Courses of Study

(Detailed Course Contents)

Four Year Under-graduate Programme

(2024-2025 Batch)

Semesters I & II

Offered by

School of Physics

Shri Mata Vaishno Devi University

Kakryal, Katra 182320 Jammu & Kashmir

Course Structure of
Four Year Undergraduate Programme (Physics) (2024-25 Batch)

Semester I **First Year**

Course Category	Course Code	Course Name	L	T	P	Credits
Major (Core)	PHL MD103	Newtonian Mechanics	3	0	0	3
Major (Core)	PHP MD103	Newtonian Mechanics Lab	0	0	2	1
Minor		To be chosen from the allied schools				4
Multidisciplinary		To be chosen from the other schools				4
AEC		To be chosen from the basket of courses				2
SEC		To be chosen from the basket of courses				2
VAC-1		Health and Wellness	2	0	0	2
VAC-2		To be chosen from the basket of courses	2	0	0	2

Semester II **First Year**

Course Category	Course Code	Course Name	L	T	P	Credits
Major (Core)	PHL MD104	Applied Optics	3	0	0	3
Major (Core)	PHP MD104	Applied Optics Lab	0	0	2	1
Minor	MTLMI 102	Analytical Geometry of 3-D and Trigonometry	4	0	0	4
Multidisciplinary		To be chosen from the other schools				4
AEC		To be chosen from the basket of courses				2
SEC		To be chosen from the basket of courses				2
VAC-1		Environmental Science and Education	2	0	0	2
VAC-2		To be chosen from the basket of courses	2	0	0	2

Minor/Discipline specific Elective –I (Sem-I) (for other schools)

Course Code	Course Title	L-T-P	Credits
PHL MI103	Newtonian Mechanics	3-0-0	3
PHP MI103	Newtonian Mechanics Lab	0-0-2	1

Minor/ Discipline specific Elective –II (Sem-II) (for other schools)

Course Code	Course Title	L-T-P	Credits
PHL MI104	Applied Optics	3-0-0	3
PHP MI104	Applied Optics Lab	0-0-2	1

Multidisciplinary course - I (Sem-I)

Course Code	Course Title	L-T-P	Credits
PHL MU101	Quantum in Everyday Life	3-1-0	4

Multidisciplinary course - II (Sem-II)

Course Code	Course Title	L-T-P	Credits
PHL MU102	Lasers and Its Applications	3-1-0	4

Ability Enhancement course

Course Code	Course Title	L-T-P	Credits
PHL AE102	Fundamentals of Energy Physics	2-0-0	2

Skill Enhancement course

Course Code	Course Title	L-T-P	Credits
PHM SE102	Software Skills in Physics	1-0-2	2

PHL MD103 /PHL MI103			Newtonian Mechanics				Course Type		Major (Core) Part-A	
Batch			2024-25	Session		2024-25	Semester		Odd	
L	T	P	C	Mid-Term Duration	Major Duration	Two Assignments (10 marks each)	Mid-Term Marks	4 Quizzes (5 marks each)	Major Marks	Total Marks
3	**0**	**0**	**3**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Learning Objectives

This course aims to review the concepts of mechanics learnt at school in a more advanced perspective and progressively builds up new concepts. The students will be able to apply the learnt concepts to many real world problems.

Course Outcomes:

After completing this course, the students will be able to

- *Apply the principles of non-inertial systems and fictitious forces to analyze motion in accelerating and rotating frames.*
- *Develop the ability to apply conservation laws to solve problems related to collisions in different reference frames.*
- *Apply the principles of central force motion to analyze and interpret planetary motion.*
- *Students will demonstrate a comprehensive understanding of angular velocity, angular momentum, and their vector nature in rigid body motion.*

Unit-I
Non-Inertial Systems and Fictitious Forces **[12]**

Unit vectors, Displacement, Velocity, Acceleration, Area and Volume elements in Cartesian and Plane Polar coordinates, Dynamics Using Polar Coordinates; Galilean Transformation; Uniformly Accelerating Systems; The Principle of Equivalence; Physics in a Rotating Coordinate System–Rate of Change of a Rotating Vector, Time Derivative of a Vector, Velocity and Acceleration, Fictitious Forces in a Rotating Coordinate System.

Unit-II
Collisions and Conservation Laws **[10]**

Concept Centre of Mass; Elastic Collision in Laboratory and Centre of MassCoordinates; Relationship between Displacement, Velocities, Kinetic energies and Angles in Laboratory and Centre ofMass Coordinates.

Unit-III
Central Force Motion **[10]**

Central Force Motion as a One-body Problem; Universal Features of Central Force Motion –Consequences of the Conservations of Angular Momentum and Energy, The Effective Potential, The Formal Solution for Central Force Motion; The Energy Equation and Energy Diagrams; Planetary Motion – Hyperbolic Orbits, Elliptic Orbits and Planetary Motion.

Unit-IV
Rigid Body Motion **[10]**

The Vector Nature of Angular Velocity andAngular Momentum;The Gyroscope; Examples of Rigid Body Motion;Conservation of Angular Momentum; Rigid Body Rotation – Angular Momentum and the Tensor of Inertia, Principal Axes, Rotation of a Rigid Body, Rotational kinetic energy, Euler forces, Euler angles, symmetric top

Text Book:

1. An Introduction to Mechanics, 2nd Ed., D. Kleppner, R. Kolenkow, McGraw-Hill, 2014 (Textbook).

Suggested Reading(s):

2. Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et al., Tata McGraw-Hill, 2007.
3. Mechanics, D.S. Mathur, S.Chand and Company Limited, 2000.

PHP MD103 /PHP MI103			**Newtonian Mechnaics Lab**				Course Type		**Major (Core) Part-B**	
Batch			**2024-25**	Session		**2024-25**	Semester		**Odd**	
L	T	P	C	Major Duration		Lab File (20 marks) + Attendance (10 marks)	Viva		Major Marks	Total Marks
0	**0**	**2**	**1**	**2 hours**		**30**	**30**		**40**	**100**

Course Outcomes:

After completing this course, the students will be able to

- *Use various instruments for measurements and perform experiments related to rotational dynamics, elastic properties, fluid dynamics, acceleration due to gravity, collisions, etc.*
- *Learn to estimate the error for every experiment performed and report the result of experiment along with the uncertainty in the result up to correct significant figures.*

Choose a minimum of 5 experiments from the list given below:

1. To determine the Young's modulus of material of a metallic bar by bending of beam method.
2. To determine the coefficient of viscosity of highly viscous liquid by Stoke's method.
3. To find the surface tension of water by Jaeger's Method.
4. To determine the value of 'g' using bar pendulum.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine the Elastic constants of a wire by Searle's method.
7. To find modulus of rigidity by Maxwell's needle.
8. To determine the moment of inertia of objects of regular shapes (rod, sheet, cylinder, sphere, spherical shell) and verify the parallel and perpendicular axes theorems.
9. To study oscillations of a bifilar pendulum.

Suggested Reading(s):

1. Advanced Practical Physics for Students, Worsnop and Flint, Methuen & Co. Ltd., 1957.
2. B. Sc. Practical Physics, C. L. Arora, S. Chand., 2001

PHL MU101			Quantum in Everyday Life				Course Type		Multidisciplinary	
Batch			2024-25	Session		2024-25	Semester		Odd	
L	T	P	C	Mid-Term Duration	Major Duration	Two Assignments (10 marks each)	Mid-Term Marks	4 Quizzes (5 marks each)	Major Marks	Total Marks
3	**1**	**0**	**4**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Learning Objectives

This course aims atfamiliarizing the students with the basic concepts on useful aspects of Quantum Physics to meet the challenges faced by Physicists at an introductory level and to apply the knowledge gained in this field to explain natural physical processes and related technological advances.

Course Outcomes:

After completing this course, the students will be able to

- *Apply the principles of quantum mechanics, particularly wave-particle duality and its experimental validations, to solve theoretical and practical problems related to quantum phenomena.*
- *Explain the classical and quantum explanations of the Particle in a Box model, emphasizing energy quantization.*
- *Apply the Schrodinger equation and quantum numbers to describe energy levels and electron configurations.*
- *Quantitatively analyze the relationship between quantum properties and electrical heating.*

Unit-I **[12]**

Schrodinger's Cat Paradox, Absolute nature of size, characteristics and types of waves, Photoelectric effect, Einstein's explanation, Dual nature of light waves, Free particle wavefunction, Interference of waves, momentum superposition, Wavepacket, Heisenberg uncertainty principle

Unit-II **[10]**

Waves of photons, electrons and baseballs (particles), Particle in a Box- Classical and Quantum explanation, Energies of the quantum particle, Energy quantization, Black body radiation spectrum of sun

Unit-III **[12]**

The hydrogen atom: Bohr's theory, Quantum theory, Schrodinger equation, quantum numbers, Energy levels, Band Gap, Fermi level, Metals, insulators and semiconductors, Phonons, Electron-Photon scattering, superconductivity

Unit-IV **[8]**

Daily life Quantum phenomena: Color of objects, Shapes of molecules, Greenhouse nature of CO_2 gas, Visible radiations of hot bodies, Electrical heating

Textbook:

1. Absolutely Small: How Quantum Theory Explains Our Everyday World, Michael D. Fayer, AMACOM (2010)

Suggested Reading(s):

2. Quantum Physics For Dummies, Steven Holzner, Wiley (2012).

PHL MD104 /PHL MI104			Applied Optics				Course Type		Major (Core) Part-A	
Batch			2024-25	Session		2024-25	Semester		Even	
L	T	P	C	Mid-Term Duration	Major Duration	Two Assignments (10 marks each)	Mid-Term Marks	4 Quizzes (5 marks each)	Major Marks	Total Marks
3	**0**	**0**	**3**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Learning Objectives

This course aims to apply the concepts of Optics learnt at school in a more advanced perspective and progressively builds up new concepts. The students will be able to apply the learnt concepts to many real world problems.

Course Outcomes:

After completing this course, the students will be able to

- *Analyze the historical developments in understanding thermal radiation and the resolution of the Ultraviolet Catastrophe through Planck's Radiation Law.*
- *Evaluate the different types of lasers, including semiconductor lasers, and their characteristics.*
- *Evaluate the properties of holograms and classify them based on their characteristics.*
- *Explain the principles of total internal reflection and its role in the propagation of light through optical fibers.*

Unit-I
Mechanism of Light Emission **[12]**

Introduction; Oscillating Electric Dipole; Thermal Radiation; The Ultraviolet Catastrophe; The Planck's Radiation Law; The Photon; Photoelectric Effect; Compton Effect; Spectrum and Spectral Lines; Atomic Structure; De Broglie Hypothesis; Heisenberg Uncertainty Principle; Wave Functions; Schrödinger Wave Equation; The Wave Mechanical Model of Atom; The Structure of the Atom; Wave Mechanical Explanation of Photon Emission; Properties of Spectral Lines; Luminescence; Scattering

Unit-II
Lasers **[12]**

Introduction; Attenuation of Light in an Optical Medium; Thermal Equilibrium; Interaction of Light with Matter; Einstein Coefficients and Their Relations; Light Amplification; Meeting the three Requirements; Components of Laser; Lasing Action; Principal Pumping Schemes; Role of Resonant Cavity; Modes of the Laser Beam; Transverse Modes; Types of Lasers; Semiconductor Laser; Laser Beam Characteristics; Applications.

Unit-III
Holography **[8]**

Introduction; Principle of Holography; Coaxial Holography; Off-axis Holography; Holograms; Important Properties of Hologram; Classification of Holograms Applications; Medical Applications of Holography.

Unit-IV
Fibre Optics **[12]**

Introduction; Optical Fibre; Total Internal Reflection; Propagation of Light Through an optical fibre; Fractional Refractive Index Change; Numerical Aperture; Skip Distance and Number of Total Internal Reflections; Modes of Propagation; Types of Rays; Classification of Optical Fibres; Three Types of Fibres; Materials; V-Number–Fabrication–Losses in Optical fibre–Distortion–Bandwidth–Characteristics of the Fibres–Splicing–Application; Fibre Optic Communication System; Merits of Optical fibres; Fibre Optic Sensors.

Text Book:

1. Optics, A. Ghatak, 6th Ed., McGraw Hill Education, 2017

Suggested Reading(s):

2. A Textbook of Optics, Subramanyam, BrijLal and Avadhanulu, S. Chand & Co., 2020.

PHP MD104 / PHP MI104			**Applied Optics Lab**				Course Type		**Major (Core) Part-B**	
Batch			**2024-25**	Session		**2024-25**	Semester		**Even**	
L	T	P	C	Major Duration		Lab File (20 marks) + Attendance (10 marks)	Viva		Major Marks	Total Marks
0	**0**	**2**	**1**	**2 hours**		**30**	**30**		**40**	**100**

Course Outcomes:

After completing this course, the students will be able to

- *Use various instruments for measurements and perform experiments related to interference, diffraction, holography, optical fibres etc.*
- *Learn to estimate the error for every experiment performed and report the result of experiment along with the uncertainty in the result up to correct significant figures.*

Choose any 6 experiments from the list given below:

1. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
2. To determine the wavelength and angular spread of laser light by using plane diffraction grating.
3. Optical image addition/subtraction.
4. Optical image differentiation
5. Recording and reconstruction of holograms (Computer simulation can also be done).
6. To determine the wavelength of sodium light by using Michelson"s interferometer.
7. To measure the numerical aperture of an optical fibre.
8. To measure the near field intensity profile of a fibre and study its refractive index profile.
9. To study the variation of the bending loss in a multimode fibre

Suggested Reading(s):

1. Fibre optics through experiments, M.R. Shenoy, S.K. Khijwania, et.al. 2009, Viva Books.
2. Introduction to Fourier Optics, Joseph W. Goodman, Tata McGraw- Hill, 1996.
3. An advanced course in Practical Physics: D. Chattopadhyay & P.C. Rakshit (New Central Book Agency).

PHL MU102			Lasers and Its Applications				Course Type		Multidisciplinary	
Batch			2024-25	Session		2024-25	Semester		Odd	
L	T	P	C	Mid-Term Duration	Major Duration	Two Assignments (10 marks each)	Mid-Term Marks	4 Quizzes (5 marks each)	Major Marks	Total Marks
3	**1**	**0**	**4**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Learning Objectives

This course aims at familiarizing the students with the basic concepts of Lasers and its applications to meet the challenges faced by industries and corporate world at an introductory level and to apply the knowledge gained in this field to explain natural physical processes and related technological advances.

Course Outcomes:

After completing this course, the students will be able to

- *Explain the fundamental principles of LASER, including the processes of induced absorption, spontaneous emission, and stimulated emission.*
- *Analyze the interplay of Lasers' characteristics in determining the their overall performance.*
- *Gain understanding of the functioning of different types of lasers.*
- *Demonstrate the ability to predict the behavior of lasers based on their characteristics in real-world contexts, enabling effective utilization in various fields.*

Unit-I
Laser Principle **[12]**

Introduction to LASER, Interaction of radiation with matter – Induced absorption, Spontaneous Emission, Stimulated Emission, Population inversion, Optical Pumping, Laser materials, Resonant cavity.

Unit-II
Laser Characteristics **[8]**

Wavelength, Intensity, Coherency, Monochromaticity, Output power, Polarization, Focussibility and Gain Bandwidth.

Unit-III
Laser Types **[12]**

LASER action: Two level, Thee level and Four level laser systems,Types of lasers (Elementary idea); Gas laser, Solid state laser, Fiber laser, Diode and Semiconductor laser.

Unit-IV
Laser Applications **[10]**

General Applications of Lasers including Industry; Drilling, cutting and welding, Defense, Medicine; Dermatology, cardiology, dentistry etc, Communication etc.

Note: The tutorial sessions will comprise of discussing problems from the textbook, assignments and quizzes.

Text Book:

1. Jeff Hecht "Understanding Lasers" (4e), IEEE press, Wiley.

Suggested Reading(s):

2. Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).

PHL AE102			Fundamentals of Energy Physics				Course Type		AEC	
Batch			2024-25		Session	2024-25	Semester		Even	
L	T	P	C	Mid-Term Duration	Major Duration	Two Assignments (10 marks each)	Mid-Term Marks	4 Quizzes (5 marks each)	Major Marks	Total Marks
2	**0**	**0**	**2**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Learning objectives

This course aims to provide the fundamental knowledge and skills in the field of energy Physics. The students will be able to learn and enhance their skills in the field of energy science.

Course Outcomes

After completing this course, students shall be able to:

- *Understand the fundamental for Energy Physics*
- *Understand the basic knowledge of thermal science*
- *Learn the fundamentals in the field of renewable energy*
- *Scientific overview of the solar energy and solar PV*

Unit-I **[12]**

Thermodynamic system and processes, Equality of temperature- The Zeroth law of thermodynamics, First law of thermodynamics, Second law of thermodynamics: Kelvin-Plank and Clausius statement of second law, Third Law of Thermodynamics, Conventional Energy Sources, Non-Conventional Energy Sources, Indian Energy Scenario and Sector wise energy Consumption pattern.

Unit –II **[12]**

Renewable Energy Potential in India, Renewable Energy Polices of India, Solar Energy, Solar radiation and its spectral characteristics, Instruments for measurement of Solar Radiation, Fundamental of Solar Photovoltaic, Types of materials for Solar Cells, Different PV Technologies, Solar Energy Polices of India, Solar cells Characteristics and Fill factor calculations.

Suggested Book(s):

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996
2. Chetan Singh Solanki , Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Publisher, 3rd Edition.
3. Non-Conventional Energy Resources by B. H. Khan, Mc Graw Hill Publication

PHM SE102				Software Skills in Physics (1-0-2)				Course Type			
Batch				2024-25	Session		2024-25	Semester			Even
L	T	P	C	**Theory**	Mid-Term Duration	Major Duration	Two Assignments (10 marks each)	Mid-Term Marks	4 Quizzes (5 marks each)	Major Marks	Total Marks
1	**0**	**0**	**1**		**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**
L	T	P	C	**Lab Comp.**	Major Duration		Lab File (20 marks) + Attendance (10 marks)	Viva		Major Marks	Total Marks
0	**0**	**2**	**1**		**2 hours**		**30**	**30**		**40**	**100**

Learning Objectives

At the end of this course, students will:

1. *Develop proficiency in **Microsoft Excel** for data analysis, visualization, and basic statistical computations.*
2. *Gain hands-on experience with **Origin software** for advanced plotting, fitting, and scientific data interpretation.*
3. *Enhance their ability to manipulate and analyze datasets through structured workflows.*
4. *Learn to use software tools effectively to generate professional reports and presentations.*

Course Outcomes:

After completing this course, students will be able to:

1. *Use Excel to perform data entry, cleaning, and visualization efficiently.*
2. *Implement statistical tools in Excel for data analysis and interpretation.*
3. *Create publication-quality plots and perform curve fitting using Origin software.*
4. *Analyze experimental data and present results effectively in scientific contexts.*
5. *Apply these software skills to interdisciplinary projects and research tasks.*

Course Structure:

Unit 1: Excel for Data Analysis **[6]**

Topics Covered:

1. **Basics of Excel**:
   - Data entry, formatting, and basic mathematical operations.
   - Understanding worksheets, cell referencing, and formulae.
2. **Data Visualization**:
   - Creating charts (line, bar, pie, scatter).
   - Using Pivot Tables and Pivot Charts.
3. **Functions and Formulas**:
   - Logical functions (IF, AND, OR).
   - Statistical functions (AVERAGE, MEDIAN, STDEV).
   - Lookup functions (VLOOKUP, HLOOKUP).
4. **Data Analysis Tools**:
   - Data sorting and filtering.
   - Solver and Goal Seek applications.
   - Regression analysis and trendlines.
5. **Macros and Automation**:
   - Basics of recording and running macros.
   - Introduction to VBA (Visual Basic for Applications).

Unit 2: Origin Software for Scientific Data Analysis **[6]**

Topics Covered:

1. **Introduction to Origin Software**:
   - Interface overview and basic navigation.

- Importing datasets and workspace organization.

2. **Data Visualization**:
   - Creating 2D and 3D plots (scatter, surface, contour).
   - Customizing graphs (legends, annotations, colors).
3. **Data Manipulation**:
   - Data smoothing, filtering, and interpolation.
   - Dataset normalization and baseline correction.
4. **Curve Fitting and Statistical Tools**:
   - Linear and nonlinear curve fitting.
   - Error analysis and parameter estimation.
   - ANOVA and other statistical tests.
5. **Advanced Graphing Techniques**:
   - Creating multi-panel graphs.
   - Exporting high-resolution graphs for publication.
6. **Templates and Batch Processing**:
   - Using templates for repetitive tasks.
   - Automating analysis with batch processing.

The students are required to perform a minimum of six experiments from each of the following units:

Lab Component for Unit 1 (10 Experiments): **[12]**

1. Data entry and formatting of a real-life dataset.
2. Create line and scatter plots for experimental data.
3. Perform statistical analysis (mean, median, standard deviation).
4. Use Pivot Tables to summarize sales data.
5. Solve optimization problems using Solver.
6. Perform a linear regression analysis and interpret the results.
7. Create dynamic dashboards for weather data visualization.
8. Implement conditional formatting for large datasets.
9. Use Lookup functions to search and organize data.
10. Record a simple macro to automate a repetitive task.

Lab Component for Unit 2 (10 Experiments): **[12]**

1. Import and clean experimental data from CSV files.
2. Create scatter plots and customize them for scientific reports.
3. Perform baseline correction on spectroscopy data.
4. Apply curve fitting to experimental growth data.
5. Generate and analyze 3D surface plots.
6. Conduct statistical tests (e.g., t-tests, ANOVA) on sample data.
7. Perform Fourier transformation on signal data.
8. Create a multi-panel graph for comparative analysis.
9. Use batch processing to analyze multiple datasets simultaneously.
10. Export high-resolution images for a journal submission.

Textbooks and Suggested Readings:

Textbooks:

1. *Excel 2019 Bible* by Michael Alexander, Richard Kusleika, and John Walkenbach.
2. *Learning Microsoft Excel Step by Step* by Curtis Frye.
3. *Getting Started with Origin* by OriginLab Corporation.

Suggested Readings:

1. *Practical Statistics for Data Scientists* by Peter Bruce and Andrew Bruce.
2. *Microsoft Excel Data Analysis and Business Modeling* by Wayne Winston.
3. Online tutorials and resources from the official **OriginLab website**.
4. *Scientific Data Analysis using Origin* by Ranjan Parekh.

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