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.
Tel : +91 - 261 - 2227141 to 2227146, Toll Free : 1800 2333 011, Digital Helpline No.- 0261 2388888
E-mail : info@vnsgu.ac.in, Website : www.vnsgu.ac.in

-: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 B.Sc. Physics Sem.-7 & 8 Honours (with OJT / without OJT) અને Honours with Research નો પેટાસમિતિ દ્વારા તૈયાર કરવામાં આવેલ અભ્યાસક્રમ ભૌતિકશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૦૫/૦૫/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંક:૦૨ થી ચેરમેનશ્રીને આપેલ સત્તા અંતર્ગત ચેરમેનશ્રીએ અભ્યાસક્રમ અભ્યાસ સમિતિવતી મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાની તા.૦૪/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંક:૧૩ થી મંજૂર કરવા એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૧૮/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંક:૧૧ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવા માં આવે છે.

(બિડાણ: ઉપર મુજબ)

ક્રમાંક:ઓથો./પરિપત્ર/૧૩૬૩૯/૨૦૨૬
તા.૧૯/૦૬/૨૦૨૬

કુલસચિવ

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

B. Sc. (Honors) With OJT /Research Project
Physics
Semester –VII
NEP- 2020

(Effective from Academic Year: 2026-2027)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

PROGRAM TITLE

Name of Program	Bachelor of Science (Honors) Physics
Program Abbreviation	B. Sc. (Hon) Physics
Duration	4 years
Eligibility Criteria	HSC (12Th Pass in Science Stream) or equivalent from recognized board/institute)
Pre-requisite	
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 B.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 B.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 analyze 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 analyze 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 (M.Sc., integrated Ph.D., etc.), 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 Leve :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 Program (Semester-VII) (Single Major -Honors with OJT/Research Project)

Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		TotalMakrs	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR -1	PH-MJ-701	Mathematical Methods and Solid-State Physics	Mathematical Methods and Solid-State Physics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-701	Practical based on "Mathematical Methods and Solid-State Physics"	Mathematical Methods and Solid-State Physics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -2	PH-MJ-702	Quantum Mechanics and Statistical Mechanics	Quantum Mechanics and Statistical Mechanics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-702	Practical based on "Quantum Mechanics and Statistical Mechanics"	Quantum Mechanics and Statistical Mechanics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -3	PH-MJ-703	Analog and Digital Electronics	Analog and Digital Electronics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-703	Practical based on "Analog and Digital Electronics"	Analog and Digital Electronics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MINOR ELECTIVE	ME-CS	Fundamentals of Cyber Security	Fundamentals of Cyber Security	400-499	4	0	2	0	4	0	50	0	50	0	100	0
***OJT/ Research Project**									**6**		50		50		100	

***OJT** (on job training) for students enrolled in **B,Sc. (honors)** with OJT is mandatory as per **University Guidelines**.

OR

Research Project for students enrolled in **B,Sc. (honors with Research)**is mandatory as per **University Guidelines**

[Subject code for Theory-2603000507011001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester VII –With OJT)</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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">Nil</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-MJ-701</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Mathematical Methods and Solid-State 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: 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:Analyze 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.</td></tr>
<tr><td>Course Content</td><td colspan="6">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</td></tr>
</table>

of derivatives and integrals; other properties of Laplace 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) Donor States(b) Acceptor States (c) Thermal ionization of donors and acceptors, Semi Metals., Superlattices. (a)Bloch Oscillator (b) Zener Tunneling.

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	2	–	2
CO2	3	3	–	2	2	–	2
CO3	3	3	1	2	2	–	2
CO4	3	3	1	2	2	–	2
CO5	2	3	–	2	3	–	2
CO6	2	3	–	2	3	–	2
CO7	3	2	–	1	2	1	2
CO8	3	3	–	2	2	–	2
CO9	3	2	–	1	2	1	2
CO10	3	2	–	1	2	2	2
CO11	2	2	–	2	3	1	2

Reference Books

1. Mathematical Methods for Physics and Engineering by K.F.Riley,M.P.Hobson,S.J. Bence, 3rd Edition Cambridge.
2. Introduction to solid State Physics by Charles Kittel. Global Edition.

Teaching Methodology

Classroom Lecture, Problem Solving, Assignments, Tutorials

Evaluation Method

Internal Assessment: 25 Marks

External Assessment: 25 Marks

[Subject code for Practical-2603000507011002]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester VII –With OJT)

Program Name	B. Sc.					
Semester	VII					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	PHP-MJ-701					
Course Level	400-499					
Course Title	Practical based on “Mathematical Methods and Solid-State Physics”					
Credit	**Theory**	**-**	**Practical:**	**02**	**Total**	**02**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	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 behavior** 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					
Course Content	**Practical** **Unit-1: Solve problems based on** 1. Vector space verification 2. Determinant evaluation 3. Determinant equation solving 4. Matrix classification					

<table>
<tr><td></td><td>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)
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)</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><th>Cos/PSOs</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</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>–</td><td>2</td></tr>
<tr><td>CO6</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO7</td><td>3</td><td>2</td><td>3</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>2</td><td>1</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO9</td><td>2</td><td>2</td><td>3</td><td>1</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO10</td><td>2</td><td>3</td><td>3</td><td>2</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO11</td><td>1</td><td>2</td><td>2</td><td>1</td><td>3</td><td>3</td><td>2</td></tr>
</table></td></tr>
<tr><td>Reference Books</td><td>1. Mathematical Methods for Physics and Engineering by K.F.Riley,M.P.Hobson,S.J. Bence, 3rd Edition Cambridge.
2. Introduction to solid State Physics by Charles Kittel. Global Edition.</td></tr>
<tr><td>Teaching Methodology</td><td>Laboratory Work, Problem Solving, Project</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 25 Marks
External Assessment: 25 Marks</td></tr>
</table>

<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.
3. In the external examination, a student will have to perform one experiment and there will be 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.

[Subject code for Theory-2603000507021001]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT **SYLLABUS (Semester VII –With OJT)**						
Program Name	B. Sc. Physics					
Semester	VII					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	PH-MJ-702					
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 –**Analyze 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 behavior of physical systems using the Darwin–Fowler method. **CO7** – Differentiate between classical and quantum regimes by analyzing 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 paramagnetism through quantum statistical principles. **CO9** – Explore Boson systems by understanding photon gases, phonons in solids, and the phenomenon of Bose–Einstein condensation, **CO10-** Explore Boson systems byextending to the behavior 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					

<table>
<tr>
<td></td>
<td>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), 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 paramagnetism(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:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table>
<tr><th>CO/PSO</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</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>CO2</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>1</td><td>3</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>3</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO5</td><td>3</td><td>3</td><td>1</td><td>2</td><td>3</td><td>2</td><td>3</td></tr>
<tr><td>CO6</td><td>3</td><td>3</td><td>1</td><td>2</td><td>3</td><td>2</td><td>3</td></tr>
<tr><td>CO7</td><td>3</td><td>3</td><td>1</td><td>2</td><td>3</td><td>2</td><td>3</td></tr>
<tr><td>CO8</td><td>3</td><td>3</td><td>2</td><td>2</td><td>3</td><td>2</td><td>3</td></tr>
<tr><td>CO9</td><td>3</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>3</td></tr>
<tr><td>CO10</td><td>3</td><td>3</td><td>2</td><td>2</td><td>3</td><td>2</td><td>3</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>

[Subject code for Practical-2603000507021002]

<table>
<tr><td colspan="7">

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester VII –With OJT)

</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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">Nil</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PHP-MJ-702</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on “Quantum Mechanics and Statistical Mechanics”</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>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">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, eigenfunctions, 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.</td></tr>
<tr><td>Course Content</td><td colspan="6">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:</td></tr>
</table>

$$\psi(x) = \frac{1}{\sqrt{5a}}\sin\frac{\pi x}{a} + \frac{2}{\sqrt{5a}}\sin\frac{3\pi x}{a}$$

(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 ofthe 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 avalue 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 thefollowing matrices:
$$A = \begin{pmatrix} 5 & 0 & 0 \\ 0 & 1 & 2 \\ 0 & 2 & 1 \end{pmatrix}, B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 03 & \\ 0 & 30 & \end{pmatrix}, C = \begin{pmatrix} 03 & 0 & \\ 30 & 2 & \\ 0 & 2 & 0 \end{pmatrix} D = \begin{pmatrix} 1 & 0\,0 \\ 0 & 0-i \\ & 0i0 \end{pmatrix}$$
(a) Find the results of the measurements of these observables.
(b) Which among these observables are compatible? Give a basis of eigenvectors commonto 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 orbitalangular momentum.
(b) Calculate the commutator between the x and y components of the orbital angular momentumoperator.
(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 energy E_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 coefficientαsuch 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

orthonormal set 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_3 respectively, write down the state of the system $\lfloor\psi(t)\rangle$ at any later time t.

(c) Determine the probability of finding the system at a time t in the state $\lfloor\phi_3\rangle$.

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1	2	1	2
CO2	3	3	1	2	2	1	3
CO3	3	3	1	2	2	1	3
CO4	3	3	2	2	2	1	3
CO5	3	3	1	2	3	2	3
CO6	2	3	2	3	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: 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 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 externalexamination.

[Subject code for Theory-2603000507031001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester VII –With OJT)</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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-MJ-703</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–Understandthe 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–Solveproblems for designing and simulating analog to digital circuits and vice versa.
CO6 –Understandthe 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–Explainthe working mechanism for various modules by different counters.
CO10–Solveproblems for designing and simulating modulo-counter circuits using flip-flops.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Filters
Introduction (8.1), 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 & 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>
</table>

<table>
<tr>
<td>Mapping between Cos and PSOs</td>
<td>Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table>
<tr><th>CO/PSO</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</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>CO2</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</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>3</td></tr>
<tr><td>CO4</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>CO5</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO6</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>CO7</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO8</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO9</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO10</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
</table>
</td>
</tr>
<tr>
<td>TextBooks</td>
<td>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.</td>
</tr>
<tr>
<td>Reference Books</td>
<td>1. Textbook of Electronics by S. Chattopadhyay, New Central Book Agency Pvt. Ltd.</td>
</tr>
<tr>
<td>Teaching Methodology</td>
<td>Classroom lectures/Assignments/Problem Solving/Tutorials</td>
</tr>
<tr>
<td>Evaluation Method</td>
<td>Internal Assessment: 25Marks
External Assessment: 25Marks</td>
</tr>
</table>

[Subject code for Practical-2603000507031002]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester VII –With OJT)</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Physics</td></tr>
<tr><td>Course Code</td><td colspan="6">PHP-MJ-703</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on Analog and Digital Electronics</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>Effective Form</td><td colspan="6">Academic Year: 2026-27</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–Solveproblems for designing and simulating analog to digital circuits and vice versa.
CO6 –Understandthe 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–Explainthe working mechanism for various modules by different counters.
CO10–Solveproblems 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 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
6. To design build and test zero crossing detector using op-amp.
7. To design build and test voltage follower using op-amp.
8. To design build and test AstableMultivibrator using op-amp.
9. To design build and test voltage limiter using op-amp and Two Zenerdiodes
10. To design build and test 4-bit binary Adder and Subtractor 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 1^{st} an 2^{nd}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

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	3	2	1	1	1	1	2
CO2	3	3	2	2	2	1	3
CO3	3	3	2	2	2	1	3
CO4	3	2	1	1	1	1	2
CO5	3	3	2	3	2	1	3
CO6	3	2	1	1	1	1	2
CO7	3	3	2	3	2	1	3
CO8	3	2	2	2	1	1	2
CO9	3	3	2	2	2	1	3
CO10	3	3	2	3	2	1	3

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.
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 externalexamination.

Veer Narmad South Gujarat University, Surat

Syllabus

B. Sc. (Honors) With OJT /Research Project

Physics

Semester –VII

NEP- 2020

(Effective from Academic Year: 2026-2027)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

PROGRAM TITLE

Name of Program	Bachelor of Science (Honors) Physics
Program Abbreviation	B. Sc. (Hon) Physics
Duration	4 years
Eligibility Criteria	HSC (12Th Pass in Science Stream) or equivalent from recognized board/institute)
Pre-requisite	
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 B.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 B.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 analyze 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 analyze 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 (M.Sc., integrated Ph.D., etc.), 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 Leve :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 Program (Semester-VII) (Single Major -Honors without OJT/Research Project)

Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total Makrs	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR -1	PH-MJ-701	Mathematical Methods and Solid-State Physics	Mathematical Methods and Solid-State Physics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-701	Practical based on "Mathematical Methods and Solid-State Physics"	Mathematical Methods and Solid-State Physics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -2	PH-MJ-702	Quantum Mechanics and Statistical Mechanics	Quantum Mechanics and Statistical Mechanics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-702	Practical based on "Quantum Mechanics and Statistical Mechanics"	Quantum Mechanics and Statistical Mechanics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -3	PH-MJ-703	Analog and Digital Electronics	Analog and Digital Electronics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-703	Practical based on "Analog and Digital Electronics"	Analog and Digital Electronics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -4	PH-MJ-704	Quantum Computation and Astrophysics	Quantum Computation and Astrophysics	400-499	4	-	2	-	4	-	50	-	50	-	50	-
MINOR ELECTIVE	ME-CS	Fundamentals of Cyber Security	Fundamentals of Cyber Security	400-499	4	0	2	0	4	0	50	0	50	0	100	0

[Subject code for Theory-2603000507011001]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester VII –With OJT)

Program Name	B. Sc.
Semester	VII
NCrF Credit Level	6
Course Type	Major
Course Subtype	Nil
Subject Type	Discipline Specific
Course Code	PH-MJ-701
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:**Analyze 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

<table>
<tr><td></td><td>of derivatives and integrals; other properties of Laplace
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) Donor States(b) Acceptor States (c) Thermal ionization of donors and acceptors, Semi Metals., Superlattices. (a)Bloch Oscillator (b) Zener Tunneling.</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>–</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>–</td><td>2</td><td>2</td><td>–</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>–</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>–</td><td>2</td></tr>
<tr><td>CO5</td><td>2</td><td>3</td><td>–</td><td>2</td><td>3</td><td>–</td><td>2</td></tr>
<tr><td>CO6</td><td>2</td><td>3</td><td>–</td><td>2</td><td>3</td><td>–</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>–</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>2</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 by K.F.Riley,M.P.Hobson,S.J. Bence, 3rd 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>

[Subject code for Practical-2603000507011002]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester VII –With OJT)

Program Name	B. Sc.					
Semester	VII					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	PHP-MJ-701					
Course Level	400-499					
Course Title	Practical based on “Mathematical Methods and Solid-State Physics”					
Credit	**Theory**	**-**	**Practical:**	**02**	**Total**	**02**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	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 behavior** 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					
Course Content	**Practical** **Unit-1: Solve problems based on** 1. Vector space verification 2. Determinant evaluation 3. Determinant equation solving 4. Matrix classification					

<table>
<tr>
<td></td>
<td>
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)
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)
</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><th>Cos/PSOs</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</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>–</td><td>2</td></tr>
<tr><td>CO6</td><td>3</td><td>3</td><td>–</td><td>2</td><td>1</td><td>–</td><td>2</td></tr>
<tr><td>CO7</td><td>3</td><td>2</td><td>3</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>2</td><td>1</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO9</td><td>2</td><td>2</td><td>3</td><td>1</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO10</td><td>2</td><td>3</td><td>3</td><td>2</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO11</td><td>1</td><td>2</td><td>2</td><td>1</td><td>3</td><td>3</td><td>2</td></tr>
</table>
</td>
</tr>
<tr>
<td>Reference Books</td>
<td>
1. Mathematical Methods for Physics and Engineering by K.F.Riley,M.P.Hobson,S.J. Bence, 3rd Edition Cambridge.
2. Introduction to solid State Physics by Charles Kittel. Global Edition.
</td>
</tr>
<tr>
<td>Teaching Methodology</td>
<td>Laboratory Work, Problem Solving, Project</td>
</tr>
<tr>
<td>Evaluation Method</td>
<td>Internal Assessment: 25 Marks
External Assessment: 25 Marks</td>
</tr>
</table>

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 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.

[Subject code for Theory-2603000507021001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester VII –With OJT)</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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">Nil</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-MJ-702</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Quantum Mechanics and Statistical Mechanics</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 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 –Analyze 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 behavior of physical systems using the Darwin–Fowler method.
CO7 – Differentiate between classical and quantum regimes by analyzing 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 paramagnetism through quantum statistical principles.
CO9 – Explore Boson systems by understanding photon gases, phonons in solids, and the phenomenon of Bose–Einstein condensation,
CO10- Explore Boson systems byextending to the behavior of imperfect Bose gases in real systems.</td></tr>
<tr><td>Course Content</td><td colspan="6">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</td></tr>
</table>

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), 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 paramagnetism(11.6).

Boson Systems:

Photons (12.1), Photons in solids (12.2), Bose-Einstein condensation (12.3), an imperfect ideal gas (12.4).

Mapping between Cos and PSOs

Mapping Key:

3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	3	2	1	1	2	1	2
CO2	3	3	1	2	2	1	3
CO3	3	3	1	2	2	1	3
CO4	3	3	2	2	2	1	3
CO5	3	3	1	2	3	2	3
CO6	3	3	1	2	3	2	3
CO7	3	3	1	2	3	2	3
CO8	3	3	2	2	3	2	3
CO9	3	2	2	2	3	2	3
CO10	3	3	2	2	3	2	3

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

Classroom lectures/Assignments/Problem Solving/Tutorials

Evaluation Method

Internal Assessment: 25 Marks
External Assessment: 25 Marks

[Subject code for Practical-2603000507021002]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS (Semester VII –With OJT)

Program Name	B. Sc. Physics					
Semester	VII					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	PHP-MJ-702					
Course Level	400-499					
Course Title	Practical based on "Quantum Mechanics and Statistical Mechanics"					
Credit	**Theory**	**-**	**Practical**	**02**	**Total:**	**02**
Effective Form	Academic Year: 2026-27					
Course Outcomes	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, eigenfunctions, 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 ofthe 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 $\langle\widehat{H}\rangle$, 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 avalue 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 thefollowing matrices:

$$A = \begin{pmatrix} 5 & 0 & 0 \\ 0 & 1 & 2 \\ 0 & 2 & 1 \end{pmatrix}, B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 03 \\ 0 & 30 \end{pmatrix}, C = \begin{pmatrix} 03 & 0 \\ 30 & 2 \\ 0\ 2 & 0 \end{pmatrix}\ D = \begin{pmatrix} 1\ 0\ 0 \\ 0\ 0-i \\ 0i0 \end{pmatrix}$$

(a) Find the results of the measurements of these observables.

(b) Which among these observables are compatible? Give a basis of eigenvectors commonto 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 orbitalangular momentum.

(b) Calculate the commutator between the x and y components of the orbital angular momentumoperator.

(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 energy E_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 $\widehat{H} = \frac{1}{2}\hat{P}^2 + \frac{1}{2}\hat{X}^2$, 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$\widehat{H}$ with eigenvalues 1/2and3/2, respectively.(b) Find the value of the coefficientαsuch 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$\widehat{H}$ with eigenvalue 5/2.
10. Consider a system whose initial state at $t = 0$ is given in terms of a complete and

orthonormal set 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$\lfloor\psi(t)\rangle$at any later time t.

(c) Determine the probability of finding the system at a time t in the state$\lfloor\phi_3\rangle$.

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

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	3	2	1	1	2	1	2
CO2	3	3	1	2	2	1	3
CO3	3	3	1	2	2	1	3
CO4	3	3	2	2	2	1	3
CO5	3	3	1	2	3	2	3
CO6	2	3	2	3	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: 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 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 externalexamination.

[Subject code for Theory-2603000507031001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester VII –With OJT)</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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-MJ-703</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–Understandthe 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–Solveproblems for designing and simulating analog to digital circuits and vice versa.
CO6 –Understandthe 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–Explainthe working mechanism for various modules by different counters.
CO10–Solveproblems for designing and simulating modulo-counter circuits using flip-flops.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Filters
Introduction (8.1), 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 & 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>
</table>

<table>
<tr>
<td>Mapping between Cos and PSOs</td>
<td>Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table>
<tr><th>CO/PSO</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</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>CO2</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</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>3</td></tr>
<tr><td>CO4</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>CO5</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO6</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>CO7</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO8</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO9</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO10</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
</table>
</td>
</tr>
<tr>
<td>TextBooks</td>
<td>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.</td>
</tr>
<tr>
<td>Reference Books</td>
<td>1. Textbook of Electronics by S. Chattopadhyay, New Central Book Agency Pvt. Ltd.</td>
</tr>
<tr>
<td>Teaching Methodology</td>
<td>Classroom lectures/Assignments/Problem Solving/Tutorials</td>
</tr>
<tr>
<td>Evaluation Method</td>
<td>Internal Assessment: 25Marks
External Assessment: 25Marks</td>
</tr>
</table>

[Subject code for Practical-2603000507031002]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester VII –With OJT)</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Physics</td></tr>
<tr><td>Course Code</td><td colspan="6">PHP-MJ-703</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on Analog and Digital Electronics</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>Effective Form</td><td colspan="6">Academic Year: 2026-27</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–Solveproblems for designing and simulating analog to digital circuits and vice versa.
CO6 –Understandthe 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–Explainthe working mechanism for various modules by different counters.
CO10–Solveproblems 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 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
6. To design build and test zero crossing detector using op-amp.
7. To design build and test voltage follower using op-amp.
8. To design build and test AstableMultivibrator using op-amp.
9. To design build and test voltage limiter using op-amp and Two Zenerdiodes
10. To design build and test 4-bit binary Adder and Subtractor 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 1st an 2ndtheorem using IC-7402 and IC-7400.
16. To design and set up a 4-bit R-2R ladder DAC.</td></tr>
</table>

<table>
<tr><td>Mapping between Cos and PSOs</td><td>Mapping Key:
3 – High Correlation / 2 – Moderate Correlation / 1 – Low Correlation /– – No Correlation
<table>
<tr><th>CO/PSO</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</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>CO2</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</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>3</td></tr>
<tr><td>CO4</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>CO5</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO6</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>CO7</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO8</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>CO9</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO10</td><td>3</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
</table></td></tr>
<tr><td>TextBooks</td><td>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.</td></tr>
<tr><td>Reference Books</td><td>1. Textbook of Electronics by S. Chattopadhyay, New Central Book Agency Pvt. Ltd.</td></tr>
<tr><td>Teaching Methodology</td><td>Laboratory Work</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 25 Marks
External Assessment: 25Marks</td></tr>
</table>

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 externalexamination.

[Subject code-2603000507051001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS (Semester VII –Without OJT)</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.</td></tr>
<tr><td>Semester</td><td colspan="6">VII</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-MJ-704</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Quantum Computation and Astrophysics</td></tr>
<tr><td>Credit</td><td>Theory:</td><td>04</td><td>Practical:</td><td>0</td><td>Total:</td><td>4</td></tr>
<tr><td>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">After successful completion, the student will be able to
CO1 Understand the fundamental principles of quantum computation, qubits, and quantum information processing.
CO2 Analyse single-qubit and multi-qubit systems, quantum gates, and quantum circuit operations.
CO3 Explain quantum measurements, projective measurements, POVM measurements, and quantum state evolution.
CO4 Apply concepts of Bell states, entanglement, and quantum teleportation in quantum communication systems.
CO5 Understand universal quantum gates, controlled operations, and basic quantum algorithms.
CO6 Develop analytical and computational skills related to quantum circuits and computational models.
CO7 Understand the basic concepts of astrophysics and cosmology including cosmological principles and constituents of the universe.
CO8 Explain the expanding universe using Hubble’s law, redshift, and cosmological models.
CO9 Analyse cosmic distance measurement techniques such as parallax, Cepheid variables, and supernovae.
CO10 Understand the Big Bang theory, nucleosynthesis, recombination, and thermal history of the universe.
CO11 Explain the origin and significance of Cosmic Microwave Background radiation and its anisotropies.
CO12 Understand dark matter, dark energy, galaxy formation, and large-scale structures of the universe.
CO13 Develop scientific temperament, research aptitude, and multidisciplinary understanding aligned with NEP 2020.</td></tr>
</table>

<table>
<tr><td>Course Content</td><td>Unit-1 Quantum Computations-Basics: Fundamental concepts of Quantum Computations Quantum bits (1.2), Multiple qubits (1.2.1), Quantum computation (1.3); Single qubit gates (1.3.1), Multiple qubit gates (1.3.2), Measurements in bases other than the computational basis (1.3.3), Quantum Circuits (1.3.4), Qubit copying circuits? (1.3.5), Example: Bell States (1.3.6), Example: quantum teleportation.
Unit-2 Quantum Computations: The postulates of quantum mechanics (2.2); State Space (2.2.1), Evolution (2.2.2), Quantum measurement (2.2.3), Distinguishing quantum states (2.2.4), Projective measurements (2.2.5), POVM measurements (2.2.6), Phase (2.2.7), Composite system.
Quantum circuits (4); Quantum algorithms (4.1), Single qubit operations (4.2), Controlled operations (4.3), Measurement (4.4), Universal quantum gates.
Unit 3: Astrophysics & Cosmology-1: Astrophysics vs Cosmology: Cosmological Principle, Constituents of Universe, Large-scale structure.
Expanding Universe: Hubble’sLaw, Redshift, Scalefactor, Comoving coordinates
Cosmological Models: Robertson–Walker metric (qualitative), Friedmann equations (physical interpretation), Critical density, Open, closed, flat universe
Distance Scale:Cosmic distance ladder, Parallax, Cepheidvariables, Supernovae, Luminosity distance
Unit 4: Astrophysics & Cosmology-2: Big Bang Theory:Evidence of Big Bang, Thermalhistory, Nucleosynthesis, Recombination.
Cosmic Microwave Background: Origin Blackbodyspectrum, Anisotropies, Dark Matter & Dark Energy: Evidence and concepts, Galaxy rotation curves Accelerating universe, Structure Formation: Galaxy-formation, Large-scale structure, Open problems</td></tr>
<tr><td>Mapping between Cos and PSOs</td><td>
<table>
<tr><th>COs \ PSOs</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</td><td>3</td><td>2</td><td>1</td><td>2</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>CO2</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>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>2</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO5</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO6</td><td>2</td><td>3</td><td>2</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>CO7</td><td>3</td><td>2</td><td>1</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>CO8</td><td>3</td><td>3</td><td>1</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>CO9</td><td>3</td><td>3</td><td>2</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>CO10</td><td>3</td><td>2</td><td>1</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>CO11</td><td>3</td><td>2</td><td>1</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>CO12</td><td>3</td><td>3</td><td>2</td><td>2</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>CO13</td><td>2</td><td>2</td><td>2</td><td>2</td><td>3</td><td>3</td><td>3</td></tr>
</table>
</td></tr>
<tr><td>Reference Books</td><td>1. Computation and Quantum Information by Michael A. Nielsen and Isaac L. Chuang, Cambridge University Press, 2010.
2. Introduction to Cosmology by Barbara Ryden, Cambridge University Press.
3. An introduction to Astrophysics by Carroll and Ostile by Cambridge University Press.
4. An introduction to Astrophysics by Baidyanath Basu,Tanuka Chattopadhyay,Sudhindra Nath Biswas Prentice Hall India (PHI)</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: 25Marks</td></tr>
</table>

Veer Narmad South Gujarat University, Surat

Syllabus

B. Sc. (Honors) With OJT /Research Project
Physics
Semester –VIII
NEP- 2020

(Effective from Academic Year: 2026-2027)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

PROGRAM TITLE

Name of Program	Bachelor of Science (Honors) Physics
Program Abbreviation	B. Sc. (Hon) Physics
Duration	4 years
Eligibility Criteria	HSC (12 Th Pass in Science Stream) or equivalent from recognized board/institute)
Pre-requisite	
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 B.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 B.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 analyze 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 analyze 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 (M.Sc., integrated Ph.D., etc.), 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 Leve :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 Program (Semester-VIII) (Single Major -Honors withOJT/Research Project)

Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total Marks	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR -1	PH-MJ-801	Classical Mechanics & Astronomy (IKS)	Classical Mechanics & Astronomy (IKS)	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-801	Practical based on "Classical Mechanics & Astronomy (IKS)"	Classical Mechanics & Astronomy (IKS) practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -2	PH-MJ-802	Atomic and Nuclear Physics	Atomic and Nuclear Physics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-802	Practical based on "Atomic and Nuclear Physics"	Atomic and Nuclear Physics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -3	PH-MJ-803	Classical Electrodynamics	Classical Electrodynamics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-803	Practical based on "Classical Electrodynamics"	Classical Electrodynamics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MINOR Elective	ME	Entrepreneurship	Entrepreneurship	400-499	4	0	2	0	4	0	50	0	50	0	100	0
*OJT/ Research Project									**6**		50		50		100	

*__OJT__ (on job training) for students enrolled in **B,Sc. (honors)** with OJT is mandatory as per **University Guidelines**.

OR

Research Project for students enrolled in **B,Sc. (honors with Research)**is mandatory as per **University Guidelines**

[Subject code for Theory-2703000508011001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-MJ-801</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Classical Mechanics& Astronomy (IKS)</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– 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.</td></tr>
<tr><td>Course Content</td><td colspan="6">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), <i>Ā</i>ryabhat<i>ī</i>ya and Siddh<i>ā</i>ntic Tradition (9.5), Pa<i>ñcāṅga</i>-The Indian Calendar System (9.6), Astronomical Instruments (Yantras) (9.7), Jantar Mantar of Raja Jai Singh Sawai (9.8).</td></tr>
<tr><td>Mapping between Cos and PSOs</td><td colspan="6">Correlation Levels:
3 – High | 2 – Moderate | 1 – Low</td></tr>
</table>

PSO/CO	**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	–	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 by Goldstein, 3rd Ed., Poole & Safco Addision, Wesley San Francisco Boston NewYork. 2. Introduction to Indian Knowledge System Concepts and Applications by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R. N.
Teaching Methodology	Classroom Teaching,Assignments,Tutorials
Evaluation Method	Internal Assessment: 25 Marks External Assessment: 25Marks

[Subject code for Practical-2703000508011002]

<table>
<tr><td colspan="7">

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

</td></tr>
<tr><td>**Program Name**</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>**Semester**</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>**Subject Type**</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>**Course Code**</td><td colspan="6">PHP-MJ-801</td></tr>
<tr><td>**Course Level**</td><td colspan="6">400-499</td></tr>
<tr><td>**Course Title**</td><td colspan="6">Practical based on “Classical Mechanics & Astronomy (IKS)”</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>**Effective Form**</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>**Course Outcomes**</td><td colspan="6">**CO1 –** Understand and apply the Hamiltonian Principle to derive Lagrange’s equations of motion for both holonomic and non-holonomic systems
CO2 – Analyze rigid body dynamics using angular momentum, inertia tensor, and Euler’s equations of motion.
CO3 – Examine torque-free motion and the motion of a symmetric top to understand rotational stability and precession
CO4 – Integrate mathematical methods and physical laws to interpret the dynamics of complex mechanical systems.
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.</td></tr>
<tr><td>**Course Content**</td><td colspan="6">**List of experiments:**
1. To measure period of oscillation of the given pendulum by changing angle and length using variable ‘g’ pendulum setup.
2. To determine the range of a 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 moment of inertia of a gyroscope by measurement of angular acceleration.
6. To study rolling motion on an inclined plane.
Solve the problems:
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 the generalized coordinates.
9. Find the Hamiltonian for a given system and use of canonical equation for that.
10. Show whether the given transformations are canonical or not.
11.**Project based on unit-2**
(Indian Knowledge System- equivalent to four experiments)</td></tr>
</table>

<table>
<tr><td>Mapping between Cos and PSOs</td><td>Correlation Levels:
3 – High | 2 – Moderate | 1 – Low
<table>
<tr><th>CO/PSO</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>–</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>–</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>2</td><td>1</td><td>2</td><td>–</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>2</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>CO5</td><td>2</td><td>1</td><td>–</td><td>–</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>CO6</td><td>2</td><td>1</td><td>–</td><td>–</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td>CO7</td><td>3</td><td>2</td><td>1</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>CO8</td><td>3</td><td>2</td><td>–</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
</table></td></tr>
<tr><td>Reference Books</td><td>1. Classical Mechanics by Goldstein, 3rd Ed., Poole & Safco Addision, Wesley San Francisco Boston NewYork.(Text Book)
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 K. Sankara Rao Publisher: PHI Learning Pvt. Ltd. 1st Ed. 2005.</td></tr>
<tr><td>Teaching Methodology</td><td>Laboratory Work, Problem Solving, Project</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 25 Marks
External Assessment: 25Marks</td></tr>
</table>

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 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 externalExamination.

[Subject code for Theory-2703000508021001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-MJ-802</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Atomic and Nuclear 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 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.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Atomic Physics
Vector Atom Model
The Molecular Bond (8.1), Electron Sharing (8.2), The H_2^+Molecular Ion (8.3), System</td></tr>
</table>

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),Vibrational Spectra (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).

Mapping between Cos and PSOs

Correlation Levels:

3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	1	2	–	2
CO2	3	3	1	1	2	–	2
CO3	3	3	2	2	2	–	2
CO4	3	2	2	1	2	1	2
CO5	3	3	3	2	2	1	2
CO6	3	2	1	2	2	1	2
CO7	3	3	2	2	2	1	2
CO8	2	2	1	2	1	–	2
CO9	3	3	2	2	2	1	3
CO10	3	2	3	1	2	2	3
CO11	3	3	3	1	2	2	3

Reference Books

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. Atomic Physics by S. N. Ghoshal.
5. Nuclear Physics by S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged Ed., 2014.
6. Introduction to Nuclear and Particle Physics by V. K. Mittal, R. C. Verma and S. C. Gupta, 3rd Ed., 2013
7. Nuclear Physics by D. C. Tayal, Himalaya Publishing House, 2017.

Teaching Methodology

Classroom Teaching, Assignments, Tutorials

Evaluation Method

Internal Assessment:25 Marks

External Assessment: 25 Marks

[Subject code for Practical-2703000508021002]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.(honors) Physics.</td></tr>
<tr><td>Semester</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PHP-MJ-802</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on “Atomic and Nuclear Physics”</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>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">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.</td></tr>
<tr><td>Course Content</td><td colspan="6">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.</td></tr>
</table>

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 a graph of energy vs. inter-nuclear distance using theoretical data and determine equilibrium bond distance and minimum energy.
6. Construct bonding and anti-bonding 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

Correlation Levels:3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	1	2	1	2
CO2	3	3	1	1	2	1	2
CO3	3	3	2	1	2	1	2
CO4	3	3	2	1	2	1	2
CO5	3	3	3	1	3	1	2
CO6	3	2	1	1	2	2	3
CO7	3	3	1	1	2	1	3
CO8	2	3	1	1	1	1	2
CO9	3	3	2	1	2	1	3
CO10	3	3	3	1	2	2	3
CO11							

Reference Books

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. Atomic Physics by S. N. Ghoshal.
5. Nuclear Physics by S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged Ed., 2014.
6. Introduction to Nuclear and Particle Physics by V. K. Mittal, R. C. Verma and S. C. Gupta, 3rd Ed., 2013.
7. Nuclear Physics by D. C. Tayal, Himalaya Publishing House, 2017.

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

[Subject code for Theory-2703000508031001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-MJ-803</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Classical Electrodynamics</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 electrostatic 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– Apply mathematical 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– Analyze multipole 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– Comprehend scalar 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– Examine time-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– Understand the 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– Analyze electromagnetic 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– Examine electromagnetic 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–Investigate the 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– Explore frequency-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.</td></tr>
<tr><td>Course Content</td><td colspan="6">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</td></tr>
</table>

(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

Correlation Levels:3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	2	1	2
CO2	3	3	1	2	2	1	2
CO3	3	3	1	2	2	1	2
CO4	3	3	1	2	2	1	2
CO5	3	3	1	2	2	1	3
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 Teaching,Assignments,Tutorials

Evaluation Method

Internal Assessment: 25 Marks
External Assessment: 25Marks

[Subject code for Practical-2703000508031002]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	B. Sc.(honors) Physics					
Semester	VIII					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	NIL					
Subject Type	Discipline Specific					
Course Code	PHP-MJ-803					
Course Level	400-499					
Course Title	Practical based on “Classical Electrodynamics”					
Credit	**Theory:**	**-**	**Practical:**	**02**	**Total:**	**02**
Effective Form	Academic Year: 2026-27					
Course Outcomes	**CO1 – Understand** electrostatic 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– Apply** mathematical 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– Analyze** multipole 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– Comprehend** scalar 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– Examine** time-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– Understand** the 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– Analyze** electromagnetic 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– Examine** electromagnetic 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–Investigate** the 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– Explore** frequency-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	**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 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 ($\sigma \approx 10^7\ (\Omega\ \mathrm{m})^{-1}$) in the visible range ($\omega \approx 10^{15}/\mathrm{s}$), 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)

Mapping between Cos and PSOs

Correlation Levels:3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2	3	3	1	2	2	1	2
CO3	3	3	1	2	2	1	2
CO4	3	3	1	2	2	1	2
CO5	3	3	1	2	2	1	2
CO6	3	3	1	2	2	1	3
CO7	3	3	2	1	2	1	2
CO8	3	3	2	2	2	1	3
CO9	3	3	2	2	3	1	3
CO10	3	3	2	2	3	2	3
CO11	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

Laboratory work , Problem Solving

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 one experiment and therewill be 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

B. Sc. (Honors) Without OJT /Research Project
Physics
Semester –VIII
NEP- 2020

(Effective from Academic Year: 2026-2027)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

PROGRAM TITLE

Name of Program	Bachelor of Science (Honors) Physics
Program Abbreviation	B. Sc. (Hon) Physics
Duration	4 years
Eligibility Criteria	HSC (12 Th Pass in Science Stream) or equivalent from recognized board/institute)
Pre-requisite	
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 B.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 B.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 analyze 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 analyze 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 (M.Sc., integrated Ph.D., etc.), 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 Leve :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 Program (Semester-VIII) (Single Major -Honors withOJT/Research Project)

Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total Marks	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR -1	PH-MJ-801	Classical Mechanics & Astronomy (IKS)	Classical Mechanics & Astronomy (IKS)	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-801	Practical based on "Classical Mechanics & Astronomy (IKS)"	Classical Mechanics & Astronomy (IKS) practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -2	PH-MJ-802	Atomic and Nuclear Physics	Atomic and Nuclear Physics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-802	Practical based on "Atomic and Nuclear Physics"	Atomic and Nuclear Physics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -3	PH-MJ-803	Classical Electrodynamics	Classical Electrodynamics	400-499	2	-	1	-	2	-	25	-	25	-	50	-
	PHP-MJ-803	Practical based on "Classical Electrodynamics"	Classical Electrodynamics practical	400-499	-	4	-	4	-	2	-	25	-	25	-	50
MAJOR -4	PH-MJ-804	Applied Physics and Instrumentation	Applied Physics and Instrumentation	400-499	4	-	2	-	4	-	50	-	50	-	100	-
MINOR Elective	ME	Entrepreneurship	Entrepreneurship	400-499	4	0	2	0	4	0	50	0	50	0	100	0

[Subject code for Theory-2703000508011001]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

Program Name	B. Sc.(honors) Physics
Semester	VIII
NCrF Credit Level	6
Course Type	Major
Course Subtype	NIL
Subject Type	Discipline Specific
Course Code	PH-MJ-801
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)** **The Hamiltonian Equations of 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) **Canonical Transformations:** 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	**Correlation Levels:** **3 – High | 2 – Moderate | 1 – Low**

PSO/CO	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	–	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 by Goldstein, 3rd Ed., Poole & Safco Addision, Wesley San Francisco Boston NewYork. 2. Introduction to Indian Knowledge System Concepts and Applications by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R. N.
Teaching Methodology	Classroom Teaching,Assignments,Tutorials
Evaluation Method	Internal Assessment: 25 Marks External Assessment: 25Marks

[Subject code for Practical-2703000508011002]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PHP-MJ-801</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on “Classical Mechanics & Astronomy (IKS)”</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>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1 – Understand and apply the Hamiltonian Principle to derive Lagrange’s equations of motion for both holonomic and non-holonomic systems
CO2 – Analyze rigid body dynamics using angular momentum, inertia tensor, and Euler’s equations of motion.
CO3 – Examine torque-free motion and the motion of a symmetric top to understand rotational stability and precession
CO4 – Integrate mathematical methods and physical laws to interpret the dynamics of complex mechanical systems.
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.</td></tr>
<tr><td>Course Content</td><td colspan="6">List of experiments:
1. To measure period of oscillation of the given pendulum by changing angle and length using variable ‘g’ pendulum setup.
2. To determine the range of a 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 moment of inertia of a gyroscope by measurement of angular acceleration.
6. To study rolling motion on an inclined plane.
Solve the problems:
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 the generalized coordinates.
9. Find the Hamiltonian for a given system and use of canonical equation for that.
10. Show whether the given transformations are canonical or not.
11.Project based on unit-2
(Indian Knowledge System- equivalent to four experiments)</td></tr>
</table>

<table>
<tr>
<td>Mapping between Cos and PSOs</td>
<td>Correlation Levels:
3 – High | 2 – Moderate | 1 – Low
<table>
<tr><th>CO/PSO</th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</td><td>3</td><td>3</td><td>1</td><td>2</td><td>2</td><td>–</td><td>2</td></tr>
<tr><td>CO2</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>–</td><td>2</td></tr>
<tr><td>CO3</td><td>3</td><td>3</td><td>2</td><td>1</td><td>2</td><td>–</td><td>2</td></tr>
<tr><td>CO4</td><td>3</td><td>3</td><td>2</td><td>2</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>CO5</td><td>2</td><td>1</td><td>–</td><td>–</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>CO6</td><td>2</td><td>1</td><td>–</td><td>–</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td>CO7</td><td>3</td><td>2</td><td>1</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>CO8</td><td>3</td><td>2</td><td>–</td><td>1</td><td>3</td><td>2</td><td>2</td></tr>
</table>
</td>
</tr>
<tr>
<td>Reference Books</td>
<td>1. Classical Mechanics by Goldstein, 3rd Ed., Poole & Safco Addision, Wesley San Francisco Boston NewYork.(Text Book)
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 K. Sankara Rao Publisher: PHI Learning Pvt. Ltd. 1st Ed. 2005.</td>
</tr>
<tr>
<td>Teaching Methodology</td>
<td>Laboratory Work, Problem Solving, Project</td>
</tr>
<tr>
<td>Evaluation Method</td>
<td>Internal Assessment: 25 Marks
External Assessment: 25Marks</td>
</tr>
</table>

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 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 externalExamination.

[Subject code for Theory-2703000508021001]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PH-MJ-802</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Atomic and Nuclear 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 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.</td></tr>
<tr><td>Course Content</td><td colspan="6">Unit – 1 Atomic Physics
Vector Atom Model
The Molecular Bond (8.1), Electron Sharing (8.2), The H_2^+Molecular Ion (8.3), System</td></tr>
</table>

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),Vibrational Spectra (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).

Mapping between Cos and PSOs

Correlation Levels:
3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	1	2	–	2
CO2	3	3	1	1	2	–	2
CO3	3	3	2	2	2	–	2
CO4	3	2	2	1	2	1	2
CO5	3	3	3	2	2	1	2
CO6	3	2	1	2	2	1	2
CO7	3	3	2	2	2	1	2
CO8	2	2	1	2	1	–	2
CO9	3	3	2	2	2	1	3
CO10	3	2	3	1	2	2	3
CO11	3	3	3	1	2	2	3

Reference Books

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. Atomic Physics by S. N. Ghoshal.
5. Nuclear Physics by S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged Ed., 2014.
6. Introduction to Nuclear and Particle Physics by V. K. Mittal, R. C. Verma and S. C. Gupta, 3rd Ed., 2013
7. Nuclear Physics by D. C. Tayal, Himalaya Publishing House, 2017.

Teaching Methodology

Classroom Teaching, Assignments, Tutorials

Evaluation Method

Internal Assessment:25 Marks
External Assessment: 25 Marks

[Subject code for practical-2703000508021002]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT **SYLLABUS**						
Program Name	B. Sc.(honors) Physics.					
Semester	VIII					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	NIL					
Subject Type	Discipline Specific					
Course Code	PHP-MJ-802					
Course Level	400-499					
Course Title	Practical based on “Atomic and Nuclear Physics”					
Credit	**Theory:**	**-**	**Practical:**	**02**	**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.					
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 a graph of energy vs. inter-nuclear distance using theoretical data and determine equilibrium bond distance and minimum energy.
6. Construct bonding and anti-bonding 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

Correlation Levels:3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	1	2	1	2
CO2	3	3	1	1	2	1	2
CO3	3	3	2	1	2	1	2
CO4	3	3	2	1	2	1	2
CO5	3	3	3	1	3	1	2
CO6	3	2	1	1	2	2	3
CO7	3	3	1	1	2	1	3
CO8	2	3	1	1	1	1	2
CO9	3	3	2	1	2	1	3
CO10	3	3	3	1	2	2	3
CO11							

Reference Books

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. Atomic Physics by S. N. Ghoshal.
5. Nuclear Physics by S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged Ed., 2014.
6. Introduction to Nuclear and Particle Physics by V. K. Mittal, R. C. Verma and S. C. Gupta, 3rd Ed., 2013.
7. Nuclear Physics by D. C. Tayal, Himalaya Publishing House, 2017.

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

[Subject code for Theory-2703000508031001]

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

<table>
<tr><td>**Program Name**</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>**Semester**</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>**Subject Type**</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>**Course Code**</td><td colspan="6">PH-MJ-803</td></tr>
<tr><td>**Course Level**</td><td colspan="6">400-499</td></tr>
<tr><td>**Course Title**</td><td colspan="6">Classical Electrodynamics</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** electrostatic 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– Apply mathematical 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– Analyze multipole 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– Comprehend scalar 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– Examine time-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– Understand the 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– Analyze electromagnetic 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– Examine electromagnetic 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–Investigate the 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– Explore frequency-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.</td></tr>
<tr><td>**Course Content**</td><td colspan="6">**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</td></tr>
</table>

(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

Correlation Levels:3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	2	1	2
CO2	3	3	1	2	2	1	2
CO3	3	3	1	2	2	1	2
CO4	3	3	1	2	2	1	2
CO5	3	3	1	2	2	1	3
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 Teaching,Assignments,Tutorials

Evaluation Method

Internal Assessment: 25 Marks
External Assessment: 25Marks

[Subject code for Practical-2703000508031002]

<table>
<tr><td colspan="7">VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
SYLLABUS</td></tr>
<tr><td>Program Name</td><td colspan="6">B. Sc.(honors) Physics</td></tr>
<tr><td>Semester</td><td colspan="6">VIII</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">NIL</td></tr>
<tr><td>Subject Type</td><td colspan="6">Discipline Specific</td></tr>
<tr><td>Course Code</td><td colspan="6">PHP-MJ-803</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Title</td><td colspan="6">Practical based on “Classical Electrodynamics”</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>Effective Form</td><td colspan="6">Academic Year: 2026-27</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1 – Understand electrostatic 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– Apply mathematical 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– Analyze multipole 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– Comprehend scalar 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– Examine time-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– Understand the 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– Analyze electromagnetic 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– Examine electromagnetic 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–Investigate the 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– Explore frequency-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.</td></tr>
<tr><td>Course Content</td><td colspan="6">Experiments:
1. To study Hall effect.
2. To study Electron Spin Resonance (ESR).
3. To determine energy band-gap of different semiconducting materials.</td></tr>
</table>

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 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 ($\sigma \approx 10^7\ (\Omega\ \text{m})^{-1}$) 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)

Mapping between Cos and PSOs

Correlation Levels:3 – High | 2 – Moderate | 1 – Low

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2	3	3	1	2	2	1	2
CO3	3	3	1	2	2	1	2
CO4	3	3	1	2	2	1	2
CO5	3	3	1	2	2	1	2
CO6	3	3	1	2	2	1	3
CO7	3	3	2	1	2	1	2
CO8	3	3	2	2	2	1	3
CO9	3	3	2	2	3	1	3
CO10	3	3	2	2	3	2	3
CO11	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

Laboratory work , Problem Solving

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 one experiment and therewill be 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 VII –Without OJT)

Program Name	B. Sc.					
Semester	VIII					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	NIL					
Subject Type	Discipline Specific					
Course Code	PH-MJ-804					
Course Level	400-499					
Course Title	Applied Physics and Instrumentation					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**4**
Effective Form	Academic Year: **2026-27**					
Course Outcomes	After successful completion of the course, students will be able to CO-1 Explain principle and working of various scientific instruments and measurement systems. CO-2 Understand characteristics and applications of sensors and transducers. CO-3 Apply concepts of signal conditioning, digital electronics and data acquisition systems. CO-4 Analyze instrumentation systems used in medical, industrial and communication applications. CO-5 Develop problem-solving ability related to measurement, calibration and instrumentation techniques.					
Course Content	**Unit-I: Measurement Systems and Error Analysis** • Basic concepts of measurements and instrumentation • Accuracy, precision, sensitivity, resolution and efficiency • Types of errors and error analysis • Standards and calibration techniques • Analog and digital measuring instruments • Multimeters, CRO and Digital Storage Oscilloscope (DSO) • Signal generators and frequency counters • Introduction to virtual instrumentation **Unit-II: Sensors and Transducers** • Classification of sensors and transducers • Resistive, inductive and capacitive transducers • Thermistors, RTDs and thermocouples • Piezoelectric and Hall effect sensors					

- Optical sensors and photo detectors
- Strain gauges and pressure sensors
- Smart sensors and MEMS devices
- Applications in industrial and scientific systems

Unit-III : Signal Conditioning and Digital Instrumentation

- Signal conditioning systems
- Amplifiers and operational amplifier applications
- Filters and noise reduction techniques
- Analog to Digital Converter (ADC)
- Digital to Analog Converter (DAC)
- Data acquisition systems
- Microprocessor and microcontroller based instrumentation
- Introduction to LabVIEW and computer interfacing

Unit-IV : Applied Instrumentation and Modern Applications

- Biomedical instrumentation: ECG, EEG and pulse oximeter
- Industrial instrumentation and process control
- Optical fiber communication instrumentation
- Laser instrumentation and applications

Mapping between COs and PSOs

COs \ PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	3	2	1	2	1
CO-2	3	3	2	2	1
CO-3	2	3	3	2	2
CO-4	2	2	3	3	2
CO-5	2	3	2	3	2

Correlation Levels:3 – High | 2 – Moderate | 1 – Low

Reference Books

1. A.K. Sawhney – A Course in Electrical and Electronic Measurements and Instrumentation.
2. H.S. Kalsi – Electronic Instrumentation.
3. D.Patranabis – Sensors and Transducers.
4. R.S.Sirohi and H.C. Radha Krishna – Mechanical Measurements.
5. Albert D. Helfrick and William D. Cooper – Modern Electronic Instrumentation.
6. David A. Bell – Electronic Instrumentation and Measurements.
7. Malvino and Leach – Digital Principles and Applications.
8. Rajendra Prasad – Electronic Measurements and Instrumentation.

Teaching Methodology

Classroom lectures/Assignments/Tutorials

Evaluation Method

Internal Assessment: 50 Marks
External Assessment: 50Marks