:$\lfloor\phi_1\rangle, \lfloor\phi_2\rangle, \lfloor\phi_3\rangle$as follows:

$$\lfloor\psi(0)\rangle = \frac{1}{\sqrt{3}}\lfloor\phi_1\rangle + A\lfloor\phi_2\rangle + \frac{1}{\sqrt{6}}\lfloor\phi_3\rangle$$

Where A is a real constant. (a) Find A so that$\lfloor\psi(0)\rangle$is normalized. (b) If the energies corresponding to$\lfloor\phi_1\rangle, \lfloor\phi_2\rangle, \lfloor\phi_3\rangle$are given by E_1, E_2, E_3respectively, write

	down the state of the system $|\psi(t)\rangle$ at any later time t. (c) Determine the probability of finding the system at a time t in the state $|\phi_3\rangle$. 11. Derive with the help of the saddle point integration method a formula for the partition function for an ideal Bose gas of N particles. 12. Find the equations of state for an ideal Bose gas and an ideal Fermi gas in The limit of high temperatures. Include the first correction due to quantum effects. 13. Estimate, for each of the following ideal gases, the temperature below which quantum effects would become important: H_2, He, N_2. Pair Correlation Function: 14. Calculate the pair correlation function $D(r_1, r_2)$ For an ideal Bose gas and an ideal Fermi gas in the limit of high temperatures. Include quantum corrections only to the lowest approximation. 15. Give numerical estimates for the Fermi energy of electrons in a typical metal. 16. Give numerical estimates for the Fermi energy of nucleons in a heavy nucleus. 17. Give numerical estimates for the Fermi energy of He^3 atoms in liquid He^3 (atomic volume = 46.2 Å^3/atom). Treat all the mentioned particles as free particles.
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	2	2	2	1	2
CO2	2	3	2	2	2	1	2
CO3	2	3	3	2	2	1	2
CO4	2	3	3	2	2	1	2
CO5	2	3	2	2	2	1	2
CO6	2	3	2	2	3	1	2

Reference Books	1. Quantum Mechanics: Concepts and Applications by NouredineZettili, 2nd Ed., A John Wiley and Sons, Ltd. Publication, 2013. 2. Statistical Mechanics by Kerson Huang, 2ndEd.John Wiley and Sons.
Teaching Methodology	Laboratory Work /Problem Solving
Evaluation Method	Internal Assessment: 25Marks External Assessment: 25 Marks

Instructions:

1. The duration of each experiment is of 2 hours.
2. There should not be more than 10 students per batch as per NEP 2020 guidelines.
3. In the external examination, a student will have to perform two experiment and duration of external examination will be of 4 hours.
4. There should be two examiners per batch in the external examination.
5. There should not be more than 10 students per examiner per session in the external examination

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

<table>
<tr><th colspan="7">SYLLABUS (Semester 1 with Course-work)</th></tr>
<tr><td>Program Name</td><td colspan="6">M. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="6">I</td></tr>
<tr><td>NCrF Credit Level</td><td colspan="6">6</td></tr>
<tr><td>Course Type</td><td colspan="6">Major</td></tr>
<tr><td>Course Subtype</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Subject Type</td><td colspan="6">Physics</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-1003</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Analog and Digital Electronics</td></tr>
<tr><td>Credit</td><td>Theory</td><td>02</td><td>Practical:</td><td>--</td><td>Total</td><td>02</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1–Understand the fundamental concepts of filters.
CO2–Apply the concepts of filters to design filter circuits for various applications.
CO3–Examine Low Pass Filter vs. High Pass Filter – Theory, Design, and Applications.
CO4–Explain the concepts of bandwidth and comparator.
CO5–Solve problems for designing and simulating analog to digital circuits and vice versa.
CO6 –Understand the fundamental concepts of flip-flops.
CO7–Apply the concepts of flip-flops to design logic circuits for various applications.
CO8–Compare various flip-flops with edge trigger.
CO9–Explain the working mechanism for various modules by different counters.
CO10–Solve problems for designing and simulating modulo-counter circuits using flip-flops.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Filters
Introduction, Active filters (8.2), First-order low pass Butterworth filter (8.3), Second order low pass Butterworth filter (8.4), First-order high pass Butterworth filter (8.5) Band pass and band reject filters (8.8, 8.9).
Basic Comparator (9.2), Zero crossing detector (9.3), Schmitt Trigger (9.4), Limitations of OP-AMPS as comparator (9.6), Voltage limiters (9.7), Window detector (9.9), Digital to analog converter with binary weighted resistors and R-2R resistors methods, Analog to digital converter with successive approximation method (9.11).
Unit – 2 Flip-flops and Counters
Flip-flops:
RS flip-flop (8.1), Clocked RS flip-flop (8.2), D flip-flop (8.3), Edge-Triggered D flip-flop (8.4), JK flip-flop (8.5), JK master-slave flip-flop (8.6)

Counters:
Synchronous counter (11.1), Asynchronous counter (11.3), A Mod-5 counter (11.5), Shift counters (11.7), A Mod-10 shift counter with decoding (11.8), Digital clock (11.9).</td></tr>
<tr><td>Mapping between COs and PSOs</td><td colspan="6">Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table><tr><td>COs \ PSOs</td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr></table></td></tr>
</table>

CO1	3	2	–	1	2	2	3
CO2	3	3	–	2	2	2	3
CO3	3	3	–	2	2	2	2
CO4	2	3	–	2	2	2	2
CO5	2	3	–	3	3	2	2
CO6	3	2	–	1	2	3	2
CO7	3	3	–	2	2	2	3
CO8	2	3	–	2	2	2	2
CO9	2	3	–	2	2	2	2
CO10	2	3	–	3	3	2	1

TextBooks	1. Op-Amp and Linear Integrated Circuits by Ramakant Gayakwad, 2nd Ed., PHI Learning Pvt. Ltd. 2. Digital Principles and Applications by A.P. Malvino, D. P. Leach, 4th Ed., Tata McGraw Hill Education Pvt. Ltd.
Reference Books	1. Textbook of Electronics by S. Chattopadhyay, New Central Book Agency Pvt. Ltd.
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 25Marks External Assessment: 25Marks

<table>
<tr><th colspan="7">SYLLABUS (Semester 1 with Course-work)</th></tr>
<tr><td>Course Code</td><td colspan="6">PHP-1003</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on “Mathematical Methods and Solid-State Physics”</td></tr>
<tr><td>Course Type</td><td colspan="6">Major</td></tr>
<tr><td>Credit</td><td colspan="6">2</td></tr>
<tr><td>Course Level</td><td colspan="6">6</td></tr>
<tr><td>Teaching Hours/ Week</td><td colspan="6">4 Hours</td></tr>
<tr><td>Teaching Time</td><td colspan="6">15×4= 60 Hours</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Credit</td><td>Theory</td><td>--</td><td>Practical</td><td>02</td><td>Total</td><td>02</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1– Apply the fundamental concepts of filters.
CO2– Apply the concepts of filters to design filter circuits for various applications.
CO3– Examine Low Pass Filter vs. High Pass Filter – Theory, Design, and Applications.
CO4– Explain the concepts of bandwidth and comparator.
CO5– Solve problems for designing and simulating analog to digital circuits and vice versa.
CO6 – Understand the fundamental concepts of flip-flops.
CO7– Apply the concepts of flip-flops to design logic circuits for various applications.
CO8– Compare various flip-flops with edge trigger.
CO9– Explain the working mechanism for various modules by different counters.
CO10– Solve problems for designing and simulating modulo-counter circuits using flip-flops.</td></tr>
<tr><td>Course Content</td><td colspan="6">Experiments:
1. To design, build and test triangular wave generator using IC-741 op-amp.
2. To design build and test voltage controlled oscillator using IC-566
3. To design build and test active band puss and band reject filter using IC-741 (op-amp)
4. To design build and test adjustable voltage regulator using LM-317
5. To design build and test voltage to current converter using op-amp (IC-741)
6. To design build and test zero crossing detector using op-amp (IC-741)
7. To design build and test voltage follower using op-amp (IC-741)
8. To design build and test AstableMultivibrator using op-amp (IC-741)
9. To design build and test voltage limiter using op-amp IC-741 and Two Zener diodes
10. To design build and test 4-bit binary Adder and Subtract or using IC-7483
11. To design build and test code converters (Binary to gray) and (Gray to Binary) using IC-7486 Ex OR gate.
12. To design build and test D-flip flop with clock using IC-7400 NAND-gate
13. To design build and test JK-flip flop with clock using IC-7400 NAND gate
14. To design build and test 4-bit up/down counters using IC-7493
15. To design build and test De-morgan’s firstand second Theorem using IC-7402 and IC-7400
16. To design and set up a 4-bit R-2R ladder DAC</td></tr>
</table>

Mapping between COs and PSOs	Mapping Key: 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	3	2	2	1	3
CO2	2	3	3	2	2	1	3
CO3	2	3	3	2	2	1	3
CO4	2	3	3	2	2	1	3
CO5	2	3	3	3	3	1	3
CO6	2	3	3	2	2	1	2
CO7	2	3	3	2	2	1	2
CO8	2	3	3	2	2	1	2
CO9	2	3	3	2	2	1	2
CO10	2	3	3	3	3	1	2

TextBooks	1. Op-Amp and Linear Integrated Circuits by Ramakant Gayakwad, 2nd Ed., PHI Learning Pvt. Ltd. 2. Digital Principles and Applications by A.P. Malvino, D. P. Leach, 4th Ed., Tata McGraw Hill Education Pvt. Ltd.
Reference Books	1. Textbook of Electronics by S. Chattopadhyay, New Central Book Agency Pvt. Ltd.
Teaching Methodology	Laboratory Work
Evaluation Method	Internal Assessment: 25 Marks External Assessment: 25Marks

Instructions:

1. The duration of each experiment is of 2 hours.
2. There should not be more than 10 students per batch as per NEP 2020 guidelines.
3. In the external examination, a student will have to perform two experiments
The duration of external examination will be of 4 hours.
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VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT **SYLLABUS (Semester 1 with Course-work)**	
Program Name	M. Sc. Physics

<table>
<tr><td>Semester</td><td colspan="6">I</td></tr>
<tr><td>NCrF Credit Level</td><td colspan="6">6</td></tr>
<tr><td>Course Type</td><td colspan="6">Major Course on Bhartiya Knowledge System (Subject Specific)</td></tr>
<tr><td>Course Subtype</td><td colspan="6">Nil</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-1004</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Bhartiya Knowledge System</td></tr>
<tr><td>Credit</td><td>Theory</td><td>04</td><td>Practical:</td><td>---</td><td>Total</td><td>04</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1- Students will be able to gain insights into the concept of traditional knowledge andits relevance.
CO2-They will also be able to understand and connect up the basics of Indian Traditional knowledge with modern perspective.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Introduction to Indian Knowledge System:
• Meaning and scope of Indian Knowledge System (IKS)
• Ancient Indian education system: Gurukul tradition
• Contribution of ancient Indian scholars in science
• Importance of Indian scientific heritage in modern physics
Unit – 2 Mathematics in Physics from Ancient India:
• Decimal number system
• Concept of zero
• Trigonometry in Indian mathematics
• Applications of ancient mathematics in modern physics
• Contributions of Bhaskara II
Unit – 3 Ancient Indian Technologies and Physical Sciences:
• Metallurgy in ancient India
• Iron Pillar of Delhi and corrosion resistance
• Ancient Indian architecture and acoustics
• Water management systems and hydraulics
• Traditional knowledge of optics and mechanics
Unit – 4 Indian Contributions to Modern Physics:
• Contributions of C. V. Raman and Raman Effect
• Contributions of SatyendraNath Bose and Bose-Einstein Statistics
• Contributions of Homi J. Bhabha
• Contributions of Vikram Sarabhai
• Indian space and nuclear research</td></tr>
<tr><td>Mapping between COs and PSOs</td><td colspan="6">Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Put Books detail</td></tr>
</table>

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1	2	3	-
CO2	2	3	1	1	2	3	-

Reference Books	1. Indian Scientific Heritag 2. History of Indian Astronomy 3. The Wonder That Was India 4. NCERT – Indian Knowledge Systems modules 5. UGC/AICTE IKS course material
Teaching Methodology	Classroom lectures/Assignments/Tutorials
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks

UGC/AICTE IKS course material:

You can access official UGC/AICTE Indian Knowledge System (IKS) course materials and textbooks from the AICTE IKS Division portal:

Official AICTE IKS Portal

AICTE Indian Knowledge Systems Division

This portal includes:

- IKS syllabus frameworks
- Textbooks and course materials
- Faculty development resources
- Curriculum guidelines
- Research and project materials
- NEP 2020 integration resources

Useful IKS Reference DocumentsIKS Guidelines PDF:

Indian Knowledge Systems Guidelines PDF

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester 1 with Course-work)</td></tr>
<tr><td>Program Name</td><td colspan="6">M. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="6">I</td></tr>
<tr><td>NCrF Credit Level</td><td colspan="6">6</td></tr>
<tr><td>Course Type</td><td colspan="6">Generic Elective</td></tr>
<tr><td>Course Subtype</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Subject Type</td><td colspan="6">Physics</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-1005</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Elective 1-Physics of Semiconductor Devices</td></tr>
<tr><td>Credit</td><td>Theory</td><td>04</td><td>Practical:</td><td>---</td><td>Total</td><td>04</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1– After completion of the course, students shall acquire knowledge about core concepts and understanding the physical mechanism of charge carriers in semiconductor physics.
CO2– Students deals traditional as well as the contemporary power device and applications of these devices via thyristors family knowledge.
CO3– In junction diode covers p-n, metal-semiconductor and heterojunctionsdetailed analysis developed to understand the operation of present–day device operation through the knowledge of the physics of semiconductor materials and devices.
CO4– In optical device students have acquired knowledge in photonic devices such that detection, generation and conversion of optical energy to electric energy or vice versa.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Carrier transport phenomena and Thyristors
Carrier transport phenomena: Mobility, Resistivity and Hall Effect, Recombination process, Phonon spectra, optical thermal and high field properties of semiconductor, basic equation for semiconductor device operation, Basic characteristic of three terminal Thyristor Reverse conducting Thyristors, Light activated Thyristor, DIAC and TRIAC, Uni-Junction Transistor and triggering Thyristor.
Unit – 2 Junction Diode
Depletion region and depletion capacitance, Abrupt and linearly graded junctions, Current-Voltage characteristics, Ideal case- Shockley equation, Generation and recombination. Diffusion capacitance, Junction breakdown, Thermal instability, Tunnelling effect, Avalanche multiplication, Terminal function. Metal-Semiconductor Contact, Energy band relation, Schottky effect, Ohmic contact, Heterojunction.
Unit – 3 Bipolar transistor
Bipolar transistors, Static characteristic, Microwave transistors, Cutoff frequency, Microwave characterization, Device geometry and performance, Power transistors, switching transistor. Basic static performance parameters, non-ideal effect, Hetro-Bipolar Junction Transistor.

Unit – 4 Optical Devices
Optical absorption: Photon absorption coefficient, Electron–Hall pair generation, Solar cell: PN Junction solar cell, Conversion efficiency and solar concentration, Heterojunction solar cell, Amorphous silicon solar cell, Photo-detectors, PIN photodiode, Light emitting diode,</td></tr>
</table>

<table>
<tr><td></td><td>Laser diode.</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table>
<tr><td>COs \ PSOs</td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
<tr><td>CO1</td><td>3</td><td>3</td><td>3</td><td>-</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>3</td><td>-</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>3</td><td>-</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>3</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
</table></td></tr>
<tr><td>Text Books</td><td>1. Semiconductor Physics and devices: D.A. Neamen, Tata McGraw-Hill Publishing Company Limited, 2002.
2. Physics of semiconductor devices: S.M. Sze, Wiley-Interscience, 1981.</td></tr>
<tr><td>Reference Books</td><td>1. Solid State Electronic Devices:B.G. Streetman,(3rd Ed.), Prentice-Hall of India Private Limited,1994.
2. Semiconductor Devices: Jasprit Singh, McGraw-Hill Publishing Company Limited, 1994.</td></tr>
<tr><td>Teaching Methodology</td><td>Classroom lectures/Assignments/Problem Solving/Tutorials</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 50 Marks
External Assessment: 50 Marks</td></tr>
</table>

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester 1 with Course-work)

<table>
<tr><td>Program Name</td><td colspan="6">M. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="6">I</td></tr>
<tr><td>NCrF Credit Level</td><td colspan="6">6</td></tr>
<tr><td>Course Type</td><td colspan="6">Generic Elective</td></tr>
<tr><td>Course Subtype</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Subject Type</td><td colspan="6">Physics</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-1005</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Elective 2-Crystal Growth and Characterization</td></tr>
<tr><td>Credit</td><td>Theory</td><td>04</td><td>Practical:</td><td>---</td><td>Total</td><td>04</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1–The development of crystal growth research group will become a focal point for not only academic based research but more broadly the research interests of the technological development.
CO2–How we think about the ways to crystallization impacts how we interpret natural crystallization processes in geochemical and biological environments as well as how we design and control synthetic crystal growth processes.
CO3– The study of different properties plays a major role in developing various applications of such materials grown by different techniques.
CO4– It is very useful for technological development.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Crystal Growth Techniques
Crystal growth, Crystal growth techniques, The chemical physics of crystal growth, Crystal growth from solution techniques, vapour growth techniques, How to start crystal growth, Advantages and disadvantages of crystal growth methods.
Unit – 2 Theory of Crystal Growth
Nucleation, classical theory of nucleation, Gibbs Thomson equation for vapour, Modified Thompson’s equation for melt, Gibbs Thomson equation for solution, Energy of formation of a nucleus, Spherical and cylindrical nucleus, Cap shaped and disc shaped nucleus.
Unit – 3Characterization Tools
Ultraviolet and visible absorption spectroscopy, Infrared spectroscopy, Basic components of infrared spectrophotometers, Fourier transform infrared spectroscopy (FTIR), Fluorescence spectroscopy, Principle and measurement Raman spectrometer, pH meters, Principle of pH measurement.
Unit – 4 Characterization Tools
Optical microscopy and morphological studies of surfaces, Electron Spin resonance spectrometers, Scanning electron microscopy (SEM), Transmission electronmicroscopy (TEM) Atomic force microscopy (AFM) Thermo analytical methods, Thermo-gravimetric metric analysis (TGA), Differential thermal analysis (DTA), Simultaneous thermal analysis/Mass spectrometer.</td></tr>
</table>

Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	2	2	2
CO2	3	3	3	3	1	1	1
CO3	3	3	3	3	1	1	1
CO4	3	3	3	3	1	1	1

Text Books	1. Crystal Growth: P. Ramaswamy and Santhan Raghavan, Kru Publications–Chennai, 2000. 2. Hand book of Analytical Instruments: R.S. Khandpur, Tata McGraw – Hill Professional Electrical Engineering Series (6^{th} Reprint), 2010. 3. Crystal Growth for BeginnersFundamentals of Nucleation, Crystal Growth and Epitaxy: Ivan V. Markov (2^{nd} Ed.), 2003.
Reference Books	1. Crystal Growth Principles and Progress: A.W. Vere,Springer 2. Nucleation and Crystal Growth: Metastability of Solution and Melts. Keshra Sangwal Wiley, 2010. 3. Crystal Growth Concepts, Mechanisms and Applications: Jinjin Li, Jianwei Li and Yanhui Chy, 2017. 4. Crystal Growth: Brain D. Pamplin (2^{nd} Ed.), 1980. 5. Crystals and Crystal Growing: Alan Holder and Phylis Morrison, MIT Press, 1982. 6. Introduction to Crystal Growth: Principles and Practice , H.L. Bhatt, CRC Press, 2014.
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 1 with Course-work)						
Program Name	M. Sc. Physics					
Semester	I					
NCrF Credit Level	6					
Course Type	Generic Elective					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-1005					
Course Level	400-499					
Course Title	Elective 3- Numerical Methods					
Credit	**Theory**	**04**	**Practical:**	**---**	**Total**	**04**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1-** Apply least squares and weighted least squares techniques to fit linear, polynomial, exponential, and nonlinear models to experimental and scientific data. **CO2-** Analyse and evaluate different curve-fitting methods for data modelling, parameter estimation, and error minimization in physical and engineering applications. **CO3-** Construct linear, quadratic, cubic spline, and B-spline interpolants for approximation and smooth representation of discrete data. **CO4-** Analyse the properties, accuracy, and applications of spline and B-spline techniques in interpolation, surface fitting, and least-squares approximation problems. **CO5-** Apply numerical differentiation methods to estimate derivatives, extrema, and error bounds from tabulated data. **CO6-** Employ basic numerical integration techniques such as Trapezoidal, Simpson's, Boole's, and Weddle's rules to evaluate definite integrals and assess their accuracy. **CO7-** Implement advanced numerical integration methods including Romberg integration, Newton–Cotes formulas, Euler–Maclaurin formula, and Gaussian quadrature for accurate numerical computation. **CO8-** Solve complex scientific and engineering problems involving Fourier integrals, double integrals, and variable-step numerical integration techniques using appropriate computational methods.					
Course Content	**Unit – 1 Least Squares** Introduction, Least Squares Curve Fitting Procedures, Fitting a Straight Line, Multiple Linear Least Squares, Linearization of Nonlinear Laws, Curve Fitting by Polynomials, Curve Fitting by a Sum of Exponentials, Weighted Least Squares Approximation, Linear Weighted Least Squares Approximation, NonlinearWeighted Least Squares Approximation. **Unit – 2Spline Functions** Introduction, Linear Splines, Quadratic Splines, Cubic Splines, Minimizing Property of cubic splines, Error in the cubic splines and its derivatives, surface fitting by cubic Splines, Cubic B-splines Representation of B-splines, Least Squares Solution, Application of B-Splines.					

	Unit – 3 Numerical Differentiation and Basic Numerical Integration Introduction, Numerical Differentiation, Errors in Numerical Differentiation, Cubic Splines Method, Differentiation Formulae with Function Values, Maximum and Minimum Values of a Tabulated Function, Numerical Integration, TrapezoidalRule, Simpson's 1/3-Rule, Simpson's 3/8-Rule, Boole's and Weddle's Rule. Use of Cubic Splines **Unit – 4 Advanced Numerical Integration** Romberg Integration, Newton-Cotes Integration Formulae, Euler-Maclaurin Formula, Numerical Integration with Different Step Sizes, GaussianIntegration, Generalized Quadrature, Numerical Calculation of Fourier Integrals,Numerical Double Integration.
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	2	1	3	1	2
CO2	2	3	1	1	3	1	2
CO3	2	3	1	1	3	1	2
CO4	2	3	1	1	3	1	2
CO5	2	3	2	1	3	1	2
CO6	2	3	2	1	3	1	2
CO7	2	3	1	1	3	1	2
CO8	3	3	2	1	3	1	3

Text Books	1.Introductory Methods of Numerical Analysis: S. S. Sastry, PHI, 2012. 2. Numerical methods for Engineers: S.C. Chapra, R.P. Canale, (5^{th} Ed)., McGraw Hill, 2006. 3.Numerical Analysis forScientists and Engineers:Theory and C Programs, Madhumangal Pal, Alpha Science International Ltd., 2007.
Reference Books	1. Numerical Methods for Scientists and Engineers: K. S. Rao, PHI, 2001. 2. Numerical Mathematical Analysis: J. B. Scarborough, Oxford Books Co.,1962.
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester 1 with Course-work)

Program Name	M. Sc. Physics
Semester	I
NCrF Credit Level	6
Course Type	Generic Elective

Course Subtype	Discipline Specific
Subject Type	Physics
Course Code	PH-1005
Course Level	400-499
Course Title	Elective 4-Basic Nuclear Properties and Radioactivity

Credit	**Theory**	**04**	**Practical:**	**---**	**Total**	**04**

Effective Form	Academic Year: **2026-27**
Course Outcomes	**CO1–** The students will learn basic nuclear properties and different methods of their measurements **CO2–** The students will be introduced to the phenomenon radioactivity, types ofradioactive radiations and their properties. They will also learn various applications of radioactivity. **CO3–** The students will have in depth study of α-decay and β- decay processes and theories giving explanation of these decay processes. They will also learn forbidden decays and comparative half-lives. **CO4–** The students will learn the process of γ- emission and basicconservation laws, internal conversion process, γ- ray spectroscopyand Mossbauer effect.

Course Content

Unit – 1 Basic Nuclear Properties

The size of nuclei: the distribution of nuclear charge, the distribution of nuclear matter;mass and abundance of nuclides;nuclear binding energy; nuclear angular momentum; nuclear electromagnetic moments; nuclear excited states

Unit – 2Radioactive Decay

The radioactive decay law; production and decay of radioactivity; growth of daughter activities, series of decays; types of decays: α-decay, β-decay, γ-decay,spontaneous fission, nuclear emission, branching ratios and partial half-lives; natural radioactivity; radioactive dating; units for measuring radiation

Unit – 3Alpha Decay and Beta Decay

Alpha Decay: Why α-decay occurs; basic α-decay processes; α-decay systematics;
theory of α-emission; angular momentum and parity in α-decay; α-decay spectroscopy; Beta Decay: Energy release in β-decay; Fermi theory of β-decay; the classical experimental tests of β-decay: the shape of the β-spectrum, the total decay rate, the mass of the neutrino; angular momentum and parity selection rules: allowed decays, forbidden decays; comparative half-lives and forbidden decays

Unit – 4Gamma Decay

Energetics of gamma decay; classical electromagnetic radiation; angular momentum and parity selection rules; angular distribution and polarization measurements; internal conversion; lifetimes of γ-emission; gamma ray spectroscopy; nuclear resonance fluorescence and the Mossbauer effect.

Mapping between COs and PSOs

Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	3	1	3
CO2	3	3	2	2	3	1	3

	CO3	3	2	2	2	2	1	3
	CO4	3	2	2	2	2	1	3
Text Books	1.Introductory Nuclear Physics: K. Krane, Wiley India Pvt. Ltd. 2.Nuclear Physics by S. N. Ghoshal,S. Chand & Co. Pvt. Ltd., Revised enlarged edition, 2014. 3. Nuclear Physics: D. C. Tayal, Himalaya Publishing House, 2017.							
Reference Books	1. Nuclear Physics: Roy & Nigam, Wiley Eastern Ltd., 1979. 2. Atomic and Nuclear Physics: S. N. Ghoshal, S. Chand & Company, 2019. 3. Nuclear Models: W. Greiner and J.A. Maruhn, Springer, 1996.							
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials							
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks							

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 1 with Course-work)						
Program Name	M. Sc. Physics					
Semester	I					
NCrF Credit Level	6					
Course Type	Skill Enhancement Course					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-1006					
Course Level	400-499					
Course Title	Measurement and Industrial Instrumentation					
Credit	**Theory**	**02**	**Practical:**	**---**	**Total**	**02**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1–**Post completion of the course, student boost their skill for utilization of equipment. **CO2–** Student will acquire basic understanding and concept of measurement **CO3–**Student would know the usage of variousmeasuring instruments.					
Course Content	**Unit – 1 Measurement System and Analysis** The Functional elements of an Instrument, Input Output configuration of measuring instruments and instrument systems. Dynamic characteristic: Generalized mathematical model of measurement system. Operational transfer function. Sinusoidal transfer function. Zero, first and second order instruments, frequency, ramp and step responses of first and second order instruments. **Unit – 2Industrial Instrumentation** Pressure measurement: Dynamics response consideration, Bourdon tube pressure gage. Diaphragm and Bellows gages. Transducer: The variable resistance transducer, The Linear Variable Differential Transformer (LVDT), Capacitive Transducer, Piezoelectric transducer, Photoelectric effect, Photoconductive transducer, Strain gauge transducer. Digital Displacement transducers, Flow measurement: Introduction, Flow obstructions methods, Hot wire and hot film anemometers. Magnetic flowmeters, Laser Doppler anemometer.					
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation					

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	1	1	1	2
CO2	2	2	2	1	1	1	2
CO3	2	2	2	1	1	1	2

Text Books	1. Measurement Systems. O. Dobelin, McGraw Hill. 2. Experimental Methods for Engineers: J.P.Holman (7th Ed) McGraw Hill.
Reference Books	1.Instrumentation, Devices & Systems: C.S.Rangan, G.R.Sharma, V.S.V.Mani, TMH

Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 25Marks External Assessment: 25Marks

Proposed Theory Question Paper for External Exam: Total 25 marks

Q-1.	Compulsory : 5 marks	Weightage is given to entire two units of course content
	Attempt any two of the following	
Q-2.	(a) 5 marks	Weightage is given to first unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-3.	(a) 5 marks	Weightage is given to second unit of course content
	(b) 5 marks	
	(c) 5 marks	

Proposed Theory Question Paperfor External Exam: Total 50 marks

Q-1.	Compulsory : 10 marks	Weightage is given to entire two units of course content
	Attempt any two of the following	
Q-2.	(a) 5 marks	Weightage is given to first unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-3.	(a) 5 marks	Weightage is given to second unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-4.	(a) 5 marks	Weightage is given to third unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-5.	(a) 5 marks	Weightage is given to fourth unit of course content
	(b) 5 marks	
	(c) 5 marks	

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT.

Syllabus

2 years PG Programme with Course work Only

SEM - II

Program:M.Sc. Physics

Effective from: Academic Year: 2026-27

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT PROGRAM TITLE	
Name of Program	Master of Science in Physics (Course-work)
Program Abbreviation	M. Sc. -Physics (Course-work)
Duration	2 years
Eligibility Criteria	B.Sc. (Physics as major subject)
Pre-requisite	Aptitude for Physical Sciences.
Medium of Instruction	English
Objective of Program	**Main objectives are:** ➢ To build strong fundamentals in Physics ➢ To promote scientific thinking and problem-solving ability ➢ To develop laboratory and experimental skills ➢ To encourage research and innovation ➢ To improve employability and professional skills with multiple entry and exit options.
Program Outcome (PO)	**PO-01:** Scientific Knowledge & Conceptual Understanding: Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advance knowledge and problem-solving abilities. **PO-02:** Analytical & Critical Thinking: Apply critical thinking and analytical reasoning to evaluate scientific data, hypotheses and real-world problems, leading to evidence-based conclusions. **PO-03:** Research & Inquiry-based Learning: Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04:** Laboratory & Technical Skills: Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05:** Digital & Computational Literacy: Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving. **PO-06:** Environmental & Societal Responsibility: Understand the role of science in addressing environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07:** Effective Communication & Collaboration: Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08:** Innovation & Entrepreneurship: Foster an entrepreneurial mind-set by applying scientific knowledge for innovation, technology development, and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09:** Lifelong Learning & Professional Growth: Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research, and professional careers. **PO-10:** Ethical Leadership & Value-based Education: Develop leadership qualities, ethical Values, and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives.
Program Specific Outcomes (PSO)	Physics is the core of natural sciences. It explains how the universe works. In general, a M.Sc. (Physics) program holds great importance both academically

	and professionally. It aims to develop analytical thinking, mathematical skills and problem-solving abilities. The program of M.Sc. Physics that includes theory and practical courses has been designed keeping in focus the below mentioned Program Specific Outcomes (PSOs): PSO1. Understanding Core Concepts of Physics: Students shall be able to inculcate in-depth knowledge of core areas of Physics such as classical mechanics, quantum mechanics, electromagnetism, statistical physics, optics, and thermodynamics through theory and practical courses. PSO2. Analytical and Problem-Solving Skills: Apply the concepts of physics to analyse physical systems, solve problems, and interpret experimental data. PSO3. Experimental and Laboratory Skills: Develop the ability to design and conduct physics-based experiments, use scientific instruments, record precise measurements, and analyse results to draw Valid conclusion PSO4.Computational Proficiency: Use programming languages and computational tools (such as Python, C+, to model and solve physical problems. PSO5. Multidisciplinary Skill: Integrate knowledge from physics with related disciplines like mathematics, chemistry, environmental science, and emerging fields like nanotechnology and materials science. PSO6.Ethics, Sustainability, and Societal Relevance: Understand the ethical dimensions and environmental implications of scientific developments and apply physics knowledge for benefit of the society. PSO7. Career Readiness: Build the foundation for higher studies and competitive exams like JAM, NET, GATE, TIFR and BARCor employment in education, industry or scientific organizations such as ISRO, DRDO, BARC, CSIR etc.
Mapping between POs and PSOs	**Correlation Level:** 3 = High Correlation,2 = Moderate Correlation,1 = Low Correlation

PO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
PO1	3	3	2	2	2	1	2
PO2	2	3	2	2	1	1	2
PO3	2	3	3	2	1	1	2
PO4	2	2	3	2	1	1	2
PO5	1	2	2	3	2	1	2
PO6	1	1	1	1	2	3	1
PO7	1	2	2	1	2	2	2
PO8	1	2	1	2	2	2	3
PO9	2	2	2	2	2	2	3
PO10	1	1	1	1	2	3	2

Structure of a two-year PG with Course-work only Program (Semester-2) (22 Credits)

Course Category	Course Code	Course Title	Marksheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		TotalMarks	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
Major-1	PH-2001	Classical Mechanics & Astronomy (IKS)	Classical Mechanics & Astronomy (IKS)	400-499	2	--	1	--	2	--	25	--	25	--	50	--
	PHP-2001	Practical based on "Classical Mechanics & Astronomy (IKS)"	Classical Mechanics & Astronomy (IKS) practical		--	4	--	4	--	2	--	25	--	25	--	50
Major-2	PH-2002	Atomic and Nuclear Physics	Atomic and Nuclear Physics	400-499	2	--	1	--	2	--	25	--	25	--	50	--
	PHP-2002	Practical based on "Atomic and Nuclear Physics"	Atomic and Nuclear Physics practical		--	4	--	4	--	2	--	25	--	25	--	50
Major-3	PH-2003	Classical Electrodynamics	Classical Electrodynamics	400-499	2	--	1	--	2	--	25	--	25	--	50	--
	PHP-2003	Practical based on "Classical Electrodynamics"	Classical Electrodynamics practical		--	4	--	4	--	2	--	25	--	25	--	50
Vocational Course	PH-2004	Python Programming and Computational Physics	Python Programming and Computational Physics	400-499	2	--	1	--	2	--	25	--	25	--	50	--
	PHP-2004	Practical based on Python Programming and Computational Physics	Python Programming and Computational Physics practical	400-499	--	4	--	4	--	2	--	25	--	25	--	50
Generic Elective	PH-2005	Elective 1- Electronic Communication **OR** Elective 2- Thin Film Technology and Non-Destructive Testing **OR** Elective 3: Numerical Techniques **OR** Elective 4- Nuclear and Particle Physics	Elective 1- Electronic Communication **OR** Elective 2- Thin Film Technology and Non-Destructive Testing **OR** Elective 3: Numerical Techniques **OR** Elective 4- Nuclear and Particle Physics	400-499	4	--	2	--	4	--	50	--	50	--	100	--
Skill Enhancement Course	PH-2006	Electronic and Biomedical Instrumentation	Electronic and Biomedical Instrumentation	400-499	2	--	1	_	2	_	25	_	25	_	50	_

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)						
Program Name	M. Sc.					
Semester	II					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-2001					
Course Level	400-499					
Course Title	Classical Mechanics & Astronomy (IKS)					
Credit	**Theory**	**02**	**Practical:**	**-**	**Total**	**02**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1**–To study formulation of Hamiltonian Mechanics. **CO2**–Understand cyclic coordinates, conservation theorems and Routh's procedure for reducing equations of motion. **CO3**–Study Canonical Transformations and its invariants. **CO4**–Examine angular momentum and Poisson bracket relations. **CO5-**Explain the unique aspects of Indian astronomy and its contributions to world astronomy. **CO6-**Trace the historical development of astronomy in India and its key milestones. **CO7**-Understand and apply the celestial coordinate system for locating astronomical objects. , the elements of the Indian calendar and their scientific basis. **CO8-**Analyze the Āryabhaṭīya and Siddhāntic traditions to appreciate their mathematical and astronomical insights, Interpret the Pañcāṅga (Indian calendar system) and its applications in daily and cultural practices.					
Course Content	**Unit-1 (Classical Mechanics)** **<u>The Hamiltonian Equations of </u>motion** Legendre transformations and Hamiltonian equations of motion (8.1), Examples, Cyclic coordinates and conservation theorem (8.2), Routh's procedure and modified Hamiltonian principles (8.3) **<u>Canonical Transformations:</u>** Equation of canonical transformations (9.1), Examples, The harmonic oscillator (9.3), The integral invariance of poincare, Lagrange and Poisson brackets (9.5), Equation of Motion, Infinitesimal canonical transformation, constant of motion and symmetry properties (9.6), angular momentum Poisson brackets (9.7) **Unit-2 Astronomy (IKS)** Unique Aspects of Indian Astronomy (9.1), Historical Development of Astronomy in India (9.2), The Celestial Coordinate System (9.3), Elements of Indian Calendar (9.4), Āryabhatīya and Siddhāntic Tradition (9.5), Pañcāṅga-The Indian Calendar System (9.6), Astronomical Instruments (Yantras) (9.7), Jantar Mantar of Raja Jai Singh Sawai (9.8).					

Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	2	1	2
CO2	3	3	2	2	2	1	2
CO3	3	3	2	1	2	1	2
CO4	3	3	2	2	3	1	2
CO5	2	1	–	–	3	2	1
CO6	2	1	–	–	2	2	1
CO7	3	2	1	1	3	2	2
CO8	3	2	–	1	3	2	2

Reference Books	1. Classical Mechanics (3rd Ed.) by Goldstein, Poole & Safco, Pearson Education (2002). 2. Introduction to Indian Knowledge System Concepts and Applications. By B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R. N.
Teaching Methodology	Classroom Lecture, Problem Solving, Assignments, Tutorials
Evaluation Method	Internal Assessment: 25 Marks External Assessment: 25 Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)	
Course Code	PHP-2001
Course Title	Practicals based on "**Classical Mechanics & Astronomy (IKS)**"
Course Type	Major
Credit	2
Course Level	6
Teaching Hours/ Week	4 Hours
Teaching Time	15×4= 60 Hours
Course Outcome	**CO1**–To study formulation of Hamiltonian Mechanics. **CO2**–Understand cyclic coordinates, conservation theorems and Routh's procedure for reducing equations of motion. **CO3**–Study Canonical Transformations and its invariants. CO4 –Examine angular momentum and Poisson bracket relations. **CO5-** Explain the unique aspects of Indian astronomy and its contributions to world astronomy. **CO6-**Trace the historical development of astronomy in India and its key milestones. **CO7-**Understand and apply the celestial coordinate system for locating astronomical objects. , the elements of the Indian calendar and their scientific basis. **CO8** -Analyze the Āryabhaṭīya and Siddhāntic traditions to appreciate their mathematical and astronomical insights, Interpret the Pañcāṅga (Indian calendar system) and its applications in daily and cultural practices.
Course Content	**List of Experiments** 1. To measure period of oscillation of pendulum by changing angle and length using variable 'g' pendulum setup. 2. To determine the range of projectile as a function of the angle of inclination using Projectile Motion experiment setup. 3. To study damping effect in various media. 4. To study the elastic and inelastic collision using Linear Air Track with digital timer setup. 5. Determination of momentum of inertia of the gyroscope by measurement of angular acceleration. **Solve the problems:** 6. To study rolling motion on an inclined plane 7. Find the relationship between Poisons bracket and Langrange bracket. 8. Prove with appropriate example that the form and conservation of Hamiltonian depend on choice of generalized coordinates. 9. Find the Hamiltonian for a given system and use of canonical equation for that. 10. Show whether given transformations are canonical or not.

	11: **Project based on unit-2** (Indian Knowledge System- equivalent to four experiments)
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	2	--	2
CO2	3	3	2	2	2	--	2
CO3	3	3	2	1	2	--	2
CO4	3	3	2	2	3	1	2
CO5	2	1	--	--	3	2	1
CO6	2	1	--	--	3	2	2
CO7	3	2	1	1	3	2	2
CO8	3	2	--	1	3	2	2

Reference Books	1.Classical Mechanics (3^{rd} Ed.) by Goldstein, Poole & Safco, Pearson Education (2002). 2. Introduction to Indian Knowledge System Concepts and Applications. By B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R. N. 3. Classical Mechanics By N.C. Rana and P.S. JoagPub.McGraw Hill Education (India) / Tata McGraw-Hill Edition: 1991 4 Classical Mechanics By N.C. Rana and P.S. JoagPub.McGraw Hill Education (India) / Tata McGraw-Hill Edition: 1991.
Teaching Methodology	Laboratory Work
Evaluation Method	1. Internal Assessment: 25Marks 2. External Assessment: 25 Marks

Instructions:

1. The duration of each experiment is of 2 hours.
2. There should not be more than 10 students per batch as per NEP 2020 guidelines.
3. In the external examination, a student will have to perform one experiment and therewill be a Project viva also. The duration of external examination will be of 4 hours.
4. There should be two examiners per batch in the external examination.
5. There should not be more than 10 students per examiner per session in the external Examination

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)						
Program Name	M. Sc. Physics					
Semester	II					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	PH-2002					
Course Level	400-499					
Course Title	Atomic and Nuclear Physics					
Credit	**Theory**	**02**	**Practical**		**Total**	**02**
Effective Form	Academic Year: 2026-27					
Course Outcomes	**CO1 -** Understand molecular bonding concepts: Students will be able to explain the formation of molecular bonds through electron sharing, analyze the structure of simple systems such as the H_2^+ molecular ion and hydrogen molecule, and evaluate the factors affecting molecular system energy. **CO2 -**Analyze bonding in complex molecules: Students will be able to describe bonding in complex molecules, interpret different types of molecular bonds, and explain the role of hybrid orbitals in determining molecular geometry and stability. **CO3 -** Interpret molecular rotational and vibrational behavior: Students will be able to derive and interpret rotational and vibrational energy levels, and analyze rotational spectra, vibrational spectra, and vibrational–rotational spectra of molecules. **CO4 -**Explain molecular electronic transitions and optical phenomena: Students will be able to interpret electronic spectra of molecules and explain radiative processes such as Fluorescence and Phosphorescence, including the mechanisms responsible for these emissions. **CO5 -** Apply spectroscopic principles to molecular analysis: Students will be able to explain and analyze the Raman effect, compare it with infrared spectroscopy, and use spectroscopic techniques to infer molecular structure and energy transitions. **CO6 -**Understand the basic principles and purpose of particle accelerators used in nuclear and high-energy physics. **CO7 -**Explain how electric and magnetic fields accelerate and control charged particles based on the Lorentz force. **CO8 -**Explain how voltage multiplication is used to accelerate charged particles in early electrostatic accelerators. **CO9 -**Explain the design and operation of a Linear particle accelerator using alternating electric fields. **CO10 -**Understand the basic principles and need for radiation detection and measurement in nuclear and particle physics. **CO11 -**Explain the interaction of ionizing radiation with matter and its role in detector operation.					

<table>
<tr><td>Course Content</td><td>Unit – 1 Atomic Physics
Vector Atom Model
The Molecular Bond (8.1), Electron Sharing (8.2), The H_2^+Molecular Ion (8.3), System energy (8.3.1), The Hydrogen Molecule (8.4), Complex Molecules (8.5), Molecular bonds (8.5.1), Hybrid orbitals (8.5.2), Rotational Energy Levels (8.6), Rotational spectra (8.6.1), Vibrational Energy Levels (8.7), VibrationalSpectra (8.7.1), Vibrational-Rotational spectra (8.7.2), Electronic Spectra of Molecules (8.8), Fluorescence (8.8.1), Phosphorescence (8.8,2), Raman effect (8.9).
Unit – 2 Nuclear Physics
Particle Accelerators:
Introduction (6.1), Cockcroft and Walton Accelerator (6.2), Van de Graaff Accelerator (6.3), Tandem Accelerator (6.4), Linear Accelerator (LINAC) or Drift Tube Accelerator (6.5), Wave-Guide Accelerators (6.6), Magnetic Resonance Accelerators or Cyclotrons (6.7), Betatron (6.8).
Radiation Detectors:
Introduction (7.1), Gas-Filled Detectors (7.2), Ionization Chamber (7.3), Proportional Counters (7.4), Geiger–Müller (GM) Counters (7.5), Scintillation Detectors (7.6), Semiconductor Radiation Detectors (7.7), Cloud Chamber (7.8).</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table>
<tr><td>COs \ PSOs</td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
<tr><td>CO1</td><td>3</td><td>3</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>2</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO5</td><td>3</td><td>3</td><td>2</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO6</td><td>3</td><td>2</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO7</td><td>3</td><td>3</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO8</td><td>3</td><td>2</td><td>1</td><td>1</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO9</td><td>3</td><td>3</td><td>1</td><td>1</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO10</td><td>3</td><td>2</td><td>3</td><td>1</td><td>2</td><td>2</td><td>3</td></tr>
<tr><td>CO11</td><td>3</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>3</td></tr>
</table></td></tr>
<tr><td>Reference Books</td><td>1. Text Book: Concepts of Modern Physics by Arthur Beiser,Shobhit Mahajan and S Rai Choudhri, McGraw Hill Publishing Co. Ltd. New Delhi, 7th Ed.
2. Atomic Physics by S. N. Ghoshal
3. Atomic and Nuclear Physics by A. B. Gupta and Dipak Ghosh, 2nd Ed., Books and Allied (P) Ltd. Calcutta, 2001
4. Nuclear Physics by S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged Ed., 2014.
5. Introduction to Nuclear and Particle Physics by V. K. Mittal, R. C. Verma and S. C. Gupta, 3rd Ed., 2013
6. Nuclear Physics by D. C. Tayal, Himalaya Publishing House, 2017.</td></tr>
<tr><td>Teaching Methodology</td><td>Classroom lectures/Assignments/Problem Solving/Tutorials</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 25 Marks
External Assessment: 25 Marks</td></tr>
</table>

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)	
Course Code	PHP-2002
Course Title	Practical based on “Atomic and Nuclear Physics”
Course Type	Major
Credit	2
Course Level	6
Teaching Hour/ Week	4 Hours
Teaching Time	15×4= 60 Hours
Course Outcome	**CO1 -** Understand molecular bonding concepts: Students will be able to explain the formation of molecular bonds through electron sharing, analyze the structure of simple systems such as the H_2^+ molecular ion and hydrogen molecule, and evaluate the factors affecting molecular system energy. **CO2 -**Analyze bonding in complex molecules: Students will be able to describe bonding in complex molecules, interpret different types of molecular bonds, and explain the role of hybrid orbitals in determining molecular geometry and stability. **CO3 -** Interpret molecular rotational and vibrational behavior: Students will be able to derive and interpret rotational and vibrational energy levels, and analyze rotational spectra, vibrational spectra, and vibrational–rotational spectra of molecules. **CO4 -**Explain molecular electronic transitions and optical phenomena: Students will be able to interpret electronic spectra of molecules and explain radiative processes such as Fluorescence and Phosphorescence, including the mechanisms responsible for these emissions. **CO5 -** Apply spectroscopic principles to molecular analysis: Students will be able to explain and analyze the Raman effect, compare it with infrared spectroscopy, and use spectroscopic techniques to infer molecular structure and energy transitions. **CO6 -**Understand the basic principles and purpose of particle accelerators used in nuclear and high-energy physics. **CO7 -**Explain how electric and magnetic fields accelerate and control charged particles based on the Lorentz force. **CO8 -**Explain how voltage multiplication is used to accelerate charged particles in early electrostatic accelerators. **CO9 -**Explain the design and operation of a Linear particle accelerator using alternating electric fields. **CO10 -**Understand the basic principles and need for radiation detection and measurement in nuclear and particle physics. **CO11 -**Explain the interaction of ionizing radiation with matter and its role in detector operation.

Course Content	**List of Experiments** 1. Use ball-and-stick molecular models to construct molecules such as H_2, O_2, CO_2. 2. Study bond length, bond angle, and molecular geometry. 3. Construct molecules showing shared electron pairs (H_2, CH_4, NH_3). 4. use computational tools to visualize molecular orbitals of H_2^+ and use computational tools to visualize molecular orbitals of H_2^+. 5. Plot energy vs. inter-nuclear distance using theoretical data and Determine equilibrium bond distance and minimum energy. 6. Construct bonding and antibonding molecular orbitals and understand molecular orbital theory for the hydrogen molecule. 7. build models showing sp hybridization ($BeCl_2$), sp^2 hybridization (BF_3) and sp^3 hybridization (CH_4) 8. analyze rotational energy levels of diatomic molecules and Study quantized rotational energy levels. 9. observe vibrational absorption bands of molecules and Verify quantized vibrational energy levels. 10. Study deflection of an electron beam in a cathode ray tube using electric and magnetic fields and understand the basic principle behind acceleration and control of charged particles. 11. Use simulation software to demonstrate ion acceleration in two stages. 12. Use a mechanical or electrical model showing particles passing through sequential drift tubes. 13. Project Work (Equivalent to four experiments)
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	2	1	2
CO2	3	2	3	1	2	1	2
CO3	3	3	3	2	2	1	2
CO4	3	2	2	1	2	1	2
CO5	3	3	2	1	2	1	2
CO6	3	2	2	1	1	2	2
CO7	3	3	3	1	1	1	2
CO8	3	2	2	2	1	1	2
CO9	3	3	3	2	1	1	3
CO10	3	2	2	1	1	2	2
CO11	2	3	2	1	1	2	2

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Teaching Methodology	Laboratory Work /Problem Solving
Evaluation Method	Internal Assessment: 25Marks External Assessment: 25 Marks

Instructions:

1. The duration of each experiment is of 2 hours.
2. There should not be more than 10 students per batch as per NEP 2020 guidelines.
3. In the external examination, a student will have to perform two experiment and duration of external examination will be of 4 hours.
4. There should be two examiners per batch in the external examination.
5. There should not be more than 10 students per examiner per session in the external examination

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)						
Program Name	M. Sc. Physics					
Semester	II					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-2003					
Course Level	400-499					
Course Title	Classical Electrodynamics					
Credit	**Theory**	**02**	**Practical:**	**-**	**Total**	**02**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1–** Understandelectrostatic potential concepts – Explain the physical meaning of potential, its relationship with the electric field, and analyze Poisson's and Laplace's equations for different charge distributions and boundary conditions. **CO2–** Applymathematical techniques to potential problems – Solve electrostatic problems using Poisson's and Laplace's equations under given boundary conditions and understand the potential of localized charge distributions. **CO3–** Analyzemultipole expansions – Approximate potentials at large distances and distinguish between monopole and dipole terms; evaluate the role of coordinate origin in multipole expansions and derive the electric field of a dipole. **CO4–** Comprehendscalar and vector potentials in electrodynamics – Formulate the relationship between electric and magnetic fields using scalar and vector potentials, and apply gauge transformations including Coulomb and Lorenz gauges. **CO5–** Examinetime-dependent potentials and moving charge systems – Derive and interpret retarded potentials and Liénard–Wiechert potentials for moving charges, explaining their significance in electromagnetic radiation and relativistic electrodynamics. **CO6–** Understandthe fundamentals of wave motion – Explain the one-dimensional wave equation, characteristics of sinusoidal waves, and the effects of boundary conditions such as reflection, transmission, and polarization. **CO7–** Analyzeelectromagnetic wave propagation in vacuum – Derive and interpret the wave equations for electric and magnetic fields, study monochromatic plane waves, and evaluate the energy and momentum carried by electromagnetic waves. **CO8–** Examineelectromagnetic wave behavior in different media – Understand how waves propagate in linear media and apply boundary conditions to determine reflection and transmission at normal and oblique incidences. **CO9–**Investigatethe effects of material properties on wave propagation – Analyze how absorption and dispersion occur in conductors and dielectric materials, and study reflection phenomena at conducting surfaces.					

CO10– Explorefrequency-dependent electromagnetic responses – Explain how the permittivity of materials varies with frequency and its implications for wave propagation, absorption, and transmission in real-world materials and applications.

Course Content

Unit – 1 Electric Potential and Multipole Expansion

Introduction to Potential (2.3.1), Comments on Potential (2.3.2), Poisson's Equation and Laplace's Equation (2.3.3), The Potential of a Localized Charge Distribution (2.3.4), Boundary Conditions (2.3.5)

Approximate Potentials at Large Distances (3.4.1), The Monopole and Dipole Terms (3.4.2), Origin of Coordinates in Multipole Expansions (3.4.3), The Electric Field of a Dipole (3.4.4)

Scalar and Vector Potentials (10.1.1), Gauge Transformations (10.1.2), Coulomb Gauge and Lorenz Gauge (10.1.3), Retarded Potentials (10.2.1), Liénard-Wiechert Potentials (10.3.1).

Unit – 2 Electromagnetic waves

Waves in One Dimension**:** The Wave Equation (9.1.1), Sinusoidal Waves (9.1.2), Boundary Conditions: Reflection and Transmission (9.1.3), Polarization (9.1.4)

Electromagnetic Waves in Vacuum: The Wave Equation for E and B(9.2.1), Monochromatic Plane Waves (9.2.2), Energy and Momentum in Electromagnetic Waves (9.2.3)

Electromagnetic Waves in Matter: Propagation in Linear Media (9.3.1), Reflection and Transmission at Normal Incidence (9.3.2), Reflection and Transmission at Oblique Incidence (9.3.3)

Absorption and Dispersion: Electromagnetic Waves in Conductors (9.4.1), Reflection at a Conducting Surface (9.4.2), The Frequency Dependence of Permittivity (9.4.3).

Mapping between COs and PSOs

Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	2	1	2
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CO6	3	3	2	1	2	1	2
CO7	3	3	2	2	2	1	3
CO8	3	3	2	2	3	1	3
CO9	3	3	2	2	3	2	3
CO10	3	3	2	2	3	2	3

Reference Books

1. Introduction to Electrodynamics by David J. Griffiths, 4th Ed., Pearson Publications, 2002.
2. Electromagnetics by B. B. Laud, New Age International Publication, 2006.
3. Electrodynamics by Gupta, Kumar and Singh, Pragati Prakashan, 2014.
4. Classical Electrodynamics by Griener, Springer Vaelag, New York, 1998.

Teaching Methodology

Classroom lectures/Assignments/Problem Solving/Tutorials

Evaluation Method

Internal Assessment: 25Marks
External Assessment: 25Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)	
Course Code	PHP-2003
Course Title	Practical based on“Classical Electrodynamics”
Course Type	Major
Credit	2
Course Level	6
Teaching Hours/ Week	4 Hours
Teaching Time	15×4= 60 Hours
Effective Form	Academic Year: **2026-27**
Course Outcomes	**CO1**– Understandelectrostatic potential concepts – Explain the physical meaning of potential, its relationship with the electric field, and analyze Poisson’s and Laplace’s equations for different charge distributions and boundary conditions. **CO2**– Applymathematical techniques to potential problems – Solve electrostatic problems using Poisson’s and Laplace’s equations under given boundary conditions and understand the potential of localized charge distributions. **CO3**– Analyzemultipole expansions – Approximate potentials at large distances and distinguish between monopole and dipole terms; evaluate the role of coordinate origin in multipole expansions and derive the electric field of a dipole. **CO4**– Comprehendscalar and vector potentials in electrodynamics – Formulate the relationship between electric and magnetic fields using scalar and vector potentials, and apply gauge transformations including Coulomb and Lorenz gauges. **CO5**– Examinetime-dependent potentials and moving charge systems – Derive and interpret retarded potentials and Liénard–Wiechert potentials for moving charges, explaining their significance in electromagnetic radiation and relativistic electrodynamics. **CO6**–Understandthe fundamentals of wave motion – Explain the one-dimensional wave equation, characteristics of sinusoidal waves, and the effects of boundary conditions such as reflection, transmission, and polarization. **CO7**–Analyzeelectromagnetic wave propagation in vacuum – Derive and interpret the wave equations for electric and magnetic fields, study monochromatic plane waves, and evaluate the energy and momentum carried by electromagnetic waves. **CO8**–Examineelectromagnetic wave behavior in different media – Understand how waves propagate in linear media and apply boundary conditions to determine reflection and transmission at normal and oblique incidences. **CO9**–Investigatethe effects of material properties on wave propagation – Analyze how absorption and dispersion occur in conductors and dielectric materials, and study reflection phenomena at conducting surfaces. **CO10**–Explorefrequency-dependent electromagnetic responses – Explain how the permittivity of materials varies with frequency and its implications for wave propagation, absorption, and transmission in real-world materials and applications.

<table>
<tr><td>Course Content</td><td>

List of Experiments:

1. To study Hall effect.
2. To study Electron Spin Resonance (ESR).
3. To determine energy band-gap of different semiconducting materials.
4. To determine charge of electron using Millikan's oil drop method.
5. To determine e/m using Helical method.
6. To determine electrical conductivity of graphite.

Solve The problems:

7. The intensity of sunlight hitting the earth is about 1300 W/m^2. If sunlight strikes a perfect absorber, what pressure does it exert? How about a perfect reflector? What fraction of atmospheric pressure does this amount to?
8. (a) Show that the skin depth in a poor conductor ($\sigma \ll \omega\varepsilon$) is $(2/\sigma)\sqrt{(\varepsilon/\mu)}$ (independent of frequency). Find the skin depth (in meters) for (pure) water.
(b) Show that the skin depth in a good conductor ($\sigma \gg \omega\varepsilon$) is $\lambda/2\pi$ (where λ is the wavelength in the conductor). Find the skin depth (in nanometers) for a typical metal ($\sigma \approx 10^7\ (\Omega\ m)^{-1}$) in the visible range ($\omega \approx 10^{15}/s$), assuming $\varepsilon \approx \varepsilon_0$ and $\mu \approx \mu_0$. Why are metals opaque?
(c) Show that in a good conductor the magnetic field lags the electric field by 45°, and find the ratio of their amplitudes. For a numerical example, use the "typical metal" in part (b)
9. (a) Calculate the (time averaged) energy density of an electromagnetic plane wave in a conducting medium (Eq. 9.138). Show that the magnetic contribution always dominates. [Answer: $(k^2/2\mu\omega^2) E_0^2 e^{-2\kappa z}$]
10. Calculate the reflection coefficient for light at an air-to-silver interface ($\mu_1 = \mu_2 = \mu_{0,}\epsilon_1 = \epsilon_{0,}\ \sigma = 6 \times 10^7 (ohm.m)^{-1}$)
11. Project Work (Equivalent to Four experiments)

</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>

Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	2	1	2
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CO5	3	3	1	2	2	1	3
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CO7	3	3	2	2	2	1	3
CO8	3	3	2	2	3	1	3
CO9	3	3	2	2	3	2	3
CO10	3	3	2	2	3	2	3

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Teaching Methodology	Laboratory Work
Evaluation Method	Internal Assessment: 25 Marks External Assessment: 25 Marks

<u>Instructions:</u>

1. The duration of each experiment is of 2 hours.
2. There should not be more than 10 students per batch as per NEP 2020 guidelines.
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<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester 2 with Course-work)</td></tr>
<tr><td>Program Name</td><td colspan="6">M. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="6">II</td></tr>
<tr><td>NCrF Credit Level</td><td colspan="6">6</td></tr>
<tr><td>Course Type</td><td colspan="6">Vocational Course: Python Programming and Computational Physics</td></tr>
<tr><td>Course Subtype</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Subject Type</td><td colspan="6">Physics</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-2004</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Python Programming and Computational Physics</td></tr>
<tr><td>Credit</td><td>Theory</td><td>02</td><td>Practical:</td><td>-</td><td>Total</td><td>02</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1- Understand the fundamental concepts of Python programming, including the Python environment, data types, variables, operators, and script development for scientific applications.
CO2- Apply Python modules, functions, and NumPy libraries to perform numerical computations and solve basic scientific and engineering problems.
CO3- Organize and manipulate data using strings, lists, tuples, dictionaries, and NumPy arrays to perform vector and matrix operations.
CO4- Implement file handling and input/output operations to process text and CSV data files for computational physics applications.
CO5- Construct Python programs using conditional statements, loops, list comprehensions, and logical operations to solve computational and numerical problems.
CO6- Generate scientific visualizations using Matplotlib, including 2D, logarithmic, contour, vector field, and 3D plots for data analysis.
CO7- Design and implement user-defined functions employing various argument-passing techniques, lambda functions, and object-oriented features to develop reusable scientific codes.
CO8- Integrate programming, numerical methods, and graphical analysis to model, simulate, and interpret physical systems and experimental data.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 <u>PYTHON Language</u>
Introduction to Python for Science and Engineering, interacting with Python, Installing Python on Your Computer, The Spyder Window, The IPython Pane:Magic commands, System shell commands, Tab completion, Recap of commands, Interactive Python as a Calculator:
Binary arithmetic operations in Python, Types of numbers, Important note on integer division in Python, Variables: Names and the assignment operator, Legal and recommended variable names, Reserved words in Python, Script Files and Programs, Python Modules: Python modules and functions: A first look, Some NumPy</td></tr>
</table>

functions, Different ways of importing modules, Getting Help: Documentation in IPython, Stand-alone IPython, Programming Errors,
Strings, Lists, Arrays, and Dictionaries:
Strings, Lists: Slicing lists, the range function: Sequences of numbers, Tuples, Multidimensional lists and tuples, NumPy Arrays: Creating arrays (1-d), Mathematical operations with arrays, Slicing and addressing arrays, Fancy indexing: Boolean masks, multi-dimensional arrays and matrices, Differences between lists and arrays, Dictionaries, Objects,
Input and Output :
Keyboard Input, Screen Output: Formatting output with str.format(), Printing arrays, File Input**:** Reading data from a text file, Reading data from an Excel file: CSV files, File Output: Writing data to a text file, Writing data to a CSV file

Unit – 2Conditionals, Loops, Plotting & Functions

Conditionals: if, elif, and else statements, Logical operators
Loops: for loops, while loops, Loops and array operations, List Comprehensions
Plotting :
An Interactive Session with PyPlot, Basic Plotting, Specifying line and symbol types and colors, Error bars, Setting plotting limits and excluding data, Subplots, Logarithmic Plots: Semi-log plots, Log-log plots, More Advanced Graphical Output: An alternative syntax for a grid of plots, Plots with multiple axes, Mathematics and Greek symbols, The Structure of matplotlib: OOP and All That: The backend layer, The artist layer, The PyPlot (scripting) layer, Contour and Vector Field Plots: Making a 2D grid of points, Contour plots, Streamline plots, Three-Dimensional Plots
Functions:
User-Defined Functions: Looping over arrays in user-defined functions, Fast array processing for user-defined functions, Functions with more than one input or output, Positional and keyword arguments, Variable number of arguments, Passing function names and parameters as arguments
Passing data (objects) to and from functions:
Variables and arrays created entirely within a function, Passing lists and arrays to functions: Mutable and immutable objects, Anonymous Functions: lambda Expressions, NumPy Object Attributes: Methods and Instance Variables.

Mapping between COs and PSOs

Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	1	–	3	1	1	2
CO2	2	3	–	3	2	1	2
CO3	1	2	1	3	2	1	2
CO4	1	2	3	3	1	1	2
CO5	1	3	–	3	2	1	2
CO6	2	2	3	3	3	1	2
CO7	1	3	–	3	2	1	2
CO8	3	3	2	3	3	1	3

Text Books	1. Introduction to Python for Science and Engineering, David J. Pine, CRC Press Taylor and Francis Group, 2019. 2. Introduction to Computational Materials Science: Fundamentals to Applications: R. Lesar, Cambridge University Press, 2013 3. Computational Physics Problem solving with Python, R. H Landau, Manuel J. Páze, and Cristian C. Bordeianu, Third edition, Wiley-VCH, 2015
Reference Books	1.Computational Physics with Python, Dr. Eric Ayars, California State University, 2013.
Teaching Methodology	Classroom lectures/Assignments/Tutorials
Evaluation Method	Internal Assessment: 25 Marks External Assessment: 25 Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)	
Course Code	PHP-2004
Course Title	Practical based on“Python Programming and Computational Physics”
Course Type	Vocational Course
Credit	2
Course Level	6
Teaching Hours/ Week	4 Hours
Teaching Time	15×4= 60 Hours
Effective Form	Academic Year: **2026-27**
Course Outcomes	**CO1:** Execute Stochastic Simulations for Physical Processes Design and execute Python programs using random number generation techniques to simulate statistical and non-deterministic physical phenomena, specifically modeling Random Walks and Radioactive Decay. **CO2:** Solve Kinetic and Mechanical Equations of Motion Numerically Develop iterative algorithms to model and animate the behavior of time-dependent classical mechanical systems, such as a simple pendulum, under varying physical constraints. **CO3:** Program Quantum Mechanical Wavefunctions and Boundary Problems Implement numerical methods to compute and solve boundary-value problems in quantum mechanics, specifically simulating the eigenvalues and state transitions of the Time-Independent Schrödinger Equation. **CO4:** Quantify Chaotic Dynamics and Non-Linear Bifurcations Construct scripts to compute, map, and analyze non-linear chaotic mathematical models, utilizing the Logistic Map to identify stable regimes, periodic doubling, and deterministic chaos. **CO5:** Apply Stochastic Approximation to Multi-Dimensional Integration Utilize Monte Carlo sampling methods to approximate complex definite integrals numerically, evaluating the accuracy, convergence rates, and statistical errors of the computational results. **CO6:** Debug and Optimize Core Scientific Python Libraries Demonstrate practical troubleshooting skills in debugging syntax, logical, and runtime errors while efficiently utilizing NumPy arrays and control loops to handle simulation datasets. **CO7:** Synthesize Computational Skills in an Independent Physics Project Formulate, code, and document an end-to-end computational physics simulation project, demonstrating self-directed technical execution and presenting the results through advanced scientific visualization.
Course Content	**List of Experiments:** **1.**Write a PYTHON program to perform the simulation of Random walk. 2. Write a PYTHON program to perform the simulation of simple pendulum. 3. Write a PYTHON program to perform the simulation of time independent Schrödinger Equation. 4. Write a PYTHON program to perform the simulation of Logistic Map.

	5. Write a PYTHON program to perform the simulation of Radioactive decay. 6. Write a PYTHON program for integration using Monte Carlo Method.
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	3	3	2	1	3
CO2	3	3	3	3	1	1	2
CO3	3	3	2	3	2	1	3
CO4	3	3	2	3	2	1	3
CO5	2	3	2	3	3	1	2
CO6	--	2	3	3	2	1	3
CO7	2	3	3	3	3	2	3

Reference Books	1. Introduction to Python for Science and Engineering, David J. Pine, CRC Press Taylor and Francis Group, 2019. 2. Computational Physics with Python, Dr. Eric Ayars, California State University, 2013. 3. Computational Physics Problem solving with Python, R. H Landau, Manuel J. Páze, and Cristian C. Bordeianu, Third edition, Wiley-VCH, 2015. 4. Introduction to Computational Materials Science: Fundamentals to Applications: R. Lesar, Cambridge University Press, 2013.
Teaching Methodology	Laboratory Work
Evaluation Method	Internal Assessment: 25 Marks External Assessment: 25 Marks

Instructions:

1. The duration of each experiment is of 2 hours.
2. There should not be more than 10 students per batch as per NEP 2020 guidelines.
3. In the external examination, a student will have to perform two experiments
The duration of external examination will be of 4 hours.
4. There should be two examiners per batch in the external examination.
5. There should not be more than 10 students per examiner per session in the external examination

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)						
Program Name	M. Sc. Physics					
Semester	II					
NCrF Credit Level	6					
Course Type	Generic Elective					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-2005					
	400-499					
Course Title	Elective 1-Electronic Communication					
Credit	**Theory**	**04**	**Practical:**	**---**	**Total**	**04**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1**–At the end of the course, the students will be able to understand in depth how the analog and digital electronic communication systems work. **CO2**–Students are familiar with signal analysis (Fourier techniques) and basic understanding of probability theory and variables. **CO3**–The objective is to introduce basic techniques used in amplitude modulation systems and to offer fundamental tools and methodologies workout in analysis and design of said systems. **CO4**–Generalized treatment of angle modulation is provided so the students will be able to differentiate Amplitude modulation-Frequency modulation and Frequency modulation-Phase modulation. **CO5**- Students are familiar with various aspects of digital data transmission with most of the discussion is allied to the binary case. Students would be realize how digital system is more powerful tool compared to analog system.					
Course Content	**Unit – 1 Fourier transform and Probability** Sampling function, Response of a linear system, Normalized power, Normalized power in a Fourier expansion, Power spectral density, Effect of transfer function on power spectral density, Fourier transform, Examples of Fourier transform, Convolution, Parseval's theorem, Correlation between waveforms, Autocorrelation, Autocorrelation of a periodic waveform, Autocorrelation of non-periodic waveform of finite energy, Concept of Probability, Random variables: Conditional Probabilities, Cumulative distribution function, and Probability density function. **Unit – 2 Random processes and Amplitude Modulation** Random processes, Classification of Random processes, Mean, correlation and covariance functions, Ergodic Processes, Central limit theorem. Amplitude modulation: Double sideband suppressed carrier AM, Modulators: Multiplier modulator, Non linear modulator, Switching modulator, Demodulation of DSB-SC Signals. Conventional amplitude modulation (AM), Sideband and carrier power, Generation of AM signals, Demodulation of AM signals, Amplitude modulation:					

	Single side band (SSB), Time domain representation of SSB signals, Generation of SSB signal, Demodulation of SSB signals. Amplitude modulation: Vestigial side band modulation (VSB), Use of VSB in broadcast television, Comparison of various amplitude modulation systems. **Unit – 3 Angle modulation and Noise** Angle modulation, Concept of instantaneous frequency, generalized concept of angle modulation, Wideband FM (WBFM), Generation of FM waves: Indirect method of Armstrong, Direct generation: Parameter variation method, Phase locked loop, Analysis of phase locked loop, Stereophonic FM broadcasting, Comparisons: Frequency and phase modulation, Frequency and Amplitude modulation, External and internal noise, Noise calculations, Noise figure, Noise temperature **Unit – 4 Digital Communication** Comparison of Analog and digital communication systems, Sampling theorem: low pass signals, Pulse amplitude modulation, other forms of pulse modulation, Time division multiplexing, Quantization of signals, Quantization error, Pulse code modulation, PCM system, Non uniform quantization, Compandor, Differential PCM: analysis of DPCM, Signal to noise ratio improvement, Delta modulation, Threshold of coding and overloading, Adaptive Delta modulation and output signal to noise ratio. Digital carrier schemes: Frequency shift keying (FSK): FSK bit rate and Baud, FSK transmitter and receiver, Bandwidth considerations of FSK, Phase shift keying: Binary PSK transmitter and receiver, Bandwidth considerations of BPSK, M-ary encoding, Differential Phase shift keying (DPSK).
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	--	2	2	2
CO2	2	3	3	--	2	2	1
CO3	3	2	3	--	2	2	2
CO4	3	3	3	--	2	3	3
CO5	3	3	3	2	3	2	3

Text Books	1. Principles of communication systems:H. Taub and D. L. Schilling, (3rd Ed.), McGraw-Hill. 1986. 2. Modern Digital and Analog communication systems:B. P. Lathi, (3rd Ed.), Oxford University Press, 1998. 3. Electronic communication systems :G. Kennedy, (3rd Ed.),McGraw-Hill, 1998 4. Advanced Electronic Communications systems:W.Tomasi, (5th Ed.), PHI 2003.
Reference Books	1. Electronic communications:D. Roddy and J. Coolen, (2nd Ed.), PHI 1981. 2. Fundamentals of communication systems: J. G. Proakis and M. Salehi,Pearson Education 2005. 3. Communication Systems: S. Haykin, (4th Ed.), John Wiley & Sons,1979. 4. Radio Engineering :G. K. Mithal, Applied Electronics Vol. II, 1987.
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)						
Program Name	M. Sc. Physics					
Semester	II					
NCrF Credit Level	6					
Course Type	Generic Elective					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-2005					
Course Level	400-499					
Course Title	Elective 2-Thin Film Technology and Non Destructive Testing					
Credit	**Theory**	**04**	**Practical:**	**---**	**Total**	**04**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1–** The understanding of vacuum technology will become a focal point for not only academic based research but more broadly the research interests of the technological development. **CO2–** The thin film preparation and characterization brief description of the devices in a cohesive manner with the impetus provided for industrial applications and recognized globally research and development work doing smoothly. **CO3–** The emphasis knowledge of thin film technology gives a brief physical basis of technical description offers state of art in various thin film devices applications. **CO4-**The knowledge of practical non-destructive testing is the requirement to understand the capabilities and advantages of non-destructive testing (NDT), non-destructive evaluation (NDE) and non-destructive inspection. Its knowledge benefits to developing the importance and material method systems for process control management and applications.					
Course Content	**Unit – 1 Vacuum Science and Vacuum Technology** Introduction: Vacuum characterization and unit of vacuum, Classification of vacuum range and pumps, characterization of good vacuum pumps. Production of vacuum: Rotary pump, Molecular Drag and Turbo-molecular pump, Diffusion pump, Sorption pump, Thermodynamics of adsorption, typical sorbents used in vacuum technology, construction and action of Sorption pump, Gettering and ion pumping.Pressure measurement in vacuum systems: Classification of Vacuum gauges, Mechanical gauges: Diaphragm, McLeod gauge, Thermal conductivity gauge, Hot and cold cathode ionization gauge, Bayard-Alpert Gauge. History, applications and scope of vacuum science and technology. **Unit – 2 Thin Film Technology** Introduction: Thin and thick films processing and technology, Advantages and applications of thin films.Thin films growth process, Thin film deposition process, Physical vapour deposition (PVD): Thermal evaporations, Sputtering Yield, Sputtering systems: DC diode Sputtering, RF diode Sputtering, Magnetron					

Sputtering, Ion beam Sputtering, ECR plasma Sputtering, Electron beam evaporation, Pulsed Laser deposition (PLD). Chemical vapour deposition (CVD) process: Decomposition reactions, Reduction reactions, Chemical transport reactions and polymerization. Major advantages of CVD, Spray Pyrolysis and Spin Coating systems.

Unit – 3Thin Film Characterization

Deposition rate and thickness measurement(insitu and exsitu) methods,
Quartz crystal monitor, Ellipsometry.Electrical, Optical and Mechanical properties of thin films, Sheet resistivity and temperature coefficient measurement, Antireflection and reflection coating, Interference filters and band pass filters.Applications of thin films: Optoelectronic applications, Photon detectors, Photovoltaic devices (Thin Film solar cell).Thin film passive components: Electrical behaviour of metal film, Dielectric behaviour of insulators film, Resistors, Capacitors and Inductors, Thin film diode, Surface Acoustic wave (SAW) devices, Charged coupled devices.

Unit – 4 Non-Destructive Testing(NDT)

Introduction: Comparison of destructive and non-destructive test, The basic principles, applications, advantages and limitations of important NDT methods.
Visual inspection: Optical aids used for visual inspection: Microscope, Borescope, Endoscope, Flexible fiber-optic Borescope, Telescope, Liquid penetrate testing, Magnetic particle testing, Ultrasonic testing. Acoustic emission testing, Insitu metallographic examination, Statistical method for quality control.

Mapping between COs and PSOs

Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	1	2	3
CO2	3	2	3	2	2	1	2
CO3	3	1	3	2	2	1	2
CO4	3	2	3	3	2	3	3

Text Books

1. Hand book of Vacuum Technology Willey – VCH Verlag Gmbh& Co. KGA. 1986.
2. Hand Book of Thin Film Technology: L. I. Maissel and R. Glang , McGraw – Hill 1983.
3.Thin Film Phenomena: K. L. Chopra, McGraw – Hill 1969.
4. Practical Non–Destructive Testing: Baldev Raj, T. Jayakumar, M. Thavasimuthu, Narosa Publishing House 2009.

Reference Books

1. Preparation of Thin Films: Joy George, Marceloekker 1992.
2. Vacuum Science and Technology: V.V. Rao, I.B. Ghosh and K. L. Chopra Allied Publications Limited.
3. Thin Film Device Applications: K.L. Chopra and I. Kaur, Plenum Press 1983.

Teaching Methodology

Classroom lectures/Assignments/Problem Solving/Tutorials

Evaluation Method

Internal Assessment: 50 Marks
External Assessment: 50 Marks

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester 2 with Course-work)</td></tr>
<tr><td>Program Name</td><td colspan="6">M. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="6">II</td></tr>
<tr><td>NCrF Credit Level</td><td colspan="6">6</td></tr>
<tr><td>Course Type</td><td colspan="6">Generic Elective</td></tr>
<tr><td>Course Subtype</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Subject Type</td><td colspan="6">Physics</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-2005</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Elective 3: Numerical Techniques</td></tr>
<tr><td>Credit</td><td>Theory</td><td>04</td><td>Practical:</td><td>---</td><td>Total</td><td>04</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1- Apply direct methods such as Gauss elimination, Gauss–Jordan method, LU decomposition, and matrix inversion techniques to solve systems of linear algebraic equations.
CO2- Analyze matrix properties, vector and matrix norms, pivoting strategies, and computational efficiency in solving linear systems and tridiagonal matrices.
CO3- Employ iterative methods to solve ill-conditioned and large-scale systems of linear equations and evaluate their convergence characteristics.
CO4- Compute and analyze eigenvalues, eigenvectors, and matrix decompositions using Householder transformation, QR method, and Singular Value Decomposition (SVD).
CO5- Apply numerical methods such as Taylor series, Euler, Modified Euler, Runge–Kutta, Predictor–Corrector, Adams–Moulton, and Milne's methods to obtain approximate solutions of ordinary differential equations.
CO6- Solve higher-order ordinary differential equations and boundary value problems using finite difference, spline, and Galerkin methods, and assess the accuracy of numerical solutions.
CO7- Implement finite difference and iterative techniques such as Jacobi, Gauss–Seidel, SOR, and ADI methods to solve partial differential equations arising in physical systems.
CO8- Analyze and solve Laplace, heat, and wave equations using numerical methods and computational tools, and evaluate the effectiveness of different solution approaches for PDEs.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1Numerical Linear Algebra-I
Introduction, Triangular Matrices, LU Decomposition of A Matrix, Vector and Matrix Norms, Solution of Linear Systems—Direct Methods,Gauss Elimination,Necessity for Pivoting,Gauss-Jordan Method,Modification of the Gauss Method to Compute the Inverse,Number of Arithmetic Operations,LU Decomposition Method,Computational Procedure for LU Decomposition Method,LU Decomposition from Gauss Elimination,Solution of Tridiagonal Systems.</td></tr>
</table>

	Unit-2 Numerical Linear Algebra-II Ill-conditioned Linear Systems, Method for Ill-conditioned Systems, Solution of Linear Systems—Iterative Methods,Matrix Eigenvalue Problem,A Eigenvalues of a Symmetric Tridiagonal Matrix, Householder's Method, QR Method,Singular Value Decomposition. **Unit – 3 Numerical Solution of Ordinary Differential Equation** Introduction, Solution by Taylor's Series, Picard's Method of Successive Approximations, Euler's Method, Error Estimates for the Euler Method, Modified Euler's Method, Runge-Kutta Methods,Predictor-Corrector Methods, Adams-Moulton Method, Milne's Method, Cubic Spline Method, Simultaneous and Higher-order Equations, Some General Remarks, Boundary-value Problems, Finite-difference Method, Cubic Spline Method,Galerkin's Method. **Unit – 4Numerical Solution of Partial Differential Equation** Introduction, Laplace's Equation, Finite-difference Approximations to Derivatives, Solution of Laplace's Equation, Jacobi's Method, Gauss-Seidel Method, Successive Over-Relaxation (SOR) Method, ADI Method, Heat Equation in One Dimension, Finite-difference Approximations, Iterative Methods for the Solution of Equations,Application of Cubic Spline, Wave Equation, Software for Partial Differential Equation
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	1	1	3	1	2
CO2	2	3	1	1	3	1	2
CO3	2	3	1	1	3	1	2
CO4	2	3	1	1	3	1	2
CO5	3	3	2	1	3	1	2
CO6	3	3	2	1	3	1	2
CO7	3	3	2	1	3	1	2
CO8	3	3	2	1	3	1	3

Text Books	1.Introductory Methods of Numerical Analysis: S. S. Sastry, fifth edition, PHI Learning Private Limited, 2012.
Reference Books	1. Numerical Methods for Scientists and Engineers: K. S. Rao. Third edition PHI Learning Private Limited, 2006. 2. Numerical Methods for Math., Science and Engineering: J. H. Mathews, Prentice Hall,1992.
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)						
Program Name	M. Sc. Physics					
Semester	II					
NCrF Credit Level	6					
Course Type	Generic Elective					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-2005					
Course Level	400-499					
Course Title	Elective 4-Nuclear and Particle Physics					
Credit	**Theory**	**04**	**Practical:**	**---**	**Total**	**04**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1–** The students will learn Deuteron Problem and properties of nuclearforces. **CO2–** The students will be able to study experimental methods of determining some of the nuclear properties. **CO3–** The students will be introduced to different nuclear models, their specifications and applications and their limitations. **CO4–** The students will learn about the sources of elementary particles, classification of fundamental particles and study their various properties.					
Course Content	**Unit – 1 The Force Between Nucleons** The Deuteron Problem: Binding Energy, Spin and Parity, Magnetic Dipole Moment, Electric Quadrupole Moment;Properties of the nuclear forces: The interaction between twonucleons consist to lowest order, the nucleon-nucleon interaction is stronglyspin dependent, the inter-nucleon potential includes a non-central term, knownas a tensor potential, the nucleon-nucleon force is charge symmetric, thenucleon-nucleon force is nearly charge independent, the nucleon-nucleoninteraction becomes repulsive at short distances, the nucleon–nucleon interaction may also depend on the relative velocity or momentum of thenucleons. **Unit – 2Determination of Some Nuclear Properties** Measurement of nuclear spin and magnetic moment: hyperfine splitting of theatomic energy levels;nuclear spin from Zeeman effect of hyperfine lines, isotope effect; nuclear spin and statistics from molecular spectra; atomic beam method of nuclear magnetic moment determination (non-resonancemethod); magnetic resonance method of Rabi; magnetic resonance absorptionmethod of measuring nuclear magnetic moment, electron paramagnetic resonance; nuclear induction method; microwave spectroscopy method; determination of theelectric quadrupole moments of nuclei.					

	Unit – 3Nuclear Models Nuclear models; liquid drop model; Bethe-Weizsacker formula; applicationsof the semi-empirical binding energy formula; Fermi gas model of the nucleus; nuclear shell structure; single particle states in the nuclei, spin-orbit interaction; applications of extreme single particle shell model: nuclear spin,nuclear magnetic moments, islands of isomerism, quadrupole moments of nuclei; single particle shell model; individual particle model; collective model. **Unit – 4Particle Physics** Introduction; productions of elementary particles; classification of particles: quanta of forces, matter particles, antiparticles; fermions, bosons, leptons, hadrons (mesons and baryons): their productions and decays, their properties,their mean-life times; quantum numbers; conservation laws.
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1	2	1	2
CO2	3	2	2	3	2	1	2
CO3	3	3	2	2	3	2	3
CO4	3	2	3	2	2	1	3

Text Books	1. Introduction to Nuclear Physics: H. Enge. 2. Introductory Nuclear Physics: K. Krane, Wiley India Pvt. Ltd. 3.Introduction to Elementary Particles: Griffiths.
Reference Books	1. Nuclear Physics: S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlargededition, 2014. 2. Nuclear Physics: D. C. Tayal, Himalaya Publishing House, 2017. 3. Introduction to Nuclear and Particle Physics: Mittal, Gupta and Verma, PHI Learning Pvt. Ltd., (3rd Ed.), 2017.
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS (Semester 2 with Course-work)						
Program Name	M. Sc. Physics					
Semester	II					
NCrF Credit Level	6					
Course Type	Skill Enhancement Course					
Course Subtype	Discipline Specific					
Subject Type	Physics					
Course Code	PH-2006					
Course Level	400-499					
Course Title	Electronic and Biomedical Instrumentation					
Credit	**Theory**	**02**	**Practical:**	**---**	**Total**	**02**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	**CO1–** Student learn about basic of Electronics instrumentations. **CO2–** Student learn to use and operate morden electronic instrumentations. **CO3–**Students can improve their skill to find the faults in an electronic system and solve it.					
Course Content	**Unit –1Electronic Instrumentation** Signal Generation: Pulse and square wave generator, function generator, Oscilloscope:Oscilloscope block diagram, CRT circuits, Vertical deflection system, Delay line, Multiple trace, Horizontal deflection system, Oscilloscopeprobes and transducers. Digital Voltmeters: 3½-Digit DVM, Resolution and Sensitivity of Digital Meters General Specifications of DVM. Digital Instruments: Digital frequency meter, Digital multi-meter, Digital panel meter.Digital tachometer, Digital pH meter, Digital phase meter, Digital capacitance meter **Unit –2Biomedical Instrumentation** Introduction: Biopotential, Cardiovascular system, Electro Cardiogram (ECG), Blood pressure measuring instruments, Doppler Sonography, Computed Tomography imaging (CT scan, CAT scan), Magnetic Resonance imaging (MRI), Specialized MRI Scans, Biofeedback.					
Mapping between COs and PSOs	**Mapping Key:** 3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation					

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	1	2	1	2
CO2	3	2	3	1	2	1	2
CO3	3	2	3	1	2	1	2

Text Books	1.Electric and Electronic measurements and Instrumentation. (19th Ed. 2016) A.K.Sawhney, Dhanpat Rai & Co. 2.Electronic Instrumentation: H.S. Kalsi, (3rd Ed.) McGraw Hill.
Reference Books	1. Electronics Instrumentation and Measurement Techniques: W. D Cooper, PHI, New Delhi.
Teaching Methodology	Classroom lectures/Assignments/Problem Solving/Tutorials
Evaluation Method	Internal Assessment: 25Marks External Assessment: 25Marks

Proposed Theory Question Paper for External Exam : Total 25 marks

Q-1.	Compulsory : 5 marks	Weightage is given to entire two units of course content
	Attempt any two of the following	
Q-2.	(a) 5 marks	Weightage is given to first unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-3.	(a) 5 marks	Weightage is given to second unit of course content
	(b) 5 marks	
	(c) 5 marks	

Proposed Theory Question Paper for External Exam : Total 50 marks

Q-1.	Compulsory : 10 marks	Weightage is given to entire four units of course content
	Attempt any two of the following	
Q-2.	(a) 5 marks	Weightage is given to first unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-3.	(a) 5 marks	Weightage is given to second unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-4.	(a) 5 marks	Weightage is given to third unit of course content
	(b) 5 marks	
	(c) 5 marks	
	Attempt any two of the following	
Q-5.	(a) 5 marks	Weightage is given to fourth unit of course content
	(b) 5 marks	
	(c) 5 marks	