Courses of Study

(Detailed Course Contents)

Integrated B.Sc. (Hons.) Physics – M.Sc. Physics & M.Sc. Physics Programmes

(2021-2022/ 2024-25 Batches)

Semester-VIII/ Semester-II

Offered by

School of Physics

Shri Mata Vaishno Devi University

Kakryal, Katra 182320 Jammu & Kashmir

Course Structure of
Integrated B.Sc. (Hons.) Physics – M.Sc. Physics (2021-22 Batch) & M.Sc. Physics (2024-25 Batch)

Semester VII (4th Yr. Int. B.Sc.-M.Sc.) & Semester I (Ist Yr. M.Sc. Physics)

Course Category	Course Code	Course Name	L	T	P	Credits
Major (Core)	PHL 6021	Classical Mechanics	4	0	0	4
Major (Core)	PHL 6033	Mathematical Physics	4	0	0	4
Major (Core)	PHL 6041	Quantum Mechanics-I	4	0	0	4
Major (Core)	PHL 6054	Physics of Semiconductor Devices	4	0	0	4
Major (Core) Lab	PHP 6123	Physics Laboratory-I	0	0	12	6

Semester VIII (4th Yr. Int. B.Sc.-M.Sc.) & Semester II (1st Yr. M.Sc. Physics)

Course Category	Course Code	Course Name	L	T	P	Credits
Core	PHL 6075	Electrodynamics and Plasma Physics	4	0	0	4
Core	PHL 6055	Digital Systems	4	0	0	4
Core	PHL 6042	Quantum Mechanics-II	4	0	0	4
Core	PHL 6113	Computational Physics	3	0	2	4
Core	PHP 6124	Physics Laboratory-II	0	0	12	6

PHL 6075			Electrodynamics and Plasma Physics				Course Type		Major (Core)	
Batch			2021-22		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
4	**0**	**0**	**4**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Unit-I: **[15]**

Faraday's Law of Electromagnetic Induction, Induced Electric Field, Inductance, Energy in Magnetic Fields, Maxwell's Equation, Magnetic Charge, Maxwell's Equations in Matter, Boundary Conditions, Continuity Equation, Poynting Theorem, Newton's Third Law in Electrodynamics, Maxwell's Stress Tensor, Conservation of Momentum, Angular Momentum.

Unit-II: **[12]**

Wave Equation in One Dimension, Boundary Conditions: Reflection and Transmission, Polarization, Wave Equation for E and B, Monochromatic Plane Waves, Energy and Momentum in electromagnetic Waves.

Unit-III: **[10]**

Scalar and Vector Potentials, Gauge Transformations, Coulomb Gauge and Lorentz Gauge, Retarded Potential, Lienard-Weichert Potentials, Fields of a Moving Point Charge.

Unit-IV: **[10]**

Electric Dipole Radiation, Magnetic Dipole Radiation, Radiation from an Arbitrary Source, Power Radiated by a Point Charge, Radiation Reaction, Physical Basis of Radiation Reaction.

Unit V: **[13]**

Occurrence of Plasmas in Nature, Definition of Plasma, Concept of Temperature, Debye Shielding, Plasma Parameters, Criteria for Plasmas, Applications of Plasma Physics.

Suggested Books:

1. D.J. Griffiths- Introduction to Electrodynamics
2. F.F. Chen- Introduction to Plasma Physics

PHL 6055			Digital Systems				Course Type		Major (Core)	
Batch			2021-22	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
4	**0**	**0**	**4**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Unit-I **[12]**

Combinational Logic Simplification and Analysis: The Karnaugh Map (K-Map), K-Map SOP Minimization, K-Map POS Minimization, Boolean Expressions with VHDL, Pulse Waveform Operation, Combinational Logic with VHDL, Ripple Carry and Look-Ahead Carry Adders

UNIT-II **[12]**

Sequential Logic Systems: Shift Register Operations, Type of Shift Registers, Shift Register counters, Shift registers applications, Asynchronous Counters, Synchronous Counters, Up/Down Synchronous Counters, Design of Synchronous Counters, Cascaded Counters, Counter Decoding. Counter Applications

UNIT-III **[12]**

Signal Conversion and Processing: Analog-to-Digital Conversion, Methods of Analog-to-Digital Conversion, Methods of Digital-to-Analog Conversion, Digital Signal Processing, Digital Signal Processor (DSP)

Unit-IV **[12]**

Semiconductor Memory: The Random-Access Memory (RAM), The Read-Only Memory (ROM), Programmable ROMs, The Flash Memory, Memory Expansion, Special Types of Memories. Magnetic and Optical Storage

Unit-V **[12]**

Microprocessor Basics: 8085 Microprocessor – Block diagram, addressing modes, 8085 instruction set, simple assembly language programs involving looping, counting and delays.

Suggested Books:

1. Digital Fundamentals by Thomas L. Floyd, 10e (2011), Pearson Ed.
2. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S. Gaonkar, 6e (2013), Penram International Publisher

PHL 6042			Quantum Mechanics-II				Course Type		Major (Core)	
Batch			2021-22	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
4	**0**	**0**	**4**	**1.5 hours**	**3 hours**	**20**	**20**	**20**	**40**	**100**

Unit-I: **[15]**

Time independent non-degenerate perturbation theory upto second order. Applications to normal He atom, perturbed harmonic oscillator. Time independent degenerate perturbation theory upto first order. Application of degenerate perturbation theory to stark effect. Time dependent perturbation theory, calculation of 1^{st} order transition amplitude, transition probability, and derivation of Fermi Golden rule.

Unit-II: **[9]**

Variational method, its application to ground state of He atom, W.K.B-approximation, classical turning points, connection formulae, Application to WKB to bound state problem.

Unit-III: **[12]**

Semi Classical theory of radiations, Expression for transition probability for absorption and induced emission using electric dipole approximation. Selection rules, Identical particles, Pauli's exclusion principle, spin-statistics connection. Elementary theory of scattering: phase shifts, partial waves, Born approximation.

Unit-IV: **[12]**

Relativistic quantum mechanics: Klein-Gordon Equation, Klein-Gordon equation in electromagnetic field, solution of Klein-Gordon equation for a particle with coulomb potential V_0 (hydrogen atom problem), Derivation of Dirac equation, γ-, β-matrices.

Unit-V: **[12]**

Dirac equation with central potential and hydrogen atom problem, existence of electron spin for a Dirac particle. Covariant form of Dirac Equation, γ-matrices and their properties, γ_5-matrix and properties, Covariance of Dirac Equation, Zitterbewegung and negative energy solutions

Suggested Books:

1. Introduction of Quantum Mechanics: D.J. Griffiths.
2. Quantum Mechanics, Ghatak & Loknathan, 1^{st} Edition, MacMillan India
3. Introduction to Quantum Mechanics: C.J. Joachain and B.H. Bransden.

PHL 6113			**Computational Physics**					Course Type		**Major (Core)**	
Batch			**2021-22**		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
3	**0**	**0**	**3**		**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**

UNIT-I **[10]**

Basic Programming concepts, Controlling programs with 'if' and 'while', Lists and Arrays, For loops, User Defined functions, Graphics and visualization, Accuracy and Speed

UNIT-II **[12]**

Integrals: The trapezoidal rule, Simpson's rule, Romberg integration, Higher-order integration methods, Gaussian quadrature, Integrals over infinite ranges, Derivatives: Forward and Backward differences, Central differences, Second derivatives, Interpolation

UNIT-III **[12]**

Simultaneous linear equations- Gaussian elimination, Back substitution, Pivoting, Calculating the inverse of a matrix, Eigenvalues and eigenvectors, Non-linear equations- Binary search, Newton's method, Secant method

UNIT-IV **[11]**

Ordinary differential equations with one variable- Euler's method, Runge-Kutta method, Fourth-order Runge-Kutta method, Differential equations with more than one variable, Second-order differential equations

Suggested Books:

1. Computational Physics: Problem Solving with Python, Landau & Paez, WILEY-VCH (3e) 2015
2. Computational Physics: Mark Newman (1e) CreateSpace Independent Publishing Platform 2013
3. Essential Python for the Physicist: Giovanni Moruzzi (1e) Springer, 2020

Computational Physics Lab component

Choose any 6 experiments from the list given below:

1. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.
2. Choose a set of 10 values and find the least squared fitted curve.
3. To find the roots of quadratic equations.
4. Perform numerical integration on 1-D function using Simpson rules.
5. Perform numerical integration on 1-D function using Trapezoid rule.

6. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.
7. To find the value of π using Monte Carlo simulation.
8. To find the solution of differential equation using Runge-Kutta method.
9. To find the solution of differential equation using Euler's method.
10. To find the value of y for given value of x using Newton's interpolation method.
11. To evaluate sum of finite series and the area under a curve.
12. To find the product of two matrices
13. To study the motion of spherical body falling in viscous medium using Euler method.
14. To study the motion of one dimensional harmonic oscillator without and with damping effects.
15. To obtain the energy eigenvalues of a quantum oscillator using Runge-Kutta method.
16. To study the motion of charged particles in uniform electric field, uniform magnetic field and combined uniform EM field.
17. To study the phenomenon of nuclear radioactive decay.
18. To study the EM oscillation in a LCR circuit using Runge-Kutta method.

Suggested Book(s):

1. Computational Physics: Problem Solving with Python, Landau & Paez, WILEY-VCH (3e) 2015
2. Data Reduction and Error analysis for Physical Sciences: Bevington & Robinson, (McGraw Hill, Noida, India) 2003.
3. Computational Physics: Mark Newman (1e) CreateSpace Independent Publishing Platform 2013
4. Essential Python for the Physicist: Giovanni Moruzzi (1e) Springer, 2020

PHL 6124			**Physics Laboratory - II**				Course Type	**Major (Core) Lab**	
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**	**12**	**6**	**3 hours**	**30**		**30**	**40**	**100**

Choose any 5 experiments from the list given in each section below:
General Experiments

1. Thickness of Mesh wire using a He-Ne Laser
2. Pitch of the Screw usinga He-Ne Laser
3. Wavelength of the He-Ne Laser using meter scale.
4. Fraunhoffer diffraction through circular apertures.
5. Measurement of numerical aperture of an optical fibre
6. Michelson Interferometer
7. Zeeman setup
8. Frank-Hertz Experiment
9. Electron spin Resonance

Digital Electronics Experiments

1. Combinational Logic Circuits – Logic Gates
2. Combinational Logic Circuits – Boolean algebra
3. Binary Addition – Half Adder & Full Adder
4. Decoders – 2 bit binary, 2 bit Decoder and 7447 decoder
5. Flip-flops
6. Counters & Registers
7. Decade Counting Unit
8. Microprocessor – Simple programs

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