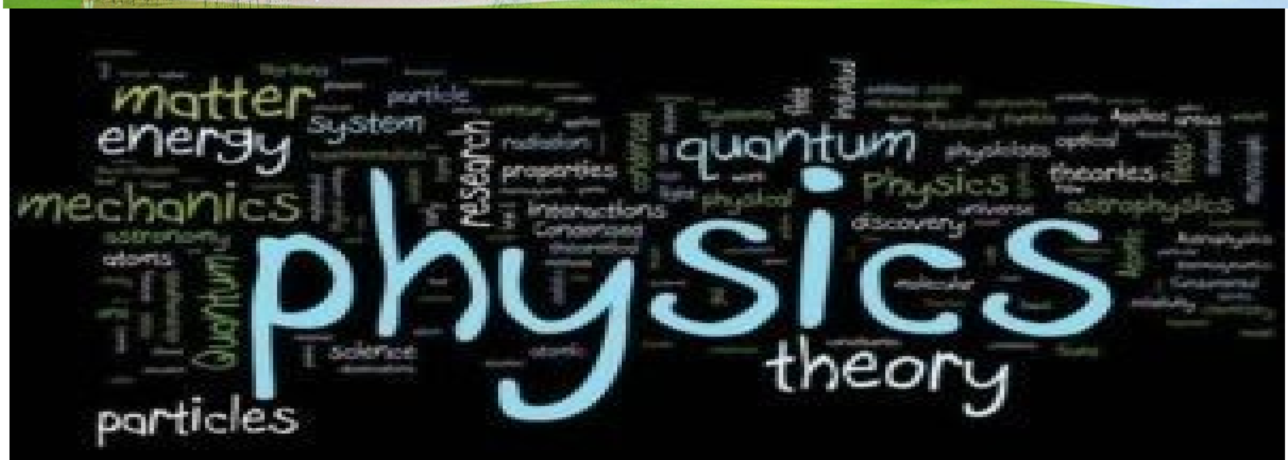
University Dept. Of Physics

Kolhan University, Chaibasa

कोलहान वि%श्ववि%द्यालय,



Choice Based Credit System (CBCS)

UNDERGRADUATE & POSTGRADUATE PROGRAMME

(Courses effective from Academic Year 2020-21)

Programme Objectives (POs)

The objectives of the M.Sc. Physics programme are manifold and start with imparting students with an in-depth knowledge and understanding through the core courses which form the basis of Physics namely, Classical Mechanics, Quantum Mechanics, Mathematical Physics, Statistical Physics, Electromagnetic Theory, Solid State Physics, Electronics, Nuclear and Particle Physics along with Atomic and Molecular Physics. Creative thinking and problem-solving capabilities are also aimed to be encouraged through tutorials. The elective and open elective courses are designed for more specialized and/or interdisciplinary content to equip students with a broader knowledge base. The core and elective labs are designed to develop an appreciation for the fundamental concepts and working of devices used in everyday life employing scientific methods/tools of physics. Computational physics course is aimed to equip the students to use computers as a tool for scientific investigations/understanding. The dissertation(s) in both theory and experimental stream are expected to give a flavor of how research leads to new findings. In addition, the M.Sc. Course is to lay a solid foundation for a doctorate in Physics/allied subjects later.

Programme Specific Outcomes (PSOs)

- Understanding the basic concepts of physics particularly concepts in classical mechanics, quantum mechanics, statistical mechanics and electricity and magnetism to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical and mathematical reasoning.
- Learn to carry out experiments in basic as well as certain advanced areas of physics such as nuclear physics, condensed matter physics, nanoscience, lasers and electronics.
- Understand the basic concepts of certain sub fields such as nuclear and high energy physics, atomic and molecular physics, solid state physics, and plasma physics, and astrophysics, general theory of relativity, nonlinear dynamics and complex system.
- Gain hands on experience to work in applied fields.
- Gain a through grounding in the subject to be able to teach it at college as well as school level.
- Viewing physics as a training ground for the mind developing a critical attitude and the faculty of logical reasoning that can be applied to diverse fields.

Programme Structure

The M. Sc. programme is a two-year course divided into four-semesters. The M.Sc. Physics Programme would make the students competent in a natural science, viz., Physics, and help them understand its role in modern day technology. Overall, the course would enable the students to understand the fundamental concepts and experimental methods of physics which would help them to innovate/apply/generate new devices/applications/insights/knowledge. Knowledge gained through the open electives would be an asset in branching out in fields other than physics.

SYLLABUS OF COURSES TO BE OFFERED

Semester	Paper – I	Paper – II	Paper – III	Paper – IV	Paper - V
I	Core - I	Core - II	Core - III	Core - IV	Core (P) - V
II	Core - VI	Core - VII	Core - VIII	Core - IX	Core (P) - X
III	Core - XI	Core - XII	**DSE - I**	**DSE (P) - II**	**Dissertation - I**
IV	Core - XIII	Core - XIV	**DSE - III**	**DSE (P) - IV**	**Dissertation - II**

DSE : Department Specific Elective

(P) : Practical

Credit Distributions

	Theory	Credit	Practical	Credits	Paper	Credits
Core	12	12 x 4	02	2 x 6	14	60
DSE	02	2 x 4	02	2 x 6	04	20
Dissertation					02 x 6	12
			Total Courses		20	92

Semester Wise Paper

Sem	Course Code	Course Name	L	T	P	Credit	Marks	Total Credit	Total Marks
I	CCPHY101	Quantum Mechanics–I	3	1	0	4	100	22	500
	CCPHY102	Solid State Physics	3	1	0	4	100		
	CCPHY103	Basic Electronics	3	1	0	4	100		
	CCPHY104	Scientific Computing	3	1	0	4	100		
	CC(P)PHY105	Computational & Electronics Lab	0	0	6	6	100		
II	CCPHY201	Quantum Mechanics–II	3	1	0	4	100	22	500
	CCPHY202	Statistical Physics	3	1	0	4	100		
	CCPHY203	Mathematical Physics	3	1	0	4	100		
	CCPHY204	Classical Mechanics	3	1	0	4	100		
	CC(P)PHY205	Optics & Modern Physics Laboratory	0	0	6	6	100		
III	CCPHY301	Atomic, Molecular & Laser Physics	3	1	0	4	100	24	500
	CCPHY302	Nuclear & Particle Physics	3	1	0	4	100		
	DSEPHY301	Selected from group A/B/C	3	1	0	4	100		
	DSE(P)PHY302	Selected from corresponding Lab	0	0	6	6	100		
	PRPHY301	Dissertation - I	0	0	6	6	100		
IV	CCPHY401	Electromagnetic Theory	3	1	0	4	100	24	500
	CCPHY402	Modern Experimental Techniques	3	1	0	4	100		
	DSEPHY401	Selected from group A/B/C	3	1	0	4	100		
	DSE(P)PHY402	Selected from corresponding Lab	0	0	6	6	100		
	PRPHY401	Dissertation - II	0	0	6	6	100		
		Total Credits & Marks						92	2000

Annexure –I: List of Discipline Specific Elective Coerces for Semester – III and Semester -IV

Table – 5

DSE Group	Sem - III		Sem - IV	
A	1	Spectroscopy & Laser I	3	Spectroscopy & Laser III
	2	Spectroscopy & Laser II	4	Spectroscopy & Laser IV
B	1	Condense Matter Physics - I	3	Condense Matter Physics - III
	2	Condense Matter Physics - II	4	Condense Matter Physics - IV
C	1	Electronics & Communication - I	3	Electronics & Communication - III
	2	Electronics & Communication - II	4	Electronics & Communication - IV

Note:

1. The elective courses may update every year in the month of June, according to availability of faculty members.

2. Instead of the above group of courses, choice of open electives may also be taken by the students of two laboratory and two theory combinations.

General Guideline for Examination / Evaluation

Theory Papers:

EIGHT questions in all will be set in which question 1 will be objective type consisting of 10 questions of one mark each and is compulsory. Out of remaining seven questions of 15 marks each, 4 are to be answered. The questions will cover the entire syllabus, equally distributed over all the units as far as practicable. The questions should divided into two parts

- to evaluate the conceptual and analysis based knowledge of the students (10 Marks)
- to evaluate the ability of students to apply the concept of Physics in Problem solving (05 Marks).

Laboratory Papers:

The Laboratory course will be evaluated on the basis of the

- Experiment performed during the Courses on the basis of Laboratory Note Book: 20 Marks
- Innovative Project: applying the experiments learned, the students can innovate some new working model / devise : 20 Marks
- Experiment performed in Exam: 40 Marks
- Viva-Voce: 20 Marks

SEMESTER – I

Sem	Course Code	Course Name	L	T	P	Credit	Marks	Total Credit	Total Marks
I	CCPHY101	Quantum Mechanics–I	3	1	0	4	100	22	500
	CCPHY102	Solid State Physics	3	1	0	4	100		
	CCPHY103	Basic Electronics	3	1	0	4	100		
	CCPHY104	Scientific Computing	3	1	0	4	100		
	CC(P)PHY105	Computational & Electronics Lab	0	0	6	6	100		

CCPHY101 : QUANTUM MECHANICS–I

Course Learning Outcomes

1. This course provides understanding and knowledge to realize the basics of molecular, atomic and subatomic physics.

2. Concept of wave function and wave packet is introduced. Students get their critical thinking ability developed by studying uncertainty principle. Study of probability, expectation value and Ehrenfest's theorem assist students to be enriched with mathematical calculation.

3. The concept of Schrodinger equation creates analytical power of students.

4. The knowledge of quantization is clarified by studying energy levels. The study of different potentials nourish them to think about system and its function with the help of mathematical tools. Students get skilled by studying the formalism of quantum mechanics in describing the systems mathematically and this knowledge becomes very useful for their study of particle physics, spectroscopy and research.

5. By studying angular momentum, the conceptual clarity regarding the calculations of the eigen-value and eigen vector. Learning the calculations of CG coefficients students get ready to solve analytical and mathematical problems

Course Content

Unit-I

Introductory concepts: Wave-particle duality, interpretation of the wave function, wave function for particles having a definite momentum, Schrodinger equation, Gaussian wave Packets and their time evolution, Fourier transform and momentum space wave function, Heisenberg uncertainty principle for position and momentum, conservation of probability, operators and expectation values, Ehrenfest theorem, time-independent Schrodinger equation, stationary states and their properties, energy quantization, properties of energy Eigen functions, general solution of the time dependent Schrodinger equation for a time independent potential. (10 Lectures + 05 Tutorials)

Unit-II

One-dimensional problems: Free-particle, box normalization, Eigen values and Eigen functions of particle in a) infinitely deep potential b) finite square well potential, and c) simple harmonic oscillator potential, potential barrier - transmission and reflection coefficients. Extension to three dimensional problems: Separation of the Schrodinger equation in Cartesian coordinates, particle in a three dimensional box.

(10 Lectures + 05 Tutorials)

Unit-III

General formalism of quantum theory: operator methods: Hilbert space, linear operators, observables, Dirac notation, Eigen functions of Hermitian operators, degeneracy, commutation of operators and compatibility, generalized uncertainty principle for two non-commuting observables, Unitary transformations, time-dependence of observables: Schrodinger and Heisenberg pictures, Simple harmonic oscillator by operator method. (10 Lectures + 05 Tutorials)

Unit-IV

Angular momentum: Orbital angular momentum commutation relations, Eigen values and Eigen functions, Central potential, separation of variables in the Schrodinger equation, the radial equation, the Hydrogen atom. General operator algebra of angular momentum operators J_x, J_y, J_z. Ladder operators, eigen values and eigenkets of J^2 and J_z, matrix representations of angular momentum operators, Pauli matrices, addition of angular momentum, Clebsch-Gordan coefficients for the case $j_1 = j_2 = 1/2$.

(10 Lectures + 05 Tutorials)

References

1. Introduction to Quantum Mechanics, David J Griffiths, 2 nd Edition, Pearson Prentice Hall, 2005.
2. Quantum Mechanics, BH Bransden and CJ Joachain, 2 nd Edition, Pearson Education, 2007.
3. Quantum Mechanics, VK Thankappan, 2 nd Edition, Wiley Eastern Limited, 1993.
4. Quantum Mechanics Vol I & II, C CohenTannoudji, B Diu and F Laloe, 2 nd Edition, Wiley Inter science Publication, 1977.
5. Quantum Mechanics, LI Schiff, 3 rd Edition, McGraw Hill Book Company, 1955.
6. Modern Quantum Mechanics, JJ Sakurai, Revised Edition, Addison-Wesley, 1995.
7. Principles of Quantum Mechanics, R Shankar, 2 nd Edition, Springer, 1994.

8. Quantum Mechanics, E Merzbacher, John Wiley and Sons, 1998.

9. Quantum Physics, S Gasiorowicz, John Wiley and Sons 2014.

10. Introduction to vectors, axial vectors, tensors and spinors, GRamachandran, MS Vidya and Venkataraya, Vijayalakshmi Prakashana, Mysuru, 2017.

CCPHY102 : SOLID STATE PHYSICS

Course Learning Outcome

This Course helps the students to

1. Find out the relationship between crystals detector, structure analysis by various methods
2. Understand the elastic constant of crystals and lattice vibration
3. Understand the Energy levels and define Electrical conductivity – Hall Effect and free electron model and band gap energy
4. Analyse the relationship between dielectric and Ferro electric properties of crystals
5. Perform and verify the theory and experimental procedure for magnetism and super conductivity phenomenon

Course Content

Unit-I

Crystal structure: Crystalline state - periodic arrangement of atoms-lattice translation vectors. The basis and crystal structure, primitive and non-primitive lattice cell-fundamental types of lattice, 2d and 3d Bravais lattice and crystal systems. Elements of symmetry operations-points and space groups-nomenclature of crystal directions and crystal planes-miller indices, X-ray diffraction: Scattering of x-rays, Laue conditions and Bragg's law, atomic scattering factor, geometrical structure factor, Reciprocal lattice and its properties. (10 Lectures + 05 Tutorials)

Unit-II

Free electron theory of metals: Free electron model, Electrons moving in one dimensional potential well, three dimensional potential well, quantum state and degeneracy, the density of states, Fermi - Dirac statistics, effect of temperature on Fermi distribution function, the electronic specific heat.

Electrical conductivity of metals, relaxation time and mean free path, electrical conductivity and Ohm's law, thermal conductivity, Wiedemann - Franz law, thermionic emission, the energy distribution of the emitted electrons, field enhanced electron emission from metals, changes of work function due to absorbed atoms, the contact potential between two metals, Hall effect.

(10 Lectures + 05 Tutorials)

Unit-III

Semiconductors: Introduction to semiconductors, band structure of semiconductors, Intrinsic and extrinsic semiconductors, expression for carrier concentration (only for intrinsic), ionization energies, charge neutrality equation, conductivity-mobility and their temperature dependence, Hall effect in semiconductors.

Superconductors: Critical temperature-persistent current-occurrence of super conductivity-ideal and non-ideal superconductors-Destruction of super conductivity by magnetic field - Meissner effect- heat capacity-energy gap-Isotope effect- BCS theory (qualitative)-Josephson tunneling - exotic superconductors- high T_c super conductors. (10 Lectures + 05 Tutorials)

Unit IV

Dielectrics: Introduction, Review of basic formulae, Dielectric constant and displacement vector - different kinds of polarization-local electric field-Lorentz field- Clausius - Mossotti equation relation- expressions for electronic, ionic and dipolar polarizability, Ferroelectricity and piezo electricity.

Magnetism: Review of basic formulae -classification of magnetic materials-Langevin theory of diamagnetism, para-magnetism and Ferromagnetism, domains-Weiss molecular field theory (classical)-Heisenberg exchange interaction theory-. Antiferro-magnetism and ferrimagnetism.

(10 Lectures + 05 Tutorials)

References

1. Crystallography Applied to Solid State Physics, A R Verma and ON Srivastava, 2 nd edition, New Age International Publishers, 2001.
2. Solid State Physics, AJ Dekker, Macmillan India Ltd., Bangalore, 1981.
3. Solid State Physics, C Kittel, V Ed., Wiley Eastern Ltd., 1976.
4. Elementary Solid state physics, MA Omar, Addison Wesley, New Delhi, 2000.
5. Solid state Physics, SO Pillai. New Age International Publication, 2002.
6. Solid state Physics, MA Wahab, Narosa Publishing House, New Delhi, 1999.
7. Introduction to Solid state physics, L Azoroff, Tata McGraw Hill publications, 1993.
8. Solid State Physics, HC Gupta, Vikas Publishing House, New Delhi, 2002.
9. Arun Kumar, ``Introduction to Solid State Physics'', PHI Learning Pvt. Ltd.

CCPHY103 : BASIC ELECTRONICS

Course Learning Outcomes

This Course Helps the Students to

1. Understand the basic principle of semiconductors various types of diode characteristics and op to electronic devices and its working
2. Construction of Op-Amp. Then characterization of its various types of working modes.
3. Understand the basic principle of various types of logic gates – Registers' and counter and also the memory device
4. Understands the construction and working of various types of oscillators. And then converts it's into various types of oscillations
5. Studying the principle, construction and working of signal modulators. Perform the working principle of various types of microwave devices.

Course Content

Unit- I

Physics of devices: Calculation of carrier concentration in intrinsic semiconductors; Calculation of carrier concentration in extrinsic semiconductors; Fermi energy level; electrical conductivity; p-n junction; abrupt junction; band structure; Calculation of junction voltage; variation of electric field across the junction; expression for width of the depletion region; expression for junction capacitance; diffusion and drift currents; equilibrium current calculation; forward and reverse bias of the diode; current relations under non equilibrium;

Derivation of diode equation; V-I characteristics of diode; Junction field effect transistor; band structure; construction and working principle; current – voltage characteristics; Metal semiconductor contacts – Schottky and ohmic contacts with band structure; Depletion and Enhancement mode MOSFET: Principle and working; calculation of threshold voltage; V-I characteristics. (10 Lectures + 05 Tutorials)

Unit -II

Operational amplifiers: Operational amplifier as open loop amplifier - Limitations of open loop configuration – Operational amplifier as a feedback amplifier: closed loop gain, input impedance, output impedance of inverting and non-inverting amplifiers - Voltage follower - Differential amplifier: voltage gain.

Applications of op-amp: Linear applications – Phase and frequency response of low pass, high pass and band pass filters (first order), summing amplifier – inverting and non-inverting configurations, subtractor, difference summing amplifier, ideal and practical Differentiator, Integrator.

Non – linear applications: comparators, positive and negative clippers, positive and negative clampers, small signal half wave rectifiers. (10 Lectures + 05 Tutorials)

Unit –III

Digital circuits – I: Simplification using Karnaugh Map technique (6 variables)- conversion of binary to Grey code - Flip flops: Latch using NAND and NOR gates- RS flip flop, clocked RS flip flop, JK flip flop, JK master slave flip flop - racing –Shift Registers basics - Counters: Ripple / asynchronous counters truth table-timing diagram, Synchronous counters-truth table-timing diagram, Decade counter. (10 Lectures + 05 Tutorials)

Unit- IV

Digital circuits - II: Digital to Analog converters, ladder and weighted resistor types. Analog to digital Converters-counter method, successive approximation and dual slope converter. Read Only Memory (ROM) and applications(Embedded microprocessor program memory, data tables, function generator) Random Access Memory (RAM), DRAM basics. Microprocessors and controllers basics – evolution of microprocessors, registers in 8085, data and address bus multiplexing in 8085, RISC and CISC instruction sets (10 Lectures + 05 Tutorials)

References

1. Semiconductor Devices Physics and Technology, SM Sze, 3 rd Edition, John Wiley and Sons Inc. Asia, 2006.
2. Solid State Electronic Devices, Ben G Streetman, Sanjay Bannerjee, 7 th edition, Pearson, Asia, 2014.
3. The art of electronics, Paul Horowitz and Winfield Hill, Second Edition, Foundation Books, Delhi, 2008.
4. Electronic Principles, AP Malvino and J Bates, Eighth Edition, Tata McGraw Hill, Delhi, 2016.
5. Op-Amps and Linear Integrated Circuits, RA Gayakwad, 4 th Edition, Eastern Economy Edition, 2004.
6. Operational Amplifiers with Linear Integrated Circuits, William Stanley, 4 th Edition, CBS Publishers, 2002.
7. Linear Integrated Circuits, D Roy Choudhury and Shail Jain, 4 th Edition, New Age International Ltd, 2010.
8. Digital principles and applications, DP Leach and AP Malvino, 5 th Edition, Tata McGraw Hill, 2002.
9. Digital systems, Principles and applications, RJ Tocci and NS Widmer, 10 th Ed, Pearson Education, 2007.
10. Introduction to electronic devices, Micheal Shur, PHI, 1996.
11. Basic Electronics, Arun Kumar, Bharati Bhawan
12. Digital Systems and Applications by Nutan lata, Pragati Prakashan, Merrut
13. Basic Electronics by Arun Kumar, Bharati Bhawan, Patna

CPHY104: Scientific Computing / Computational Physics (Open Elective) for all science/math

Credits: 4, Lectures: 60

(All the programs are to be learned in Python/C/C++)

Python/C/ C++ Programming Languages & in SciLab / Metlab

Course Objectives:

1. To learn computer programming languages
2. solve physics problems through different numerical techniques
3. use computer programming for simulation and data analysis.

Course Content

Unit – I

Introduction: Role of computers in physics; Numerical analysis, modeling and simulation; Flow charts; Introduction to computer programming in Python/C/C++, Integer and Floating point arithmetic, Operators and Expressions, While, Do-While, For loops, Arrays and Strings, Functions, I/O with files.

Programs:- (1) Roots of a Quadratic Equation, (2) Sum and Average of Numbers, (3) Sum, Difference and Product of Matrices, (4) Largest of Three Numbers, (5) Factorial of an Integer by Normal Method and by Recursion, (6) Largest of a List of Numbers and its Location in the List, (7) Fitting a Straight Line to a Data, (8) Deviations About an Average, (9) Arrange a List of Numbers in Ascending and Descending Order, (10) Binary Search.
(10 L + 5 T/P/D)

Unit - II

<u>Numerical Analysis</u>

Errors and Iterative Methods: Truncation and Round-off Errors. Floating Point Computation. Overflow and Underflow. Single and Double Precision Arithmetic. Iterative Methods.

Solution of Algebraic and Transcendental Equations: (1) Fixed-Point Iteration Method, (2) Bisection Method, (3) Secant Method, (4) Newton-Raphson Method, and (5) Generalized Newton's Method. Comparison and Error Estimation.

Matrices and Linear System of Equations: Solution of Linear Equations :- (1) Gauss Elimination Method and (2) Gauss-Seidel Iterative Method.

Eigenvalues and Eigenvectors :- Computation of Eigenvalues and Eigenvectors of Matrices by using Iterative Methods. (10 L + 5 T/P/D)

Unit - III

Interpolation: Forward and Backward Differences. Symbolic Relation. Differences of a Polynomial. Newton' Forward and Backward Interpolation Formulas. Divided Differences. Newton's General Interpolation Formula.

Curve Fitting, B-Splines and Approximation: Curve Fitting by Least Square Methods : (1) Fitting a Straight Line. (2) Non-Linear Curve Fitting : (a) Power Function, (b) Polynomial of nth Degree, and (c) Exponential Function. (3) Linear Weighed Least Square Approximation. Orthogonal Polynomials. Gram-Schmidt Orthogonalization Process. Cubic B-Splines. Least-Squares Solution. Representation of B-Splines through Divided Differences. Approximation of Functions. Chebyshev Polynomials. (10 L + 5 T/P/D)

Unit - IV

Numerical Differentiation Numerical Differentiation using (1) Newton's Interpolation Formulas and (2) Cubic Spline Method. Errors in Numeric Differentiation. Maximum and Minimum Values of a Tabulated Function.

Numerical Integration: General Quadrature Formula. Trapezoidal Rule. Simpson's 1/3 and 3/8 Rules. Weddle's Rule. Gauss Quadrature Formulas : (1) Gauss- Hermite and (2) Gauss-Legendre Formulas.

Solution of Ordinary Differential Equations (ODE's) First Order ODEs :- Solution of Initial Value Problems : (1) Euler's Method, (2) Modified Eulers's Method, (3) Runge-Kutta Method of Second Order with Error Estimation.

Second Order ODEs. :- Solution of 2-Point Boundary Value Problems. Finite Difference Approximation of Derivatives. Finite Differnce Method.

Random Variables and Monte Carlo Methods: Random numbers, Pseudo-random numbers, Monte Carlo integration: Monte Carlo Simulations: Buffen's needle experiment, Importance of sampling, Random Walk (10 L + 5 T/P/D)

References:

1. Computational Physics with Python by Dr. Eric Ayars
2. Numerical Methods in Engineering with Python by Jaan Kiusalaas, Cambridge University Press.
3. Mathews, J. H., Numerical Methods for Mathematics, Science and Engineering, Prentice-Hall, (2000).
4. Introduction to Numerical Analysis, S.S. Sastry, PHI Learning Pvt. Ltd.
5. Schaum's Outline of Programming with C++., J. Hubbard, MCGraw-Hill Pub.
6. Numerical Recipes in C: The Art of Scientific Computing W.H Pressetal, Cambridge University Press.
7. A First Course in Numerical Methods, U.M Ascher& C. Greif, PHI Learning.
8. Elementary Numerical Analysis, K.E.Atkinson, Wiley India Edition.
9. Numerical Methods for Scientists & Engineers, R.W. Hamming, Courier Dover Pub.
10. An Introduction to Computational Physics, T. Pang, Cambridge Univ.
11. Simulation of ODE/PDE Models with Matlab® , Octave and Scilab, Scientific and Engineering Applications: A.V. Wouwer, P.Saucez, C.V.Fernandez. 2014 Springer.
12. Scilab by Example: M. Affouf 2012, ISBN: 978-1479203444.

13. Scilab(A free Software to Matlab): H.Ramchandran, A.S. Nair. 2011, S.Chand& Company.
14. Scilab Image Processing, Lamberr M.Surhone, 2010 Betascript Publishing.

CC(P)PHY105: Scientific Computating & Electronics Lab

A: Computational Physics

Students assigned the computer laboratory work will to develop & execute the following in Phython/C/C++ & in MATLAB/Scilab:

Python/C/C++-Programming

1. To evaluate a Polynomial :- (1) Converting Temperature from Fahrenheit to Celsius, (2) Area of a Circle, (3) Volume of Sphere etc.
2. To find the Roots of a Quadratic Equation : Real and Distinct, Repeated and Imaginary.
3. To locate a Number in a Given List (linear search).
4. (i) To find the Largest of Three Numbers.
   (ii) To find the Largest Number in a Given List of Numbers.
5. (i) To check whether a Given Number is a Prime Number.
   (ii) To calculate the first 100 prime numbers.
6. To rearrange a List of Numbers in Ascending and Descending Order.
7. (i) To calculate Factorial of a Number.
   (ii) To calculate the first few Factorials.
8. Manipulation of Matrices
   (i) To Add and Subtract two Matrices.
   (ii) To Multiply two Matrices.

Numerical Analysis Lab

I : Algebraic & Transcendental Equations

1. To find the Roots of an Algebraic Equation by Bisection Method.
2. To find the Roots of an Algebraic Equation by Secant Method.
3. To find the Roots of an Algebraic Equation by Newton-Raphson Method.
4. To find the Roots of a Transcendental Equation by Newton-Raphson Method.

II : Linear Equations & Eigenvalue Problem

1. To find the Roots of Linear Equations by Gauss Elimination Method.
2. To find the Roots of Linear Equations by Gauss-Seidal Iterative Method.
3. To find the Eigenvalue and Eigenvector of a Matrix by Iterative Method.

III : Interpolation

1. To form a Forward Difference Table from a Given set of Data Values.
2. To form a Backward Difference Table from a Given Set of Data Values.

3. To find the value of y near the beginning of a Table of values of (x, y).
4. To find the value of y near the end of a Table of values of (x, y).

IV : Curve Fitting, B-Splines & Approximation

1. To fit a Straight Line to a given Set of Data Values.
2. To fit a Polynomial to a given Set of Data Values.
3. To fit an Exponential Function to a given Set of Data Values.
4. To fit a natural Cubic B-Spline to a given Data.

V : Differentiation

1. To find the First and Second Derivatives near the beginning of a Table of values of (x, y).
2. To find the First and Second Derivatives near the end of a Table of values of (x, y).

VI : Integration

1. To evaluate a Definite Integral by Trapezoidal Rule.
2. To evaluate a Definite Integral by Simpson's 1/3 Rule.
3. To evaluate a Definite Integral by Simpson's 3/8 Rule.
4. To evaluate a Definite Integral by Gauss Quadrature Formula.
5. To evaluate an Integral by Monte Carlo

Techniques VII : Differential Equations

1. To solve a Differential Equation by Euler's Method.
2. To solve a Differential Equation by Modified Euler's Method.
3. To solve a Differential Equation by Second Order Runge Kutta Method.
4. To solve a Differential Equation by Fourth Order Runge Kutta

Method. VIII: Others

1. Fast Fourier Transform
2. Test of randomness for random numbers generators
3. Monte Carlo integration
4. Use of a package for data generation and graph plotting.
5. Test of randomness for random numbers generators

Note: Addition and deletion in the list of experiments may be made from time to time by the department.

Part B : Electronics Laboratory

Unit I – Device Characteristics and Application

1. p-n junction diodes-clipping and clamping circuits.
2. FET – characteristics, biasing and its applications as an amplifier
3. MOSFET – characteristics, biasing and its applications as an amplifier.
4. UJT – characteristics, and its application as a relaxation oscillator.

5. SCR – Characteristics and its application as a switching device.

Unit II – Linear Circuits

1. Resonant circuits
2. Filters-passive and active, all pass (phase shifters)
3. Power supply-regulation and stabilization
4. Oscillator-design and study
5. Multi stage and tuned amplifiers
6. Multivibrators-astable, monostable and bistable with applications
7. Design and study of a triangular wave generator
8. Design and study of sample and hold circuits

Unit III – Digital Circuits, Microcontroller and Microprocessors

1. Combinational
2. Sequential
3. A/D and D/A converters
4. Digital Modulation
5. Microprocessor application

6. Microcontroller Application

Note: Atleast 10 Experiments from Each Group

Semester - II

Sem	Course Code	Course Name	L	T	P	Credit	Marks	Total Credit	Total Marks
II	CCPHY201	Quantum Mechanics–II	3	1	0	4	100	22	
	CCPHY202	Statistical Physics	3	1	0	4	100		500
	CCPHY203	Mathematical Physics	3	1	0	4	100		
	CCPHY204	Classical Mechanics	3	1	0	4	100		
	CC(P)PHY205	Optics & Modern Physics Laboratory	0	0	6	6	100		

CCPHYS-201 : Quantum Mechanics – II

Course Learning Outcomes:

This Course helps the students to:

1. Will be able to solve and analyse various quantum mechanical problem related to Time Independent Perturbation Theory.
2. Will be able to treat molecules quantum mechanically.
3. Will be able to apply semi-classical method to treat atom field interactions.
4. Will be able to treat Two- Level System Quantum Mechanically.
5. By learning the symmetry principles, the visualization about the system gets stronger. Concept of linear vector space help them to write the systems in proper way.
6. Will be able to understand the central concept and principles of relativistic Quantum Mechanics.

Course Content

Unit-I

Approximation Methods for stationary problems: Time independent perturbation theory: Time independent perturbation theory for i) non-degenerate and ii) degenerate energy levels, applications: 1) one dimensional harmonic oscillator subjected to a perturbing potential in x and x 2 , 2) the fine structure of the hydrogen atom and 3) Zeeman effect.

Variational Method: Bound states (Ritz Method), Expectation value of the energy, Applications: 1) Ground state of harmonic oscillator, 2) ground state of Helium.

WKB approximation: the 'classical region', connection formulae, alpha decay and tunneling.

(10 Lectures + 05 Tutorial)

Unit –II

Approximation Methods for time dependent problems: Time dependent perturbation theory: Approximate solution of the Schrodinger equation with time dependent Hamiltonian, constant perturbation, harmonic perturbation, transition to a continuum, transition probability and Fermi golden rule.

Quantum Collision Theory: The scattering experiment, relationship of the scattering cross section to the wave function, scattering amplitude and scattering cross-section, Integral equation of potential scattering, Born approximation, scattering by a spherically symmetric potential, cross-section for scattering in a screened coulomb potential.

Method of partial waves: Expansion of a plane wave in terms of partial waves, scattering by a central potential, optical theorem. (10 Lectures + 05 Tutorial)

Unit-III

Symmetry Principles and Conservation Laws: Continuous symmetries: Spatial translation symmetry and conservation of linear momentum, time translation symmetry and conservation in energy, Rotations in Space: Conservation of angular momentum.

Discrete symmetries: Parity, Time reversal, Permutation symmetry, symmetric and antisymmetric wave functions, Slater determinant, ortho and para helium, scattering of identical particles.

Three dimensional problems: Spin 1/2 particles in a box – The Fermi gas. (10 Lectures + 05 Tutorial)

Unit-IV

Relativistic quantum mechanics: Klein-Gordon equation for a free relativistic particle, Plane wave solutions, probability density and probability current density.

Dirac Hamiltonian for a free relativistic particle, properties of alpha and beta matrices, probability density and probability current, positive and negative energy solutions, orthogonality and completeness of the solutions, intrinsic spin of the Dirac particle, Negative energy sea, gamma matrices, covariant form of Dirac equation, Non-relativistic approximation of Dirac equation in the presence of central potential and spin-orbit energy, Dirac particle in an external magnetic field, magnetic moment. (10 Lectures + 05 Tutorial)

References

1. Introduction to Quantum Mechanics, David J Griffiths, 2 nd Edition, Pearson Prentice Hall, 2005.
2. Quantum Mechanics, VK Thankappan, 2 nd Edition, Wiley Eastern Limited, 1993.
3. Quantum Mechanics Vol I & II, C CohenTannoudji, B Diu and F Laloe, 2 nd Edition, Wiley Interscience Publication, 1977.
4. Quantum Mechanics, LI Schiff, 3 rd Edition, Mc Graw Hill Book Company, 1955
5. Quantum Mechanics, BH Bransden and CJ Joachain, 2 nd Edition, Pearson Education, 2007.
6. Modern Quantum Mechanics, JJ Sakurai, Revised Edition, Addison-Wesley, 1995.
7. Principles of Quantum Mechanics, R Shankar, 2 nd Edition, Springer, 1994.
8. Quantum Mechanics, E Merzbacher, John Wiley and Sons, 1998.
9. Quantum Physics, S Gasiorowicz, John Wiley and Sons, 2014.

10. Introduction to vectors, axial vectors, tensors and spinors, G Ramachandran, MS Vidya and Venkataraya, Vijayalakshmi Prakashana, Mysuru, 2017.

CCPHYS-202 : Statistical Mechanics

Course Learning Outcomes

Students should be able to

1. Know basics of probability, statistical approaches, theorems and various types of ensembles.
2. Use various ensemble theories to calculate the thermodynamic properties of different systems.
3. Compute properties of systems behaving as ideal Fermi gas or ideal Bose gas.
4. Understand the approach required to predict the evolution of non-equilibrium systems.

Unit-I

Classical statistical description of system of particles: Specification of the state of a classical system, Phase space, Statistical ensemble, Basic postulates, Probability calculations, Behaviour of density of states, Statistical Equilibrium, Liouville theorem, Irreversibility and conditions of equilibrium, Reversible and irreversible processes, Thermal interaction between macroscopic systems, Microcanonical, canonical, grand canonical ensembles. (10 Lectures + 05 Tutorial)

Unit-II

Application of classical statistical mechanics: System in contact with a heat reservoir (Maxwell Boltzmann distribution), Simple applications of the canonical distribution – Paramagnetism, Molecule of an ideal gas in the presence of gravity, Calculation of mean values in the presence of gravity, Connection with thermodynamics, Partition function of ideal gas and their properties, Calculation of thermodynamic quantities of ideal monoatomic gas, Gibbs' paradox, Equipartition theorem. (10 Lectures + 05 Tutorial)

Unit-III

Quantum statistical mechanics: Basic concepts – Quantum ideal gas, Identical particles and symmetry requirements, Quantum distribution functions, Bose - Einstein statistics, Ideal Bose gas, black body radiation, Bose - Einstein condensation, specific heat of Ideal Bose gas, Fermi-Dirac statistics, Ideal Fermi gas, properties of simple metals, Pauli paramagnetism, electronic specific heat, Quantum statistics in the classical limit. (10 Lectures + 05 Tutorial)

Unit-IV

Irreversible processes and fluctuations: Random walk in one dimension, Brownian motion, Langevin equation, Fluctuation dissipation theorem, Einstein relation, Fourier analysis of random functions, Wiener- Khintchine relations Nyquist's theorem, Fluctuations and Onsager relations.

(10 Lectures + 05 Tutorial)

References

1. Fundamentals of Statistical and Thermal Physics, F Reif, First Indian Edition, Levant Books, 2010.

2. Statistical Mechanics, K Huang, Wiley Eastern Limited, New Delhi, 1963.

8. Statistical Mechanics, RK Pathria and PD Beale,3 rd Edition, Academic Press (Oxford), 2011.

9. Introduction to Statistical Physics, Silvio R A Salinas, Springer, 2001.

10. Fundamentals of Statistical Mechanics, BB Laud, 5 th Edition, New Age International Publication, 2015.

11. An introduction to statistical thermodynamics, Terrel Hill, Courier corporation, 1986.

12. Principles of statistical Mechanics, Richard Tollman Claredon Press, 1979.

13. An introduction to Thermodynamics and Statistical Mechanics, 2dnd Edition, Cambridge Uni Press, 2013.

14. Statistical mechanics, McQuarrie, Donald A, New York: Harper & Row, 2 nd edition, 2000.

CCPHYS-203: Mathematical Physics

Students should be able to

1. to solve different physical problems which contain complex variables.
2. Be familiarized with different special functions like Associated Legendre Polynomials, Polynomials, etc. and their solutions in solving different physical problems.
3. obtain knowledge of Fourier Transforms in solving different problems of Mechanics and Electronics etc. The module will also impart some basic knowledge of Probability.
4. learn about the concept and uses of Tensors.
5. Learn about matrices, eigen value, eigen functions and Green's function method to solve different differential equations.
6. Useful to obtain the basic knowledge of Group theory and its applications.

Course Content

Unit I

Complex Analysis: Functions of complex variables, Analytic functions, Cauchy-Riemann conditions, Multivalued functions, Cauchy's theorem and Cauchy integral formula, Derivatives of analytic functions, Liouville theorem, Power series, Taylor's theorem and Laurent's theorem, Calculus of residues, Evaluation of real definite integrals, Integrals involving branch cuts, Summation of series using complex integration, Principal value integrals and Dispersion relations.

(10 L + 5 T)

Unit - II

Fourier series, Fourier integrals, Fourier transform, Inverse Fourier transform, Parseval relations, Convolutions. Special functions and their properties: Classification of singularities of Legendre, Bessel, Hermite, Laguerre and their associated equations. Power series and contour integral solution of Legendre and Associated Lagendre equation near regular singular points. (10 L + 5 T)

Unit - III

Matrices and Tensors: Introduction of matrices through rotation of co-ordinate systems, Orthogonal, Hermitian, Unitary, Null and Unit matrices, Singular and Non-singular matrices, Inverse of a matrix, Trace of a matrix, Eigenvalues and Eigenvectors, Diagonalization. Tensorial character of physical entities, Covariant, Contravariant and Mixed tensors, Contraction, Quotient rule, Differentiation, Kronecker tensor, Pseudotensor, Symmetric and Anti symmetric tensors.

Green's Function: Introduction Construction of the Green's function for 1d, 2d and 3d problems. Solution of some standard problems using Green's function technique. (10 L + 5 T)

Unit - IV

Group Theory: Definition and examples of physically important finite groups, Basic symmetry operations and their matrix representations, Multiplication table, Cyclic groups and subgroups, Classes. Reducible and Irreducible representation, Schur's lemma, Orthogonality theorem, Character of a representation, Construction character tables.

References:

1. Mathematical Methods for Physicists, G.BArfken, H.J.Waber, E.E. Harris, 2013, 7 th Edn., Elsevier.

2. Boas, M.L., "Mathematical Methods in Physical Sciences", Wiley International Editions.

3. Group Theory and Quantum Mechanics, M.Timkham.

4. Matrices and Tensors: A. W. Joshi

5. Mathematical Physics: Das and Sharma.

6. Mathematical Physics: A.K.Ghatak, I.C.Goyal& S.J. Chua.

7. Mathematical Methods for Physicist & Engineers: Pipes &Harvel.

8. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

9. Mathematical Methods for Scientists and Engineers: D.A.McQuarrie, 2003, Viva Book.

10. Advanced Engineering Mathematics: D.G.Zill and W.S.Wright, 5-Ed, 2012, Jones and Bartlett Learning.

11. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

12. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.

CCPHYS-204 : CLASSICAL MECHANICS

Course Learning Outcomes

Students will be able to:

1. Formulate the Lagrangian mechanics concepts and solve the problems with the help of Lagrangian mechanics.

2. Compare the formulation of Hamiltonian and Lagrangian mechanics and solve the problems of classical and relativistic mechanics

3. Solve the problems of generating function, canonical transformation & Poisson brackets.

4. Formulate the equations of rigid body dynamics and demonstrate the examples of non inertial frames of reference.

5. Solve the equations of coupled oscillator and to examine the two coupled pendulums, and double pendulum related problems.

Course Content

Unit-I

System of particles: Center of mass, total angular momentum and total kinetic energies of a system of particles, conservation of linear momentum, energy and angular momentum.

Lagrangian Formulation: Constraints and their classification, degrees of freedom, generalized co-ordinates, virtual displacement, D'Alembert's principle, Lagrange's equations of motion of the second kind, uniqueness of the Lagrangian, Simple applications of the Lagrangian formulation - 1) Single free particle in a) Cartesian and b) plane polar coordinates 2) Atwood's machine 3) bead sliding on a uniformly rotating wire in a force free space 4) Motion of a block attached to a spring 5) Simple pendulum.

Symmetries of space time: Cyclic coordinate, Conservation of linear momentum, angular momentum and energy. (10 Lectures + 05 Tutorials)

Unit- II

Central forces: Reduction of two particle equations of motion to the equivalent 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 force).

Scattering in a central force field: general description of scattering, cross-section, impact parameter, Rutherford scattering, center of mass and laboratory coordinate systems, transformations of the scattering angle and cross-sections between them.

Motion in non-inertial reference frames: Motion of a particle in a general non-inertial frame of reference, notion of pseudo forces, equations of motion in a rotating frame of reference, Coriolis force, deviation due east of a falling body, the Foucault pendulum. (10 Lectures + 05 Tutorials)

Unit -III

Rigid body dynamics: Degrees of freedom of a free rigid body, angular momentum and kinetic energy of a rigid body, moment of inertia tensor, principal moments of inertia, classification of rigid bodies as spherical, symmetric and asymmetric, Euler's equations of motion for a rigid body, Torque free motion of a rigid body, precession of earth's axis of rotation, Euler angles, angular velocity of a rigid body, notions of spin, precession and nutation of a rigid body.

Small oscillations: Types of equilibria, quadratic forms for kinetic and potential energies of a system in equilibrium, Lagrange's equations of motion, normal modes and normal frequencies, examples of (i) longitudinal vibrations of two coupled harmonic oscillators (ii)Normal modes and normal frequencies of a linear symmetric, triatomic molecule (iii)oscillations of two linearly coupled plane pendula. (10 Lectures + 05 Tutorials)

Unit- IV

Hamiltonian formulation: Generalized momenta, canonical variables, Legendre transformation and the Hamilton's equations of motion, Examples of a) the Hamiltonian of a particle in a central force field b) the simple harmonic oscillator cyclic coordinates and conservation theorems, derivation of Hamilton's equations from variational principle.

Canonical transformation: Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of Poisson brackets (anti-symmetry, linearity and Jacobi identity), Poisson brackets of angular momentum, The Hamilton-Jacobi equation, Linear harmonic oscillator using Hamilton-Jacobi method. (10 Lectures + 05 Tutorials)

References

1. Classical mechanics, H Goldstein, C Poole, J Safco, III Edition, Pearson Education Inc.2018.
2. Classical mechanics, KN Srinivasa Rao, University Press, 2003.
3. Classical mechanics, NC Rana and PS Joag, Tata McGraw-Hill, 1991.
4. Classical dynamics of particles and systems, JB Marian, Academic Press, 1970.
5. Introduction to classical mechanics, Takwale and Puranik, Tata McGraw-Hill, 2006.
6. Classical mechanics, LD Landau and EM Lifshitz, 4th edition, Pergamon press, 1985.
7. Classical Mechanics, BA Kagali and T Shivalingaswamy, Himalaya publications, 2018.

CC(P)PHYS-205 : Optics & Modern Physics Laboratory

Group – A Optics

1. Studies with Michelson's Interferrometer.

(a) Determination of wavelength separation of sodium D-lines.

(b) Determination of thickness of mica sheet.

2. Studies with Fabre-Perot Etalon.

3. Studies with Edser-Butler Plate.

4. Studies of phenomena with polarized light:

(a) Verification of Brewster's law.

(b) Verification of Fresnel's law of reflection of plane polarized light.

(c) Analysis of elliptically polarized light using λ/4 plate and Babinet's compensator.

5. Verification of Rayleigh's criterion for the limit of resolution of

spectral lines using

(a) prism spectrum and (b) grating spectrum.

6. Determination of optical constants of metal in thin film form.

7. Studies on Zeeman effect.

8. Young's modulus determination by optical method.

9. Experiments using He-Ne laser source:

(a) Determination of laser parameters.

(b) Measurement of the angle of a wedge plate using Heidinger fringes.

(c) Determination of grating pitch using phenomena of self-imaging.

(d) Determination of wavelength with a vernier caliper.

Group – B Modern Physics

1. 'e/m' measurement by Braun's tube and by Magnetron valve method.

2. 'e' measurement by Millikan oil drop apparatus.

3. Characterization of Photo –resister.

4. Determine the plateau characteristics of the given GM counter.

5. Verification of Inverse Square Law for Gamma-rays.

6. To measure the absorption coefficient of gamma rays in Aluminum or Copper.

7. To plot the Gaussian or normal distribution curve for background radiation.

8. Determination of dead time of the GM Counter.

Semester - III

Sem	Course Code	Course Name	L	T	P	Credit	Marks	Total Credit	
III	CCPHY301	Atomic, Molecular & Laser Physics	3	1	0	4	100	24	500
	CCPHY302	Nuclear & Particle Physics	3	1	0	4	100		
	DSEPHY301	Selected from group A/B/C	3	1	0	4	100		
	DSE(P)PHY302	Selected from corresponding Lab	0	0	6	6	100		
	PRPHY301	Dissertation - I	0	0	6	6	100		

CCPHYS-301 : Atomic, Molecular & Laser Physics

Credits: 4, Lectures: 60

Total Marks: (30 + 70) Duration of Exam : 3 Hours

Course Learning Outcomes

1. Study the Quantum state of electrons in atoms
2. Analyse the Quantum chemistry of molecule
3. Study the microwave and infrared spectroscopy
4. Study the Raman and electronic spectra of molecules
5. Understand the basic concept of NMR and ESR spectrometers
6. Understand the basic concept of LASER and holography

Course Contents

Atomic Spectra: Space quantization, Relation between angular momentum and magnetic moment, Bohr magnetron. Fine structure of spectral lines, Term symbols of alkali and alkaline earth atoms. LS and JJ coupling. Quantum theory of Zeeman effect (normal and anamolous),Paschen-Back effect, Stark effect (linear and non-linear). Hyperfine structure of spectral lines, X-ray spectra characteristics and absorption.

The Rotation of the Molecule: Rotational spectra-Rigid diatomic molecule, The intensities of spectral lines, Effect of isotopic substitution, the non-rigid rotator, Simple harmonic oscillator, The an-harmonic oscillator, Diatomic vibrating rotator,

Born Oppenheimer approximation, Techniques and instrumentation applications.

Molecular Spectra: Infrared and Raman spectra of diatomic molecules using an-harmonic oscillator, non-rigid rotator and vibrating rotator as models.

Electronic states and electronic transitions in diatomic molecules, Frank Condon principle.

Resonance Spectroscopy: Nature of spinning particle, Interaction between spin and a magnetic field, Larmor Precession, Theory of NMR, Chemical shift-relaxation Mechanism, experimental study of NMR, Theory and experimental, study of NQR, Theory of ESR, Hyperfine structure and fine structure of ESR, Experimental studies and applications, Mossbauer spectroscopy, Principle-Isomer shift, Quadrupole effect, effect of magnetic field, Instrumentation applications.

Laser and Holography: Spontaneous and stimulated emission, Einstein A and B coefficients, Basic Principles of Laser, Population Inversion-Two level and Three level Laser system, optical pumping- rate equation, modes of resonator and coherence length, The Nd 3+ , YAG laser, The Neodymium Glass laser, The CO2 Laser, Organic Dye lasers, Semi-conductor Laser, Liquid Laser, Principle of Holography, Theory Practical applications including data storage.

Books Suggested:

1. Kuhn, "Atomic Spectctra".
2. Arun Kumar, ``Introduction to Solid State Physics'', PHI Learning Pvt. Ltd.
3. Ghatak&Loknathan, "Quantum Mechanics".
4. Herzberg, Spectra of diatomic molecules
5. Elements of Spectroscopy: Gupta, Kumar and Sharma, PragatiPrakashan.
6. Fundamentals of Molecular Spectroscopy: Colin and Elaine, TMH.
7. Laser and Non-linear Optics: B.B.Laud, New Age Publications.

CCPHYS-302 : Nuclear & Particle Physics

Course Learning Outcomes

1. To study the basic properties of nuclear forces.
2. Learn about different nuclear models to understand nucleus structure.
3. To understand the radiative decays and nuclear radiative detectors
4. To study the various types of accelerator and nuclear fission and fusion.
5. To understand the basic ideas about elementary particle

Course Content

Unit - I

Basic concepts of General properties of nuclei: Masses and relative abundances, mass defect, size and shape, binding energy, angular momentum, magnetic dipole moments and electric quadrupole moments. Nuclear radius, Radioactivity, units of radiation, Alpha, Beta and Gamma-Rays decay.

(10 L, 5 T/S/D)

Unit - II

Constituents of nuclei : Nature of interactions: Electromagnetic, weak interactions and Hadronic interactions. Nucleon - Nucleon scattering, scattering cross section, low energy neutron-Proton scattering, Phase shift, proton-proton scattering, high energy nucleon-nucleon scattering. Theory of nuclear forces, Measurement of nuclear parameters, the Mössbaur effect. (10 L, 5 T/S/D)

Unit - III

Nuclear Models : Liquid drop model, Fermi Gas Model, Shell Model, Collective Model, Single particle model of nucleus Magic numbers, spin-orbit coupling prediction of angler momenta of nuclear ground states, Nuclear Energy levels and their applications. (10 L, 5 T/S/D)

Unit - IV

Reaction dynamics, the Q of Nuclear reaction, Compound nucleus formation and breakup, nuclear fission and heavy ion induced reactions, fusion reactions, types of nuclear reactors. Theory of striping reactions. Basic principles of (i) electron accelerator and (ii) ion accelerators. Linear accelerator, cyclic accelerator Pelletron Electron gun, Radiation detectors; Gas detectors, Nal(Te) detectors Semiconductor detectors, Radiation detector's Gas detectors, Nal(Te) detector, Bubble chamber, Cloud chamber, Spark chamber. (10 L, 5 T/S/D)

Unit - V

Elementary particle physics, Hadrons and leptons, their masses, spin parity decay structure, quarks and gluons. Anti proton production in laboratory., Semiconductor detector. Gell-mann-Nishijima formula, C, P and T invariance and applications of symmetry arguments to particle reactions, parity non conservation in weak interactions etc. (10 L, 5 T/S/D)

Books :

1. Introductory nuclear Physics by Kenneth S. Krane, Wiley India Pvt. Ltd., 2008.
2. Concepts of nuclear physics by Bernard L. Cohen, Tata Mcgraw Hill, 1998.
3. Introduction to Elementary Particles by D. Griffith, John Wiley & Sons
4. Introductory Nuclear Physics by S.S.M. Wong, PHI
5. Theoretical Nuclear Physics by J.M. Blatt, & V.F. Weisskoff, John Wiley
6. Introduction to Nuclear Physics by H.A. Enge, Addison Wesley
7. Nuclear Physics by R.R. Roy, &B.P.Nigam, John Wiley
8. Introductory Nuclear Theory by L.R.B Elton, Sir Isaac Pitman & Sons Ltd.
9. Physics of the Nucleus byM.A. Preston, Addison Wesley
10. Quarks and Leptons by F. Halzen and A.D. Martin, Wiley India, New Delhi
11. Basic ideas and concepts in Nuclear Physics - An Introductory Approach byK. Heyde (IOP-Institute of Physics Publishing, 2004).
12. Introduction to the physics of nuclei & particles by R.A. Dunlap. Thomson Asia, 2004.
13. The Atomic Nucleus by R.D. Evans, TMH

DSE : GROUP - A

DSEPHY-301 : SELECTED FROM GROUP A/B/C

Condensed Matter Physics-I

(Elective) Unit-I

Inter-atomic forces and bonding in solids: Forces between atoms, binding energy, cohesion of atoms and cohesive energy, calculation of cohesive energy, bond energy of NaCl molecule, calculation of lattice energy of ionic crystals, calculation of Madelung constant of ionic crystals, calculation of repulsive exponent from compressibility data, Born-Haber cycle.

Diffusion in solids: Fick's law of diffusion, determination of diffusion coefficients, diffusion couple, applications based on second law of diffusion, atomic model of diffusion-electrical conductivity of ionic crystals. (10 L + 05 T)

Unit-II

Imperfections in crystals: Classification of imperfections, crystallographic imperfections, point defects, concentrations of Schottky and Frenkel defects, line defects, edge dislocations, screw dislocation, Burgers vector, dislocation motion, stress fields around dislocations, observation of dislocations, plane defects, grain boundaries, tilt and twin boundaries, surface imperfections - role of dislocations in crystal growth. (10 L + 05 T)

Unit-III

Lattice vibrations and phonons: Elastic vibrations of continuous media, Group velocity of harmonic wave trains, Wave motion of one dimensional atomic lattice, lattice with two atoms with primitive cell, Some facts about diatomic lattice, number of possible normal modes of vibrations in a band, phonons, momentum of phonons,

Thermal properties: Classical calculations of lattice specific heat, Einstein theory of specific heats, Debye's model of lattice specific heat, Debye approximation, An-harmonic crystal interactions, thermal expansion, lattice thermal conductivity of solids- Umklapp process. (10 L + 05 T)

Unit-IV

Optical properties: Absorption process, photoconductivity, photoelectric effect, photovoltaic effect, photoluminescence, color centers, types of color centers, generation of color centers-properties-models and applications.

Elastic constants: Stress components. Analysis of elastic strains, elastic compliance and stiffness constants, elastic energy density, stiffness constants of cubic crystals, elastic waves in cubic crystals, waves in [100] direction, [110] direction, experimental determinations of elastic constants. (10 L + 05 T)

References

1. Solid State Physics, AJDekker, MacmillanIndia Ltd, Bangalore, 1981.
2. Solid State Physics, C Kittel, V Ed, Wiley Eastern Ltd, 1976.
3. Elementary Solid state physics,MA Omar, AddisonWesley, New Delhi, 2000.
4. Solid State Physics, SO Pillai,New Age International Publication, 2002.

5. Solid State Physics, MA Wahab, Narosa Publishing House, New Delhi. 1999
6. Introduction to Solids, L Azoroff, Tata McGraw Hill publications, 1993.
7. Solid State Physics,HC Gupta,Vikas Publishing House, New Delhi. 2002
8. Introduction to Solid State Physics, Arun Kumar, PHI Learning Pvt. Ltd., New Delhi
9. Introduction to Solid State Physics, Arun Kumar, PHI Learning Pvt. Ltd., New Delhi

DSE(P)PHYS-302 : Selected from corresponding Lab

Condensed Matter Physics-I (Elective)

1. Analysis of X-ray powder photographs (NaCl, KCl, Cu)
2. Analysis of single crystal rotation photograph(NaCl)
3. Analysis of a backscattering of powder photograph of copper
4. Estimation of R-factor using X-ray diffractogram.
5. Calibration of electromagnet and magnetic susceptibility determination of magnetic salts ($MnSO_4$, $MnCl_2$) by Quincke's method
6. Experiments with pn-junction (a) determination of n, Eg and dV/dt of pn -junction material (b) determination of junction capacitance C_D
7. Determination of Curie temp for a ferromagnetic material (Ni-Fe alloy)
8. Study of the temperature variation of conductivity (σ) and estimation of activation energy of ionic solid.
9. Study of B-H curve of a Ferromagnetic material (both hard and soft).
10. Electrical resistivity of semiconducting Ge sample using four probe method.

DSE : GROUP - B

DSEPHY301 SELECTED FROM GROUP A/B/C

Laser and Spectroscopy – I (Elective)

Unit – I

Interaction of Matter with radiation: Interaction of electromagnetic radiation with matter, Einstein coefficients (2 level system interacting with radiation) Beer's law- attenuation and amplification of light. Width and shape of spectral lines: natural broadening-derivation of line shape, Doppler broadening-estimation of half width, Voigt profiles, transit time broadening, power broadening, pressure broadening. (10 L + 05 T)

Unit - II

Molecular symmetry: Review of definition and properties of a Group. Molecular symmetry elements and symmetry operations: Notations, symmetry classifications of molecular point groups: C_{2v} and C_{3v} point groups.

Matrix representation of symmetry operations, geometric transformations. Reducible and Irreducible representation for simple molecules such as NH_3 and H_2O. Great Orthogonality Theorem, character table for C 2v and C 3v point groups. (10 L + 05 T)

Unit-III

Spin resonance spectroscopy-A:Basic principles of NMR, absorption and resonance condition, Relaxation processes: concepts of spin-lattice relaxation and spin-spin relaxation, Line broadening and dipolar interaction, MASS experiment, chemical shift, spin-spin coupling, First order spectra, nomenclature for spin systems, Chemical equivalence and magnetic equivalence of nuclei. Techniques for observing nuclear resonances in bulk materials, continuous wave, pulsed and FT-NMR, chemical analysis using NMR. (10 L + 05 T)

Unit-IV

Spin resonance spectroscopy-B:Electron spin and magnetic moment, Basic concepts of ESR, characteristics of g-factor and its anisotropy, nuclear hyperfine interaction, Spin Hamiltonian, ESR of organic and inorganic radicals: equivalent and non-equivalent sets of nuclei, experimental

technique and ESR spectrometer (Block diagram level). Basic principles of NQR, nuclear quadrupole interaction, fundamental requirements of NQR.

Electron Nuclear Double Resonance (ENDOR)-General treatment of an ENDOR experiment in a system with s = 1⁄2 and I = 1⁄2. Advantages of ENDOR over ESR. (10 L + 05 T)

References

1. Physics of atoms and molecules, Bransden and Joachain, 2 nd Edition, Pearson Education, 2004.
2. Fundamentals of Molecular Spectroscopy, Banwell and McCash, Tata McGraw Hill, 1998.
3. Modern Spectroscopy, JM Hollas, John Wiley, 1998.
4. Molecular Quantum Mechanics, PW Atkins and RS Friedman, 3 rd Edition, Oxford Press, 2004.
5. Spectra of Atoms and Molecules, P Bernath, Oxford Press, 1999.
6. Molecular Spectroscopy, JL McHale, Pearson Education, 1999.
7. Atomic Physics, CJ Foot, Oxford University Press, 2008.
8. Introduction to Magnetic Resonance Spectroscopy: ESR, NMER, NQR, 2 nd Edition, DN Sathyanarayana, IK
International Publishing House Ltd, 2014.
9. Basic Principles of Spectroscopy, Raymond Chang, McGraw-Hill Kogakusha Ltd, 1971.
10. Chemical Applications of Group Theory, F Albert Cotton, 3 rd Edition, John Wiley and Sons, 1990.

DSE(P)PHYS-302 : Spectroscopy & Laser I I(Elective)

1. Determination of g-factor for standard ESR sample using portable ESR spectrometer
2. Ion trap (q/m determination) quadrupole AC trap
3. CCD spectrometer to record absorption bands of Iodine molecule
4. CCD spectrometer to record band spectrum of AlO
5. Analysis of band spectrum of PN molecule
6. Analysis of Rotational Raman spectrum of a molecule
7. Twyman-Green interferometer
8. Fabry-Perot interferometer experiments
9. Zeeman effect experiment
10. Numerical aperture and bending loss of optical fiber.
11. Wavelength of laser by diffraction method (Transmission grating).
12. Wavelength of laser by diffraction method (Reflection grating).
13. Wavelength of laser by interference method.
14. Determination of spin coupling constant from NMR spectrum of a molecule

DSE : GROUP - C

DSEPHY 301 Selected from Group A/B/C

ELECTRONICS A ND COMMUNICATION – I

Operational Amplifier: Operational amplifier (op amp) types, salient features, parameters and modeling, Voltage op amp based circuits such as:

- Instrumentation amplifier (IA)
- Negative impedance converter (NIC)
- Inductance simulation
- Precision rectification
- Active Butterworth low pass, high pass and band pass 2 nd order filters

Simulation of differential equations

- Analog multiplier and its use in integer power generation, frequency multiplication, divider and generation of fractional powers

D/A and A/D converters

20 Lectures

Current Conveyor: Current conveyor types, their salient features, modeling and simple applications in realizing bandwidth independent gain amplifier, Current conveyor based differentiator, integrator, adder and instrumentation amplifier, Advantages of current conveyor based circuits over the conventional voltage op amp based circuits.

BJT Logic Families: TTL logic NAND gate circuit, ECL logic OR/NOR gate circuit, analysis and evaluation of logic parameters.

MOS Logic Families: NMOS inverter circuit and its analysis with linear and non-linear loads, CMOS inverter.

Radar: Basic arrangement of radar system, Azimuth and range measurement, Operating characteristics of a radar system, Derivation of radar range equation.

Antenna: Antenna action, Short electric doublet, Linear array of n isotropic sources of equal amplitude and spacing, Broad-side array, Ordinary end-fire array, End fire array with increased directivity, Beam width of the main loab, Yagi antenna, Resonant and non-resonant array arrangement

Satellite Communication: Orbital and geostationary satellites, Orbital patterns, Look angles, Satellite system, Link modules.

Books Suggested:

1. A first course in Electronics, A.A.Khan &K.K.Dey, Prentice Hall India.

2. Basic Electronics, Arun Kumar, Bharati Bhawan

3. Millman&Brabel, “Microelectronics”, McGraw-Hill (International Students’ Edition).

4. Mitchell & Mitchell, “Introduction to Electronics Design”, Prentice-Hall of India.

5. Nagrath, “Electronics: Analog and Digital”, Prentice-Hall of India.
6. Soclof, “Design and Applications of Analog Integrated Circuits”, Prentice-Hall of India.
7. Gayakwad, “Op-Amps and Linear Integrated Circuits”,3/e, Prentice-Hall of India
8. Sedra& Smith, “Microelectronic Circuits”, 3/e, Sounders College Publishing.
9. Microwave and Radar Engineering Kulkarni, Umesh Publication.
10. Electromagnetic Waves and Radiating Systems: Jordan, PHI
11. Hand Book of Electronics, Gupta & Kumar, PragatiPrakashan, Merrut.
12. Electronics Communications: RoddyCoolen, PHI
13. Electronic Communication: Kennedy & Davis, TMH

DSE(P)PHY302: SELECTED FROM CORRESPONDING LAB

ELECTRONICS AND COMMUNICATION

L AB I

Credits: 6 Hrs. per week: Total Marks: 100

Time: 6 Hrs.

1. Operational amplifier parameters measurements and their dependence on frequency.
2. Basic operational amplifier configurations: inverting amplifier, non-inverting amplifier, voltage follower, differentiator, integrator and instrumentation amplifier.
3. Butterworth second order active low pass and high pass filters.
4. Studies on second order band-pass and band-elimination active filters.
5. Precision rectification: half- and full- wave.
6. Design and study of Wein bridge oscillator circuit.
7. Design and study of op amp based square wave oscillator.
8. To draw the characteristic curve of SCR and to determine its holding voltage, holding current and break-over voltage
9. Use of IC 555 timer.
10. To simulate electronic circuits using Pspice/ MultiSim.
11. BCD adder and subtractor.
12. DIAC and TRIAC characteristics and applications.

PRPHY-301 : Dissertation - I

I. Course Objective:

This course is focused to facilitate student to carry out extensive research and development project or technical project at place of work through problem and gap identification, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research. The overall goal of the dissertation is for the student to display the knowledge and capability required for independent work.

II Course Learning Outcomes (CLOs):

The student will be able to

- gain in-depth knowledge and use adequate methods in the major subject/field of study.
- create, analyze and critically evaluate different technical/research solutions
- clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings
- identify the issues that must be addressed within the framework of the specific dissertation in order to take into consideration

III **Project Allotment:** On the first day of 3rd semester, a common guideline will be provided to the students & within a week the field/ title & supervisor will be decided by the departmental council. It may be theoretical, experimental & computational in nature. The student should work continuously as per the credit hour under the supervision of Guide. The final Master's Dissertation will be uploaded on the Departmental website, archives & on INFLIBNET.

IV Project Submission & Evaluation

At the end of third semester, the students will submit the soft binding of report in three copies (Dept., Guide & Candidate). The student will prepare a presentation & present it in front of External Examiner, Faculty members of Dept. & students of the Department. The dissertation will be evaluated according to the relevance of topic, intensity of actual work done, conceptual understanding of the work. The marking guidelines are following

- Marks Awarded for 2 Reviews (20 + 20) (Guide + External Examiner) = 40 Marks
- Evaluation of the Dissertation (20 + 20) : (Guide + External Examiner) = 40 Marks
- Presentation (15 Min) followed by Viva-voce Examination (05 Min) : 20 Marks

Total : 100 Marks

Semester - IV

Sem	Course Code	Course Name	L	T	P	Credit	Marks	Total Credit	
IV	CCPHY401	Electromagnetic Theory	3	1	0	4	100	24	500
	CCPHY402	Modern Experimental Techniques	3	1	0	4	100		
	DSEPHY401	Selected from group A/B/C	3	1	0	4	100		
	DSE(P)PHY402	Selected from corresponding Lab	0	0	6	6	100		
	PRPHY401	Dissertation - II	0	0	6	6	100		

CCPHYS-401 : Electromagnetic Theory

Course Learning Outcomes

1. Understand the basic properties of Coulomb's law, Gauss law for electric potential
2. Analyse the relation between electrostatics & magnetostatics, Biot Sarvat law, Ampere's law
3. Study the Faraday's Electromagnetic induction & Verify with Vector and Scalar potential
4. Study of EM waves and their propagation in different medium
5. Learning about dispersion of EM wave, Electromagnetic radiations
6. Study of connection between special theory of relativity and electrodynamics

Course Content

Unit-I

Electrostatics: Coulomb's law, Electric field, Gauss's law, applications of Gauss's law, Electric Potential, Poisson's equation and Laplace's equation, Work and energy in electrostatics, Techniques for calculating potentials: Laplace's equation in one, two and three dimensions, boundary conditions and uniqueness theorems, Method of Images, Multipole expansion.

Magnetostatics: Biot-Savart Law, Divergence and Curl of B, Ampere's law and applications of Ampere's law, Magnetic vector potential, Multipole expansion of the vector potential. (10 L + 5 T)

Unit-II

Electrodynamics: Faraday's law, Energy in magnetic fields, Maxwell's equations, Maxwell's displacement current, Maxwell's equations and magnetic charge, Maxwell's equations inside matter, boundary conditions.

Scalar and vector potentials, Gauge transformations, Coulomb and Lorentz Gauge; Lorentz force law in potential form, Energy and momentum in electrodynamics, Poynting's theorem Maxwell's stress tensor, Conservation of momentum. (10 L + 5 T)

Unit –III

Electromagnetic waves: Electromagnetic waves in non-conducting media: Monochromatic plane waves in vacuum, propagation through linear media, Reflection and transmission at interfaces.

Fresnel's laws; Electromagnetic waves in conductors: Modified wave equation, monochromatic plane waves in conducting media.

Dispersion: Dispersion in non-conductors, free electrons in conductors and plasmas. Guided waves, TE waves in a rectangular wave guide. (10 L + 5 T)

Unit-IV

Electromagnetic radiation: Retarded potentials, Electric dipole radiation, magnetic dipole radiation, Radiation from a point charge: Lienard-Wiechart potentials, fields of a point charge in motion, power radiated by a point charge.

Electrodynamics and Relativity: Review of special theory of relativity, Lorentz transformations, Minkowski four vectors, energy-momentum four vector, covariant formulation of mechanics, Transformation of electric and magnetic fields under Lorentz transformations, field tensor, invariants of electromagnetic field, covariant formulation of electrodynamics. (10 L + 5 T)

References

1. Introduction to Electrodynamics, David J Griffiths, 2 nd Edition, Prentice Hall India, 1989.
2. Classical Electrodynamics, JD Jackson, 4 th Edition, John Wiley & Sons, 2005.
3. Classical Electromagnetic Radiation, MA Heald and JB Marion, Saunders, 1983.
4. Electrodynamics, Gupta,Kumar, Singh, Pragathiprakashan,18 th edition, 2010.

CCPHYS-402 : MODERN EXPERIMENTAL TECHNIQUES (OPEN ELECTIVE FOR SCIENCE: CHEMISTRY & LIFE SICENCES, GEOLOGY, ENVIRONMENTAL SCIENCE)

Course Learning Outcomes

1. This is a soft-core course. It deals with different experimental techniques in Physics. Studying different temperature and electrical measurements the concept of measurements for regular equipment is grown within the students.
2. Studying the vacuum techniques, Low temperature physics, sensors/detectors based on electric, dielectric, acoustic, thermal, optical and mechanical phenomena.
3. Learning structural, surface and spectroscopic characterization using different techniques
4.

Course Content

Unit-1 :

Signal Processing : Analog to digital and digital to analog convertors, amplifiers, multiplexers, sample and hold circuits, data filtering, concepts of digital filters, interfacing with microporcessors. Time and frequency domain analysis, spectral analysis, random signals, auto and cross correlation, transfer functions of system etc. **(8 L + 2 T)**

Unit – II:

Vacuum Physics : Important and fields applications of vacuum, gas properties, gas flow regimes, gas transport properties, gas conductance of apertures, elbows, tubes etc. for viscous and molecular flow regimes, principles of pumping concepts (vacuum pumps), vacuum measurement, leak detection, source of gases in vacuum system, evaluation of gas load, vacuum system design. **(8 L + 2 T)**

Unit - III :

Low temperatures techniques (cryogenic): Refrigeration principle (including thermodynamical aspects) and low temperature production techniques, production of solid CO and its applications, Liquifaction of hydrogen, helium and nitrogen, principles of magnetic cooling, measurement techniques of low temperatures. **(8 L + 2 T/S/D)**

Unit - IV

Sources and detectors : Techniques of production of UV/Visible, microwave, IR radiations, classification of sensors/detectors, sensor characteristics, operation principles of sensors based on electric, dielectric, acoustic, thermal, optical and mechanical phenomena and important types of sensing position, temperature, humidity, pressure and different types of radiations, basics of image processing **(8 L + 2 T)**

Unit - V

Structural & surface characterization : Microscopy: optical, electron, FEM-FIM, STM, AFM, ANOM, Diffraction techniques, XRD, Electron and Neutron diffraction, LEED. **(8 L + 2 T)**

Module-VI

Spectroscopic characterization : Spectroscopy : IR, UV-VIS, PL, X-ray Abs, AES, XPS, SIMS, NMR, ESR, Mössbauer Spectroscopy. **(8 L + 2 T)**

Books :

1. Introduction to analysis and processing of signals, Paul Lynn, Howard W. (Sams and Company, 1983).
2. Probability, Random Variables and Stochastic Process, A. Papoulis, international student Edition (McGraw-Hill International Book Company, 1984)
3. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall.
4. Vacuum technology, A. Roth, (North Holland, Elsevier Science B.V. 1990)
5. High vacuum techniques, J. Yarwood, (Chapman and Hall, Londong, 1967)
6. Nuclear Radiation Detectors, S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited, Bombay)
7. Experimental Principles and Methods below 1K, O. U. Lounasmaa, (Academic Press, London and New York, 1974)
8. Thermometry at ultra low temperatures, W. Weyhmann in Methods of Experimental Physics, Vol. II (R. V. Coleman, Academic Press, New York and London, 1974).

9. Cryophysics, K. Mendelssohn, Interscience (London, 1960)
10. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth- Heinemann (1992)

DSE : Group - A

DSEPHYS-401 : Condensed Matter Physics-I I(Elective)

Unit-I

Crystal Physics: Introduction, symmetry elements of crystals, concept of point groups, derivation of equivalent point position, experimental determination of space groups, expression for structure factor, analytical indexing, Weissenberg and rotating crystal method, Determination of relative structures, amplitudes from measured intensities, Multiplicity factor, Lorentz polarization factor, Reciprocal lattices, concept of reciprocal lattice, geometrical construction, relation between reciprocal lattice vector and inter-planar spacing, properties of reciprocal lattice. (10L + 5T)

Unit-II

Energy bands in solids: Elementary ideas of formation of energy bands, Bloch function, Kronig-Penney model, number of states in a band, Energy gap, Distinction between metals, insulators and intrinsic semiconductors, concept of holes, equation of motion for electrons and holes, effective mass of electrons and holes.

Nearly free electron approximation, Tight binding method of energy bands-applications to cubic system, orthogonalized plane wave method, Wigner-Seitz method, pseudo, potential method. Fermi surface studies and Brillouin zones characteristics of Fermi surfaces. (10 L + 5 T)

Unit-III

Ferroelectrics: General properties of ferroelectric materials, Classification and properties of representative ferroelectrics, The dipole theory of ferroelectricity, objections against the dipole theory, ionic displacements and behaviour of BaTiO 3 above the Currie temperature, The theory of spontaneous polarization of BaTiO 3 ,

Thermodynamics of ferroelectric transitions, ferroelectric domains. (10 L + 5 T)

Unit-IV

Films and surfaces: Preparation - Thermal Vapour Deposition, Chemical Vapour Deposition, laser ablation, Molecular Beam Epitaxy, study of surface topography by multiple beam interferometry, conditions for accurate determination of step height and film thickness Fizeau fringes, Electrical conductivity of thin films, difference of behaviour of thin films from bulk material, expression for electrical conductivity for thin film. (10 L + 5 T)

References

1. Crystallography Applied to Solid State Physics, AR Verma and ON Srivastava 2 nd edition, New age International publishers, 2001.
2. Solid State Physics, AJDekker, MacmillanIndia Ltd, Bangalore, 1981.

3. Solid State Physics, C Kittel, V Ed, Wiley Eastern Ltd, 2013.

4. Elementary Solid state physics, MA Omar, Adison Wesley, New Delhi,2000.

5. Solid state Physics, SO Pillai. New age international publication, 2002.

6. Solid state Physics, MA Wahab, Narosa publishing house, New Delhi., 1999.

7. Introduction to Solid state physics, L Azoroff, Tata McGraw Hill publications,1993.

8. Solid State Physics, H.C. Gupta, Vikas publishing house, New Delhi,2002.

DSE(P)PHYS-402 : Condensed Matter Physics-I (Elective)

1. Magnetic susceptibility of Ferrous ammonium sulphate by Gouy's balance method
2. Temperature variation of dielectric constant and determination of Curie point of a Ferro electric solid PZT (Lead Zirconium Titanate)
3. Thermo-stimulated luminescence of F-centre in Alkali halide.

4. Hall effect experiment in semiconductors.
5. Determination of Fermi energy of copper.
6. Determination of Plank's constant using LED's
7. Determination of energy gap of a semiconductor using diode.
8. Determination of Solar cell characteristics
9. Energy band gap of a thermistor
10. Determination of lattice parameter using Bernal Chart

DSE : GROUP - B

DSEPHY401 Laser and Spectroscopy – I I(Elective)

Unit-I

Absorption spectroscopy: Basic principles, Beer - Lambert law, Molar extinction coefficient, Intensity of electronic transitions. Types of electronic transitions. Franck - Condon principle, Ground and excited electronic states of diatomic molecules. Electronic spectra of polyatomic molecules, Electronic spectra of conjugated molecules - dissociation and pre-dissociation spectra, UV-Visible spectrophotometer - Principles and Instrumentation, Applications. (10L + 5T)

Unit-II

Fluorescence spectroscopy: Jablonski diagram; characteristics of fluorescence emission - Stokes shift, mirror image rule; solvent and environmental effects on fluorescence; lifetimes and quantum yields; Fluorescence quenching: mechanism and dynamics; Fluorescence anisotropy; Spectrofluorimeter - Principles and Instrumentation, Applications. (10L + 5T)

Unit-III

Laser Raman spectroscopy: Review of Raman scattering and Raman spectrum of diatomic and linear polyatomic molecules, molecular polarizability, Polarization of Raman lines, Depolarization ratio and its determination, Resonance Raman scattering. Application of Raman spectroscopy to study phase transitions and proton conduction in solids. Non- linear effects of Raman scattering: General principles. Hyper Raman effect, Inverse Raman effect, stimulated Raman scattering, Principle and experimental technique. (10L + 5T)

Unit-IV

Mossbauer spectroscopy: Mossbauer effect, recoilless absorption and emission of gamma rays, basic principles of gamma ray fluorescence spectroscopy, hyperfine interaction, chemical isomer shift, magnetic hyperfine and quadruple interaction and interpretation of spectra. Mossbauer isotopes, applications to study magnetic materials. (10L + 5T)

References

1. Fundamental of Photochemistry, KK Rohatgi-Mukherjee, New Age International Ltd, New Delhi, 1986.
2. Principles of Fluorescence Spectroscopy, 3 rd Ed, JR Lakowicz, Springer, New York, 2006.
3. Fundamentals of Molecular Spectroscopy, Banwell and McCash, Tata McGraw Hill, 1998.
4. Modern Spectroscopy, JM Hollas, John Wiley, 1998.
5. Molecular Quantum Mechanics, PW Atkins and RS Friedman, 3 rd Edition, Oxford Press, 2004.
6. Spectra of Atoms and Molecules, P Bernath, Oxford Press, 1999.
7. Molecular Spectroscopy, JL McHale, Pearson Education, 1999.
8. Mossbauer effect, Principles and application, GK Wathaim, Academic Press, New York, 1964.
9. Mossbauer effect and its applications, VG Bhide, Tata McGraw Hill publications, 1973.

DSE(P)PHYS-402 : Spectroscopy & Laser I (Elective)

1. Determination of hyper fine coupling constant from ESR spectrum of a molecule
2. Michelson Interferometer:
3. Experiment with CCD: Analysis of the spectrum of aluminium oxide (AlO)
4. Analysis of Mossbauer spectrum
5. Visual mapping of some important sources: Hg, Na, Fe, Cu arc, Brass arc and laser
6. Refractive index of liquid using Hallow prism
7. Experiment and analysis the spectrum of iron and Brass arc using Photograph method
8. Spatial and temporal coherence of He-Ne laser.
9. Experiments with lasers and fibre optics kit.
10. Experiments with lasers and reflection grating.
11. To photograph the spectra of Fe (standard) and Cu arc using CDS spectrograph and to determine the wavelengths of Cu spectrum using Hartman formula
12. Verification of Beer-Lambert law
13. Iodine absorption spectra using CDS

DSE : GROUP - C

DSE(P)PHYS-402 : Electronics & Communication II (Elective)

Transmission line: Types of transmission line, distributed parameters, voltage and current relations on a radio frequency transmission line with respect to sending and receiving ends, propagation constant (γ), attenuation constant (α) and phase constant (β), expressions for α and β, transmission line distortion and attenuation, conditions for no distortion, low distortion and low loss, line termination across a short circuit, open circuit pure resistance and complex impedance, quarter wave and half wave lines and their impedance matching properties.

Wave Guide: Field expression for propagatingTE and TM waves in hollow circular cylindrical wave guides, Impossibility of TEM waves in hollow wave guide, Attenuation in wave guides and Q- factor.

Fiber Optic Communication: Principle of light transmission in a fiber. Light sources for fiber optic communication, Effect of index profile on propagation, Modes of propagation, Number of modes a fiber may support, Single mode fiber (SMF), Losses in fibers.

Microprocessor Architecture: 8085 Microprocessor Architecture, Real Mode and protected modes of memory addressing, memory paging.

Addressing Modes: Data addressing modes, Program memory addressing modes, stack memory addressing modes.

Instruction Set: Data movement instructions, arithmetic and logic instructions, Program control instruction, Assembler details.

Interrupts: Basic interrupt processing, Hardware interrupt. Expanding the interrupt structure 8259A PIC.

Direct Memory Access: Basic DMA operation, 8237 DMA controller, Shared Bus operation Disk Memory systems.

Books Suggested:

1. Miah, “Fundamentals of Electromagnetic”, TMH

2. Mano, “Computer System Architecture”, Prentice-Hall of India.

3. Goankar, Microprocessors Architecture, Programming & Applications
with 8085,

4. Senior, “Optical Fiber Communications: Principles and Practice”,
2/e, Prentice-Hall.

5. Jordon &Balmain, “Electromagnetic waves and Radiating
Systems”, Prentice-Hall of India.

DSE(P)PHYS-402 : Electronics & Communication (Elective)

Credits: 6 Hrs. per week: Total Marks: 30 + 70

Time: 6 Hrs.

1. Studies on the polar pattern of microwave transmitting horn antenna.

2. Familiarity with microwave components, microwave propagation in hollow rectangular wave-guide and measurement of dielectric constant in X-band.

3. Amplitude modulation and demodulation.

4. Studies on Phase Locked Loop (PLL) IC 565 and its use in frequency multiplication.

5. Design, construct and test electronically regulated power supplies using Zener diode, 3-pin regulators (78xx/79xx) and IC 723.

6. Design and study of the characteristics of TTL logic NAND gate and the evaluation of its parameters.

7. Familiarity with circuit simulation and fundamentals of PSpice commands and circuit programming.

8. Simulation of amplifier, oscillator and TTL logic NAND gate circuits. Analog computation using PSpice: solution of differential equations.

PRPHYS-401 : Dissertation - II

Same project will continue from 3rd semester:

I Course Objective:

This course is focused to facilitate student to carry out extensive research and development project or technical project at place of work through problem and gap identification, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research. The overall goal of the dissertation is for the student to display the knowledge and capability required for independent work.

II Course Learning Outcomes (CLOs):

The student will be able to

- gain in-depth knowledge and use adequate methods in the major subject/field of study.
- create, analyze and critically evaluate different technical/research solutions
- clearly present and discuss the conclusions as well as the knowledge and arguments
- that form the basis for these findings
- identify the issues that must be addressed within the framework of the specific
- dissertation in order to take into consideration

III Final Dissertation Submission & Evaluation

At the end of 4th semester, the students will submit the soft binding of final dissertation, report in three copies (Dept., Guide & Candidate). The soft copy of final Master's Dissertation will be uploaded on the Departmental website, archives & on INFLIBNET. The student has to prepare a presentation & present it in front of External Examiner, Faculty members of Dept. & students of the Department. The marking guidelines are following

- Marks Awarded for 2 Reviews (20 + 20) (Guide + External Examiner) = 40 Marks
- Evaluation of the Dissertation (20 + 20) : (Guide + External Examiner) = 40 Marks
- Presentation (15 Min) followed by Viva-voce Examination (05 Min) : 20 Marks

Total : 100 Marks

PRPHY-401 : Dissertation

-II I. Course

Objective:

This course is focused to facilitate student to carry out extensive research and development project or technical project at place of work through problem and gap identification, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research. The overall goal of the dissertation is for the student to display the knowledge and capability required for independent work.

Course Learning Outcomes (CLOs):

The student will be able to

- gain in-depth knowledge and use adequate methods in the major subject/field of study.
- create, analyze and critically evaluate different technical/research solutions
- clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings
- identify the issues that must be addressed within the framework of the specific dissertation in order to take into consideration