Atal Bihari Vajpayee Vishwavidyalaya, Bilaspur (C.G.)

Scheme and Syllabus

of

M. Sc. (Physics)

Program Code: MSCPHYR121

Semester system for affiliated college
(As per LOCF and credit system)

w.e.f. 2023-2024

(As approved by AC and EC meetings held on 16.08.2023 and 18.04.2023 respectively)

Scheme of M.Sc. Physics under Semester

SystemProgram Code: MSCPHY121

Semester	Course Code	Subject Name	Credit			Total Credit	Marks			
			L	P	T		ESE	IA	Total	
									Max	Min
First	PHYT 101	Mathematical methods-I	3	0	1	4	80	20	100	36
	PHYT 102	Classical Mechanics	3	0	1	4	80	20	100	36
	PHYT 103	Numerical Method and Python Programming	3	0	1	4	80	20	100	36
	PHYT 104	Electronics - I	3	0	1	4	80	20	100	36
	PHYP 105	Lab-I Optics and Electronics	0	2	0	2	100	-	100	36
	PHYP 106	Lab-II Python Programming	0	2	0	2	100	-	100	36
		Subtotal	**12**	**4**	**4**	**20**	-	-	**600**	-
Second	PHYT 201	Mathematical Methods - II	3	0	1	4	80	20	100	36
	PHYT 202	Quantum Mechanics - I	3	0	1	4	80	20	100	36
	PHYT 203	Electrodynamics	3	0	1	4	80	20	100	36
	PHYT 204	Electronics - II	3	0	1	4	80	20	100	36
	PHYP 205	Lab-I Electronics	0	2	0	2	100	-	100	36
	PHYP 206	Lab-II General	0	2	0	2	100	-	100	36
		Subtotal	**12**	**4**	**4**	**20**	-	-	**600**	-

Abbreviation used:

ESE: End Semester Exam

IA: Internal Assessment

Part A: Introduction				
Program: M.Sc. (Physics)		Semester: I	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 101		
2.	Course Title	Mathematical Methods - I		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • To understand mathematical concepts used for solving physics problems. • Understand special function, Laplace transform (LT), Fourier Series. • Master vector spaces, matrices, linear algebra, eigenvalues, eigenvectors, and their applications. • Master orthogonal functions: Legendre, Bessel, Hermite, Laguerre; properties, solutions, orthogonality. • Use Mathematical methods that will be used in many of the other courses in the M.Sc. Syllabus.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Vector Spaces and Matrices**: Dimensional analysis, Vector algebra and vector calculus, Linear algebra, matrices, Inverse, Orthogonal and unitary Matrices, Independent elements of a matrix, Cayley-Hamilton Theorem, Eigen values and eigenvectors, Diagonalization; Complete orthonormal set of functions.	12
II.	**Legendre Functions:** Second order ordinary differential equations, Solution by series expansion, Legendre Polynomial: Generating function, recursion relations; Rodrigues formula, orthogonal properties, Associated Legendre polynomials, Recurrence formulae and orthogonal properties.	12

III.	**Bessel's Functions:** Bessel's differential equation, First and Second kind, Recurrence formulae and generating function for $J_n(x)$, Jacobi Series, Bessel's Integrals, orthonormality of Bessel's functions, spherical Bessel's function: Recurrence relation and orthogonality.	12
IV.	**Hermite Functions:** Differential equation and polynomials, generating function, Recurrence relation, Rodrigue formula, orthogonality Laguerre Polynomial: Generating function, recursion relations: Rodrigue formula, orthogonal properties, Associated Laguerre differential equation and polynomial.	12
V.	**Integral Transforms**: Laplace transform: first and second shifting theorems, Inverse LT by partial fractions; LT of derivative and integral of a function. Fourier series: FS or arbitrary period; Half-wave expansions; Partial sums; Fourier integral and transforms Dirac delta function, three-dimension delta function.	12

Part C - Learning Resources

Text Books , Reference Books, E -Resources

Text Books:

1. Mathematical Physics, H K Dass, Dr. Rama Verma, 2022, S. Chand & Company Ltd.
2. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 44TH Edition

Reference Books:

1. Mathematical Methods for Physicists (6/e): G.B. Arfken and H.J. Weber, Elsevier
2. Applied Mathematics for Engineers and Physicists: L.A. Pipes and L.R. Harvill, Dover Publications Inc.
3. Fourier and Laplace Transforms: R.J. Beerends, H.G. ter Morsche, J.C. van den Berg, and E.M. van de Vrie, 2003, Cambridge University Press
4. Advanced Engineering Mathematics, E. Kreyzig , Pearson (2nd Ed., Pearson, 2002)

E -Resources:

1. https://nptel.ac.in/courses/115103036
2. https://nptel.ac.in/courses/115105097
3. https://nptel.ac.in/courses/115106086
4. https://nptel.ac.in/courses/111106152

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester -I	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 102		
2.	Course Title	Classical Mechanics		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, students will have learnt: • The conservation principles involving momentum, angular momentum and energy and understand that they follow from the fundamental equations of motion. • Have a deep understanding of Newton's laws. • Students learn about Lagrangian and Hamiltonian formulation of Classical Mechanics. • Analyse central force orbits and rigid body dynamics. • Kinematics and Dynamics of rigid body in detail and ideas regarding Euler's equation of motion.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks: 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Basics and Lagrangian:** Application of Newton's Laws and Conservation Law, system of particles. Generalised Notations (1) Generalized Displacement, velocity, Acceleration, momentum force and potential, Constrained motion, constraint force and their types ,degrees of freedom(translation, rotational), D'Alembert's Principle, Lagrange's equations form D'Alembert's principle. Application of Lagrange's equation of motion energy in Lagrangian formulation Lagrange's equation for nonholonomic system, procedure to eliminate consideration of Ignorable coordinates the Routhian function.	12
II.	**Variational principle:-** Variational Principle, calculus of variation, some techniques of calculus of variables, Euler Lagrange differential equation.	12

	Hamilton variational principal ,Deduction of Hamilton's Principle from D'Alembert's principle. Deduction of Newton's second law of motion from Hamilton's Principle. Deduction of Lagrange's equations of motion from Hamilton's Principle for conservative and for non-conservative systems, Non conservative forces. Dissipative system, Rayleigh's. Dissipation function, Lagrangian for a charged particle in an electromagnetic field.	
III.	**Hamilton formulation:** Hamiltonian formulation of mechanics; Phase space and phase space trajectories, Hamiltonian function, Hamilton's canonical equation of motion. Physical significance of H Deduction of Canonical equation from variational principle. Hamilton's canonical equation of motion in different coordinate system. Application of Hamilton equation of motion. Hamiltonian for a charged particle in an electromagnetic field. Principle of least action statement and its proof.	12
IV	**Canonical transformations and it's consequences:** Canonical and constant transformation, its advantages example of canonical transformation, necessary and sufficient condition for a transformation to be canonical, Infinitesimal contact transformations. Hamilton-Jacobi partial differential equation for Hamilton's Principal function. Solution of harmonic oscillator problem by Hamilton- Jacobi method, Hamiltonian Jacobi theory. Poisson Bracket: Definition and properties Invariance of Poisson Brackets with respect to canonical transformation interpretation in term of Poisson Brackets. The angular momentum and Poisson Bracket Lagrange's Brackets: definition and properties. Relation with Poisson Brackets.	12
V.	**Central force and Rigid Body:** Central force problem: Reduction of two body problem into one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of orbits, conditions for closed orbits, The Kepler problem (inverse-square law of force) Rigid body dynamics: Angular momentum, rotational kinetic energy and moment of inertia of a rigid body -Euler's angles - Euler's equations of motion - Torque - free motion of a rigid body-Motion of a symmetrical top under the action of gravity.	12

Part C - Learning Resources

Text Books , Reference Books, E -Resources

Text Books:

1. Classical Mechanics by J. C. Upadhyaya, Himalaya Publishing House.
2. Classical Mechanics, Herbert Goldstein, Pearson India (2011)

Reference Books:

1. Classical Mechanics, N.C. Rana and P.S. Joag, Tata McGraw Hill
2. Principles of Classical Mechanics, J.L. Synge and B.A Griffith, 1949, Mc.Graw-Hill, New York.
3. Classical Mechanics, S.N. Biswas, 1998, Books and Allied Ltd., Kolkata.
4. Classical Dynamics of Particles and Systems, S.T. Thornton and J.B. Marion, (2013), Brooks/Cole
5.

E -Resources:

1. https://archive.nptel.ac.in/courses/115105098/
2. https://youtu.be/rk0rp2Jpidc
3. https://youtu.be/941RpKWr2qo
4. https://youtu.be/e10eRk9aUBs
5. https://youtu.be/YXk-mcS2np4

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: I	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 103		
2.	Course Title	Numerical Method and Python Programming		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Find roots of different types of equations and Obtain the eigenvalues of matrices and understand its applicability in various physics aspects. • Understand experimental data, its behaviour and various interpolating techniques. • Understand techniques to evaluate integrals bounded in a range and solve initial value and boundary value problems of ordinary differential equation. • To know about Various Control statements of Python. • To know about Functions and Module structures in Python. • Write the program in Python for scientific problems.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks: 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**(Without Programming)** **Roots of Equation and Simultaneous Equation:** Methods for determination of Zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative Method, Matrix inversion. Eigen values and eigenvectors of matrices , power and Jacobi method.	12
II.	**Curve Fitting and Interpolation :** Least square curve fitting, Straight line and polynomial fits. Finite Differences ,interpolation with equally spaced and unevenly spaced points.	12

III.	**Differentiation, Integration and ODE :** Numerical differentiation: forward, backward and centred difference formulae, Newton cote's formula, Trapezoidal and Simpson's rule. Numerical solution of ordinary differential equation, Euler & Runge - Kutta methods. Predictor method.	12
IV.	**(With Programming)** **Introduction of python and Decision making:** keywords and Identifiers, Statements and comments, variables , data types and type conversion , Output Input, Operators , expression, hierarchy of operators, scope and namespace. Flow control statements, if , if else and nested if else , Loops (for , while , do while), break and continue.	12
V.	**Functions, Module and Plotting:** Built in and user defined functions, function definition and calling the function, function with argument and return, Variable scope . Python module, import , module, packages, library(SciPy, NumPy, math, Matplotlib) , python array. Basic plotting using matplotlib: polynomial (linear, quadratic), sine and cosine function.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books: (a) For Numerical Methods

1. B.S. Grewal, Numerical Methods in Engineering & Science with Programs in C, C++ & MATLAB, Khanna Publishers
2. S. S. Sastry, Introductory methods of numerical analysis, Prentice Hall of India

(b) For Python Programming

1. Fundamentals of Python: First Programs, Course Technology, Kenneth Lambert , Cengage Learning.
2. Dr Pooja Sharma, Programming in Python ,2017, BPB

Reference Books:

1. Numerical Recipes, Teukolsky , Vetterling and Flannery , Cambridge University Press

2. Numerical Mathematical Analysis, J. B. Scarborough, Oxford Publishing, 6th Edition,1990
3. Numerical methods for mathematics, science and engineering, John H. Matthews , Prentice Hall of India, 2nd Edition, 2000
4. Making Use of Python, Rashi Gupta, Wiley Publishing.

E -Resources:

1. https://nptel.ac.in/courses/115104095
2. www.python.org
3. https://wiki.python.org/moin/BeginnersGuide
4. https://www.w3schools.com/python/

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: I	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 104		
2.	Course Title	Electronics - I		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course , the student will be able to : • Understand principle of transistors and its application. • Understand working principle of MIS, MOS diode. • Gain deep knowledge on microwave devices and electron transfer devices. • Understand concept of Modulation. • Understand concept of multiplexing.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Transistors: BJT and FET:** Bipolar Junction transistor (BJT) - Different methods of biasing. Thermal stabilization , stability factor, h - parameters, Feedback in amplifiers Advantages of negative feedback, Principle of oscillators. Junction Field Effect Transistor (FET)-N channel and P channel FET, Working principle, static and dynamic characteristic curves, pinched off voltage, Coefficient of FET, and relation between different coefficients.	12
II.	**MOSFET and UJT :** Metal Oxide Field Effect Transistor (MOSFET) - DE MOSFET and E-MOSFET , construction and working principle, static and dynamic characteristics. Uni-junction transistor (UJT) basics structure, working principle. Voltage - Current characteristics and important parameters.	12
III.	**Semiconductor Devices and Charge-Coupled Devices:** MIS Diode: Introduction, Energy band diagram, accumulation, depletion and inversion	12

	condition concept of surface space charge, surface potential, surface capacitance, Ideal MIS curves. MOS diode: structure, Ideal MOS, surface depletion region, Ideal MOS curves, $Si-SiO_2$ MOS diode-(real case) interface trapped charge, oxide charges. Charged Couple Device (CCD): Basic structure, working principle, charge transfer with clock voltage.	
IV.	**Microwave Devices:** Tunnel Diode - Introduction, Definition, Tunnelling Phenomenon, Energy band Structure, Volt-Ampère Characteristics, Negative Resistance of tunnel diode (Characteristics of tunnel diode). Transfer Electron Devices: Transfer Electron Effect, Gun Diode -Introduction and characteristics. Backward Diode: Introduction and Characteristics. IMPATT Diode: Introduction, Structure, Principle of operation, Static and Dynamic Characteristics.	12
V.	**Modulation and Multiplexing :** Modulation: Definition, Types of Modulation , Mathematical expression of modulation , Percentage of modulation, Amplitude modulation, Generation of Amplitude modulation, Demodulation, Demodulation of Amplitude modulated wave, side bands, band width , DSBSC modulation , Generation of DSBSC waves. SSB modulation, Generation and Detection of SSB waves. Multiplexing: Frequency division multiplexing (FDM).	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Principles of Electronics, V.K. Mehta, Rohit Mehta, S. Chand
2. Hand Book of Electronics, Gupta Kumar ,Pragati Prakashan

Reference Books:

1. Physics of semiconductor Devices , S.M. Sze ,Wiley Eastern Ltd.
2. Foundation of Electronics, D. Chattopadhyay, P.C. Rakshit, B. Saha, N. N. Purkait, New Age International Pvt. Ltd.
3. Electronic Devices and Circuits, Jacob Millman, Christos C. Halkias , Tata McGraw Hill
4. Basic Electronics (Solid state), B.L. Theraja ,S. Chand & Company Ltd.

E -Resources:

1. https://nptel.ac.in/courses/108101091
2. https://nptel.ac.in/courses/115102014
3. https://nptel.ac.in/courses/117103063
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mlqRALksfwQH9v8YSMrw==

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: I	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYP 105		
2.	Course Title	Lab-I Optics and Electronics		
3.	Course Type	Practical		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Understand the principles of diffraction and analyze the diffraction pattern produced by a single slit. • Comprehend the behavior of light when passing through a narrow aperture and its spread using a laser kit. • Determine the separation between the plates of a Fabry-Perot Etalon and understand its applications. • Study the prismatic spectrum using Cauchy's relation and analyze the dispersion of light. • Calibrate a constant deviation spectrometer and apply it to determine the wavelength of an unknown source. • Use Cornu's method to determine the Young modulus of glass and understand its mechanical properties. • Verify the Brewster law of reflection for polarized light and understand the concept of polarization. • Analyze the characteristics of an NPN transistor in Common Emitter (CE) mode and its applications. • Analyze the characteristics of a Unijunction Transistor (UJT) and understand its behavior as a switching device. • Study the characteristics of a Field-Effect Transistor (FET) and its applications as an amplifying device. • Analyze the characteristics of a Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) and understand its operation. • Study the energy band gap and diffusion phenomena in a P-N junction and understand its behavior as a semiconductor device. • Study Zener and IC regulated power supply circuits, and understand their use in voltage regulation.		
6.	Credit Value	4		
7.	Total Marks	IA: Na ESE: 100 Marks		Max. marks : 100 Min. Marks: 36

Part B: Contents of the Course

List of experiments	
S.N.	Title
1.	To study the diffraction pattern by using single slit.
2.	To study light spread when passes through a narrow aperture by using laser kit.
3.	To determine the separation between the plates of a Fabry Perot Etalon
4.	To study the prismatic spectrum by using Cauchy's relation.
5.	Calibration of constant deviation spectrometer and determination of unknown wavelength.
6.	To Determine Young modulus of glass by Cornu's method.
7.	To Verify the Brewster law of reflection for polarized light.
8.	To study the characteristic of NPN transistor in CE mode.
9.	To study the characteristic of UJT.
10.	To study characteristics of FET.
11.	To study the characteristic of MOSFET.
12.	To study the energy band gap & diffusion of P-N junction.
13.	To study Zener regulated and IC regulated power supply.

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: I	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYP 106		
2.	Course Title	LAB - II Python Programming		
3.	Course Type	Practical		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Find roots of quadratic equation using python programming. • Add and subtract matrices using python programming. • Multiply matrices using python programming. • Sort numbers in ascending order using python programming. • Find largest of N numbers using python programming. • Print factors of a given number using python programming. • Calculate factorial of an integer using python programming. • Produce a table of sin, cos, and tan using while loop using python programming. • Calculate the value of a series (1 + 1/1! + 1/2! + ... + 1/n!) using python programming. • Print Celsius/Fahrenheit equivalences using for loop using python programming. • Find result, relative error, percentage error of an experiment using python programming. • Plot a straight line using python programming. • Plot potential and wavefunction of 1D harmonic oscillator using python programming. • Plot y = Asin(Bx + C) using python programming. • Find roots of cubic polynomial using bisection method using python programming. • Perform integration using Simpson's 1/3rd rule using python programming.		
6.	Credit Value	4		
7.	Total Marks	IA: Na ESE: 100 Marks	Max. marks : 100 Min. Marks: 36	

Part B: List of experiments	
S.N.	Title of Practical
1.	Python program to find roots of quadratic equation.

2.	Python program to add and subtract matrices.
3.	Python program to multiply matrices.
4.	Python program to short number in ascending order.
5.	Python program to find largest of N number.
6.	Write a program to print factors of a given number.
7.	Write a function that takes an integer input and calculates the factorial of that number.
8.	Using while loop, produce a table of sins, cosines and tangents. Make a variable x in range from 0 to 10 in steps of 0.2. For each value of x, print the value of sin(x), cos(x) and tan(x)
9.	Write a function that takes an integer 'n' as input and calculates the value of 1+1/1!+ 1/2! + 1/3! +.....+ 1/n!
10.	Using for loop, print a table of Celsius/Fahrenheit equivalences. (Let c be the Celsius temperatures ranging from 0 to 100, for each value of c, print the corresponding Fahrenheit temperature.)
11.	Python program to find result, relative error, percentage error of an experiment. (In an experiment of determination of diameter of pencil using Vernier caliper, let X_1, X_2 , X_3, X_4 .....X_N be the measurement of diameter repeated N times. Write a python program which will take no. of repetition N and value of X_1, X_2 , X_3, X_4 .....X_N as input from user and will give result, errors, etc. as output)
12.	Python program to plot straight line. (In which user enters slope and y- intercept of straight line)
13.	Python program to plot potential and wavefunction of one dimensional harmonic oscillator.(potential and wavefunction for ground state)
14.	Python program to plot y=Asin(Bx +C).
15.	Python program to find roots of cubic polynomial using bisection method.
16.	Python program to perform integration using Simpson's 1/3rd rule.

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: II	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 201		
2.	Course Title	Mathematical Methods - II		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Basic knowledge about the complex variable function. • Uses of partial differential equation to solve boundary value problem. • Basic knowledge about Tensor and Group Theory. • Use concept of Green's function to solve Differential Equation.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Complex Analysis:** Function of Complex Variables, limit, continuity and differentiability, Analytic function, the necessary and sufficient condition for a function to be analytic, Cauchy-Riemann condition, Cauchy integral theorem, Taylor's series and Laurent's series expansion, Zeros and singular points, Multivalued functions, Branch Points and Cuts, Residues, Residue theorem, evaluation of line integral by indefinite integration, Cauchy's integral formula, Derivatives of an analytic function. Singularities of analytic functions, Residues and their Evaluation, Cauchy's residue theorem. Contour integration.	12
II.	**Boundary value problems:** Transverse vibration of a stretched string, D'Alembert solution, Two-dimensional heat flow, rectangular membrane, Poisson's and Laplace equations, Solution of partial differential equation by Fourier and Laplace transform methods.	12

III.	**Green's function**: Non-homogeneous boundary value problem, Green's function for one dimensional problem, eigen function expansion of Green's function, method of constructing Green's function, Green's function for electrostatic boundary value problems and quantum mechanical scattering problem.	12
IV.	**Tensors:** Definition of Tensor, contra variant and covariant tensors, the algebra of -tensor, Quotient law, Symmetric & antisymmetric tensors, invariant tensors, associate tensors, conjugate tensors, metric tensors; length of a vector, angle between tensors, Christophers symbol and their transformation law, equation of geodesies, Covariant differentiation of vectors and tensors of higher rank.	12
V.	**Group Theory**: Concept of a group (additive and multiplicative), Matrix representation of a group, reducible and irreducible representation of a group, Examples of SO(2), SO(3), and SU(2) groups, Qualitative idea of the orthogonality theorem.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Advance Engineering Mathematics, H K Dass, S. Chand Publishing
2. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 44TH Edition

Reference Books:

1. Mathematical Methods for Physicists (6/e): G.B. Arfken and H.J. Weber, Elsevier Academic Press
2. Applied Mathematics for Engineers and Physicists, L.A. Pipes and L.R. Harvill, McGraw-Hil
3. Advanced Engineering Mathematics, E. Kreyzig (2nd Ed., Pearson, 2002)
4. Complex variables and applications, R. V. Churchill and J.W. Brown, McGraw-Hill; Edition: 5th Edition
5. Group Theory in Physics, W.-K. Tung ,World Scientific

E -Resources:

1. https://nptel.ac.in/courses/115106086
2. https://nptel.ac.in/courses/115105097
3. https://nptel.ac.in/courses/115103036
4. https://nptel.ac.in/courses/111107119

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: II	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 202		
2.	Course Title	Quantum Mechanics - I		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to : • Understand general formalism and Dirac notation in quantum mechanics. • Master the applications of quantum mechanics in one dimensional and three dimensional physics problems. • Apply angular momentum algebra to find out C G coefficients. • Apply Quantum mechanics to solve hydrogen atom problem. • Understand Heisenberg and Dirac formalism of Quantum mechanics.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Review of concepts:** Limitations of Classical Mechanics, Wave-particle duality, Schrodinger equation, Acceptable wavefunctions, Probability interpretation, Continuity equation, Ehrenfest theorem, Stationary states.	12
II.	**Formalism:** Dirac notation, operators, Hermitian operators and their properties, commutator algebra, Uncertainty relation between two operator, Eigen values and eigenfunction of operator, Matrix representation of bra - ket and operator , unitary transformations , position and momentum space representation, matrix and wave mechanics.	12

III.	**Postulates of quantum mechanics:** Basic postulates, Superposition principle, observables and operators, Measurements, expectation value, symmetries and conservation laws. General properties of one dimensional motion, One dimensional problems, Problems , potential wells and barriers, Harmonic oscillator operator method.	12
IV.	**Angular momentum:** Commutation relations of angular momentum operators, Eigenvalues, eigenvectors. Ladder operators and their matrix representations. Spin angular momentum and Pauli matrices, addition of angular momentum , rotation in quantum mechanics, Clebsch-Gordan coefficients.	12
V.	**Three Dimensional problem:** Central force problem; Solution of Schrodinger equation for spherically, symmetric potentials , Hydrogen atom, Three-Dimensional Square Well Potential and Energy levels, degeneracy.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Introduction to Quantum Mechanics 4th edition, D J Griffiths, Cambridge University
2. Quantum Mechanics: Theory and Applications, Ajoy Ghatak and S Lokanathan, 5th edition, Macmillan India Ltd.
3. A Textbook of Quantum Mechanics, K. Venkatesan, (2010). P.M. Mathews, Dorling Kindersley (India) Pvt. Ltd.

Reference Books:

1. Quantum Mechanics-Concepts and Applications , N. Zettili, (2009), Wiley
2. Quantum Mechanics , E. Merzbacher, (2011). Wiley India Pvt. Ltd., New Delhi, India.
2. Quantum Mechanics, L.I. Schiff, (2010). Tata McGraw-Hill Education
3. Modern Quantum Mechanics, J. J. Sakurai, (2009), Pearson Education
4. Quantum Mechanics - Nonrelitavistic Theory: Course Of Theoretical Physics - Vol. 3, L D Landau, E. M. Lifshitz , Butterworth-Heinemann Ltd.

E -Resources:

1. https://nptel.ac.in/courses/115101107
2. https://nptel.ac.in/courses/115106066
3. https://nptel.ac.in/courses/115102023
4. https://hcverma.in/QuantumMechanics
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==
6. https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: II	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 203		
2.	Course Title	Electrodynamics		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Solve problems involving electrostatics and magnetostatics. • Analyze and understand Maxwell's equations and electromagnetic wave behaviour. • Predict and explain the reflection, refraction, and transmission of electromagnetic waves. • Apply the principles of relativity to electromagnetic field dynamics. • Comprehend the characteristics and sources of electromagnetic radiation.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Electrostatics :** Gauss's law and its applications, Laplace and Poisson equations, boundary value problems , dielectrics, polarization of a medium, electrostatic energy. **Magnetostatics**: Biot -Savart law, differential equation for static magnetic field, vector potential, examples of magnetostatic problems, Faraday's law of induction, magnetic energy of steady current distributions.	12
II.	**Maxwell's Equations:** Maxwell's Equation of continuity, Maxwell's equations (SI Unit) and its derivation, Integral form of equation, Maxwell's equations in some particular cases, Electromagnetic energy. Poynting Theorem. The wave equation, electromagnetic waves in free space. Plane electromagnetic waves in a Non-conducting isotropic medium (i.e. Isotropic dielectrics). Plane electromagnetic waves in Anisotropic Non-conducting medium (Anisotropic dielectric). Plane electromagnetic waves in conducting medium. Propagation of electromagnetic waves in ionized gases. Gauge symmetry, Coulomb and Lorentz gauges.	12

III.	**Interaction of EM Waves:** Boundary conditions at the interface two media, Reflection and Refraction of electromagnetic waves at the interface of Non-conducting media, Reflection and transmission coefficients at the interface between two non conducting media, Brewster's law and degree of polarisation, Total-internal reflection, Propagation of Electromagnetic waves between parallel conducting planes. Wave guides. TM modes and TE modes.	12
IV.	**Relativity and Electromagnetic Field Dynamics:** Postulates of Einstein's special theory of relativity, Galilean transformations. Lorentz's transformations and its consequence, Transformation of differential operator, Invariance of D'Alembertian operator, Invariance or charges, transformation of charge density, Electric field measured in different frames of reference, Minkowski space, Concept of four vector, Lorentz transformation or space and time in four vector form, Transformation for charge and current density, Transformation of electromagnetic potential A and S. Lorentz condition in covariant form. Covariance or Maxwell field equation in terms of four vectors.	12
V.	**Electromagnetic Radiation:** Electromagnetic vector and scalar potential, Lorentz Gauge, Lienard- Wiechert potentials, the electromagnetic field of a uniformly moving point charge, Radiation from an accelerated charge at low velocity - Larmor's formula, Angular distribution of radiation emitted by an accelerated charge, Radiation damping, Cherenkov radiation, Radiation due to an oscillating electric dipole, electric quadra pole radiation, Radiation due to small current element, Radiation from linear antenna.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Classical Electrodynamics; J.D. Jackson, Wiley
2. Introduction to Electrodynamics; D.J. Griffiths, Pearson
3. Electrodynamics; Gupta, Kumar, Sharma, Pragati Prakashan

Reference Books:

1. Modern Electrodynamics; A. Zangwil; Cambridge University Press, Cambridge, U.K.
2. Principles of Electrodynamics; Melvin Schwartz (Dover Publications,1987).
3. Classical Electrodynamics, J. Schwinger, L.L. Deraad Jr, K.A. Milton, W Y. Tsai and J. Norton (Westview Press, 1998).
4. Electrodynamics of Continuous Media; L. D. Landau and E. M. Lifshitz & L. P. Pitaevskii (Oxford, 2005)

E -Resources:

1. https://nptel.ac.in/courses/115101004
2. https://nptel.ac.in/courses/115105132
3. https://nptel.ac.in/courses/115101005
4. https://nptel.ac.in/courses/115104134
5. https://nptel.ac.in/courses/115106122
6. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: II	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYT 204		
2.	Course Title	Electronics - II		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Understand radiative and nonradiative transitions in electronic devices. • Analyze performance of photoconductive devices and emission spectra. • Design and analyze light-emitting diodes (LEDs) and photodetectors. • Apply operational amplifier principles in differential amplifier circuits. • Gain practical skills in analyzing and designing Op-amp circuits, including oscillators and comparators.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Fundamental of Optoelectronics Devices:** Radiative and nonradiative transitions Optical-Absorption, bulk and thin film, photoconductive devices (LDR). Emission spectra. Luminescent efficiency, method of excitation. Light emitting diode (LED): high frequency limit, effect of surface and indirect combination current, operation of LED, Visible LEDs, and infrared LEDs. Diode Laser , Condition for population inversion in active region, light confinement factor, optical gun and threshold current for lasing, Fabry Perrot Cavity Length for losing and the separation.	12
II.	**Photodetectors, Phototransistors, and Solar Cells:** Photoconductor, equivalent circuit of photoconductor , Phototransistor Bipolar phototransistor, photo - Darlington transistor, V-I characteristic of bilateral hetero structure phototransistor, Solar cells, Solar radiation, solar-spectrum, ideal conversion efficiency. Energy band diagram of solar cell , I-V characteristics of solar cell, PN junction solar cells, Hetero junction, Interface thin fin solar cells.	12
	Introduction to Op-amp: Basic Op-amp, Differential amplifier - circuit configurations, dual input, balanced output, differential amplifier -DC analysis,	

III.	Ac analysis, inverting and non-inverting inputs, GMRR Constant current bias level transistor. Block diagram of a typical Op-amp, Analysis open loop configuration, inverting and non-inverting amplifier, Op-amp with negative feedback, Voltage series feedback, effect of feedback on closed loop gain input persistence output, resistance bandwidth and output offset voltage, voltage follower.	12
IV.	**Practical Op-amp Circuits and Applications:** Practical Op-amp. Input offset voltage, Input offset current, total output offset voltage, CMRR frequency response, DC and AC amplifier summing scaling and averaging amplifiers instrumentation amplifier, integrator and differentiator.	12
V.	**Oscillators, Comparators, and Waveform Generators:** Oscillator's principles, oscillator types, frequency, stability response, the phase shift oscillator. Wein bridge oscillator, Multivibrators, Monostable and Astable Comparators, square wave and triangle wave generators.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Hand Book of Electronics - Gupta Kumar (Pragati Prakashan)
2. Electronic Devices and circuit theory - Robert Baylested and Iquis Nashdsky, PHI, New Delhi

Reference Books:

1. Semiconductor Devices - Physics and Technology S.M. Sze, Wiley, 1985
2. Introduction to Semiconductor Devices - M.S.Tyagi, John Wiley & sons
3. Electronic Fundamentals and applications - John D. Ryder PHI, New Delhi
4. Operational Amplifier and their applications - Subir Kumar Sarkar, S.Chand & Sons

E -Resources:

1. https://nptel.ac.in/courses/108101091
2. https://nptel.ac.in/courses/115102014
3. https://nptel.ac.in/courses/117103063
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: II	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYP205		
2.	Course Title	LAB - 1 Electronics		
3.	Course Type	Practical		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Understand the characteristics of Light Dependent Resistors (LDR) and their applications in various electronic circuits. • Comprehend the behaviour of Light Emitting Diodes (LED) and their use as light sources in electronic devices. • Study the working principles and characteristics of Photo transistors, which are light-sensitive transistors used for detecting light signals. • Explore the characteristics of Photodiodes, which are semiconductor devices that convert light into electrical current. • Design inverting amplifier circuits using Op-amps (Operational Amplifiers), with the ability to amplify input signals for specific DC voltage gains. • Analyze and design inverting amplifier circuits using Op-amps, considering their behaviour and response to varying frequencies. • Design non-inverting amplifier circuits using Op-amps (741, 351) and understand their frequency response characteristics. • Perform addition of two DC voltages using Op-amps in both inverting and non-inverting modes. • Design precision Differential amplifier circuits using Op-amps, meeting specific input and output specifications. • Investigate the use of Op-amps as Integrators, capable of performing mathematical integration of input signals. • Investigate the use of Op-amps as Differentiators, capable of performing mathematical differentiation of input signals. • Design a Wien bridge oscillator circuit using an Op-amp to generate a specific frequency for electronic applications. • Design a phase shift oscillator using Bipolar Junction Transistors (BJT) to meet given frequency specifications. • Study the operation and working principles of the Colpitts oscillator, a type of electronic oscillator circuit used in various applications. • Through these practicals and learning experiences, students will gain hands-on knowledge and understanding of various electronic components and circuit designs, enabling them to apply this knowledge in real-world electronic projects and applications.		
6.	Credit Value	4		

7.	Total Marks	IA: Na ESE: 100 Marks	Max. marks : 100 Min. Marks: 36

Part B: Contents of the Course	
List of experiments	
S.N.	**Title**
1.	To study the characteristic of LDR.
2.	To study the characteristic of LED.
3.	To study the characteristic of Photo transistor.
4.	To study the characteristic of Photodiode.
5.	To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
6.	To design inverting amplifier using Op-amp (741,351) and study its frequency response.
7.	To design non-inverting amplifier using Op-amp (741,351) & study its frequency response.
8.	To add two dc voltages using Op-amp in inverting and non-inverting mode.
9.	To design a precision Differential amplifier of given I/O specification using Op-amp.
10.	To investigate the use of an op-amp as an Integrator.
11.	To investigate the use of an op-amp as a Differentiator.
12.	To design a Wien bridge oscillator for given frequency using an op-amp.
13.	To design a phase shift oscillator of given specifications using BJT.
14.	To study the Colpitts oscillator.

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: II	Year: First	w.e.f. : 2023-2024
1.	Course Code	PHYP206		
2.	Course Title	LAB - II General (Electrodynamics, Quantum Mechanics and Statistical Mechanics)		
3.	Course Type	Practical		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Check how light behaves when it passes through a filter called a polarizer. • Measure how much light bends when it goes from air to glass and a liquid. • Observe how hot objects emit radiation and find a constant related to it. • Find the temperature at which a certain metal loses its magnetic properties. • Calculate a special number of nature and learn about the connection between light and electrons in materials. • Study how electrons behave in a magnetic field and find the strength of the field when they resonate. • Observe how light behaves in the presence of a magnetic field and explore fine energy level structures. • Measure the basic electric charge carried by electrons using tiny oil droplets. • Investigate how electrons are deflected by electric and magnetic fields to find a specific ratio. • Understand how radiation is emitted by hot objects and compare different laws related to it at high and low temperatures. • Explore how the heat capacity of solids changes with temperature using different models. • See how particle velocities are distributed in a gas at different temperatures. • Study the distribution of energy levels in a system of particles called fermions at varying temperatures. • Study the distribution of energy levels in a system of particles called bosons at varying temperatures.		
6.	Credit Value	4		
7.	Total Marks	IA: Na ESE: 100 Marks		Max. marks : 100 Min. Marks: 36

Part B: Contents of the Course	
List of experiments	
S.N.	Title

1.	To verify the law of Malus for plane polarized light.
2.	To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
3.	To verify the Stefan's law of radiation and to determine Stefan's constant.
4.	To determine Curie temperature of Monel metal by using a transformer.
5.	To Determination of Planck's constant and work function of Materials by photoelectric effect.
6.	Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.
7.	Study of Zeeman effect: with external magnetic field; Hyperfine splitting.
8.	To determine electron charge by Millikan's experiment.
9.	To determine the e/m of electron by Thomson method.
10.	Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
11.	Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.
12.	Plot Maxwell-Boltzmann distribution function versus temperature.
13.	Plot Fermi-Dirac distribution function versus temperature.
14.	Plot Bose-Einstein distribution function versus temperature.

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