Course Curriculum

(Course Structure and Syllabi)

for

Bachelor of Technology

in

Engineering Physics

(Second Year Onwards)

Department of Physics and Photonics Science

National Institute of Technology Hamirpur

Hamirpur – 177 005 (India)

Second Year

3rd Semester							4th Semester						
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	HS-203	Organizational Behaviour	3	0	0	3	1	MA-203	Engineering Mathematics-III	3	1	0	4
2	PH-211	Quantum Physics	3	1	0	4	2	PH-221	Atomic and Molecular Spectroscopy	3	1	0	4
3	PH-212	Solid State Physics	3	1	0	4	3	PH-222	Classical Mechanics	3	1	0	4
4	PH-213	Electromagnetic Theory	3	1	0	4	4	PH-223	Mathematical Physics	3	1	0	4
5	CS-201	Data Structures	3	1	0	4	5	PH-224	Engineering Thermodynamics	3	0	0	3
6	PH-214	Solid State Physics Lab	0	0	2	1	6	PH-225	Spectroscopy Lab	0	0	2	1
7	PH-215	Electricity & Magnetism Lab	0	0	2	1	7	PH-226	Thermal Physics Lab	0	0	2	1
8	CS-202	Data Structures Lab	0	0	2	1	8	PH-227	Numerical Methods Lab	0	0	2	1
		Total Hours = 25				**22**			**Total Hours = 25**				**22**

Third Year

5th Semester							6th Semester						
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	PH-311	Nuclear Science & Engineering	3	1	0	4	1	PH-321	Fundamentals of Semiconductor Devices	3	1	0	4
2	PH-312	Plasma Physics	3	1	0	4	2	PH-322	Analog & Digital Electronics	3	1	0	4
3	PH-313	Statistical Mechanics	3	1	0	4	3	PH-323	Lasers and Photonics	3	1	0	4
4	PH-314	Engineering Optics	3	0	0	3	4	PH-324	Measurements and Instrumentation	3	0	0	3
5	OET	Open Elective-I	3	0	0	3	5	OET	Open Elective-II	3	0	0	3
6	PH-315	Optics Lab	0	0	2	1	6	PH-325	Digital Electronics Lab	0	0	2	1
7	PH-316	Modern Physics Lab	0	0	2	1	7	PH-326	Lasers and Photonics Lab	0	0	2	1
8	PH-317	Computational Physics Lab	0	0	2	1	8	PH-329	Seminar	0	0	2	1
		Total Hours = 24				**21**			**Total Hours = 24**				**21**

Fourth Year

7th Semester							8th Semester						
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	PH-411	Materials Synthesis and Characterization	3	0	0	3	1	HS-404	Engineering Economics & Accountancy	3	0	0	3
2	PH-412	Physics of Nanosystems	3	0	0	3	2	PH-421	Microprocessor and Peripheral Devices	3	0	0	3
3	DET	Professional Elective-I	3	0	0	3	3	DET	Professional Elective-III	3	0	0	3
4	DET	Professional Elective-II	3	0	0	3	4	DET	Professional Elective-IV	3	0	0	3
5	PH-418	Industrial Training Presentation	0	0	2	1	5	PH-428	General Proficiency	0	0	0	1
6	PH-419	Major Project (Stage-I)	0	0	12	6	6	PH-429	Major Project (Stage-II)	0	0	12	6
		Total Hours = 26				**19**			**Total Hours = 24**				**19**

Semester Wise Credits									
Semester	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**Total**
Credits	24	24	22	22	21	21	19	19	**172**
Hours/week	28	28	25	25	24	24	26	24	**204**

Professional Elective Courses

Professional Elective-I (courses related to tools/techniques)

PH-430 Laser Metrology
PH-431 Applications of Lasers in Technology
PH-432 Optical Fibre Communication

Professional Elective-II (courses related to Material Applications)

PH-450 Meta Materials
PH-451 Solar Photovoltaic
PH-452 Renewable Energy and Storage Devices

Professional Elective-III (courses related to Emerging Technologies)

PH-440 Quantum Computing
PH-441 Quantum Electronics
PH-442 Thin Film Technology

Professional Elective-IV (courses related to Nanoscience)

PH-460 Functional Nanomaterials
PH-461 Low Dimensional Physics
PH-462 Condensed Matter Physics

Open Elective Courses

Open Elective-I

PH-370 Laser and Photonics
PH-371 Physics of Semiconductor Devices

Open Elective-II

PH-380 Nuclear Technology
PH-381 Microwave Physics

Course Name:	**Organizational Behaviour**
Course Code:	**HS-203**
Course Type:	**Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the behavioural aspects related to professional organizations
- To introduce the fundamental concepts relevant to understanding of individual & group behavior in the organization
- To enable the students to understand the applied organizational themes like perception, motivation, interpersonal relationships, group dynamics, leadership theories, role of power & politices in organizational context, conflict and negotiation, organizational diversity, dynamics of personality, attitude and job satisfaction, etc.

Unit Number	Course Content	Lectures
UNIT-01	**Organizational Behavior (OB):** Concept, nature, characteristics, conceptual foundations, determinants and importance, management functions, role & skills, disciplines that contribute to the field of OB, Challenges & Opportunities for OB, diversity in Organizations, attitudes & Job satisfaction.	**04L**
UNIT-02	**Perception**: Concept, nature, process, importance, management and behavioral applications of perception. Personality: concept, nature, types and theories of personality shaping. Learning; concept and theories of learning.	**08L**
UNIT-03	**Motivation:** concept, principles, theories-content, process & contemporary, Monetary and non-monetary motivation, applications of motivation. Leadership: Concept, functions, styles, and theories of leadership- trait, behavioural, and situational.	**06L**
UNIT-04	**Group and Interpersonal Relationship:** Analysis of Interpersonal Relationship, developing interpersonal relationship, Group Dynamic: Definition of Group, stages of Group Development, Punctuated Equilibrium Model, Group Structure, Group Decision Making, understanding work teams.	**05L**
UNIT-05	**Organizational Power and Politics:** concept of power, structure of power, classification of power, contrasting leadership & power, dependence a key to power, causes & consequences of political behaviour. Organizational conflict: view of conflict, conflict process, negotiation & bargaining strategies.	**06L**
UNIT-06	**Conflict and Negotiation:** conflict definition in conflict thought: Traditional view, the Human relation view, interactionist view. Functional versus dysfunctional conflict, conflict process. Negotiation Bargaining strategies, the negotiation process and issues in negotiation.	**07L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify the challenges of the present organization

CO2: Describe the organizational system

CO3: Apply the principles of organizational behavior to inculcate the habit of team work and which is essential for the organization

CO4: Assess the role of psychological and social principal in improvement of efficiency as well as quality of empoyee life

Books and References

1. Organizational Behavior by S.P. Robbins, Prentice Hall of India.
2. Organizational Behavior by F. Luthans, McGraw-Hill.
3. Human Behavior at Work: Organizational Behavior by K. Davis, Tata McGraw-Hill.

Course Name: **Quantum Physics**
Course Code: **PH-211**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- An ability to understand the framework of quantum mechanics.
- An understanding of the methods used to solve physics problems using quantum mechanics.
- The broad education necessary to understand microscopic systems.
- A knowledge of concepts like wavepacket, operators, commutators etc.

Unit Number	Course Content	Lectures
UNIT-1	**Wave Packets and Uncertainty Principle:** Plane waves; Superposition of plane waves; Wave packets; Fourier analysis; Group velocity; Propagation of wave packets; Wave packet broadening; Gaussian wave packet	**8L**
UNIT-2	**Schrödinger Equation**: The wave equation and the interpretation of ψ; Operators and expectation values of dynamical variables; Commutators and operator algebra; Stationery states; Dirac notations.	**7L**
UNIT-3	**Postulates of Quantum Mechanics:** The Basic Postulates of Quantum Mechanics, The State of a System, Observables and Operators, Measurement in Quantum, Time Evolution of the System's State.	**7L**
UNIT-4	**Problems in one-dimension:** Potential step, rectangular potential barrier, symmetries and invariance properties, reflection and transmission coefficients, potential well, Kroning-Penny Model, Harmonic Oscillator: Energy eigen values and eigen functions of a 1-D harmonic oscillator.	**7L**
UNIT-5	**Angular momentum:** Orbital angular momentum, General Formalism of angular momentum, Spin angular momentum, Eigenfunctions of Orbital angular momentum, Clebsch-Gordon coefficients.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the quantum mechanical systems.
CO2: Identify the applications of quantum mechanics.
CO3: Write down the concepts elated to the framework of quantum mechanics.
CO4: Learn and to apply concepts learnt in Quantum mechanics to one dimensional problems.

Books and References

1. Quantum Physics by S. Gariorowicz, John Wiley & Sons.
2. Concepts of Modern Physics by A. Beiser, McGraw Hill International.
3. Quantum Mechanics by A. Ghatak and S. Lokanathan, McMillan India Ltd.
4. Introduction to Quantum Mechanics, D. J. Griffiths, Pearson Prentice Hall.
5. A Text Book of Quantum Mechanics by P.M. Mathews and K.Venkatesan, Tata McGraw Hill.

Course Name:	**Solid State Physics**
Course Code:	**PH-212**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- An ability to understand the basic framework of solid state physics
- An understanding of concepts bonding, crystal structure, crystal lattice.
- The broad education necessary to understand material science.
- A knowledge of concepts like lattice vibrations, defects in solids and magnetism.

Unit Number	Course Content	Lectures
UNIT-1	**Bonding and Mechanical Properties:** Covalent bonding, ionic bonding, metallic bonding, hydrogen bonding and Van der Waals bonding. Elastic constants and elastic waves.	**8L**
UNIT-2	**Crystal Structure:** Point symmetry, translational symmetry, two and three- dimensional lattices, simple crystal structures, Miller indices, diffraction from periodic structures, reciprocal lattice,Brillouin zones.	**7L**
UNIT-3	**Lattice Vibrations:** One dimensional lattices (monoatomic and diatomic), quantization of elastic waves, phonon momentum, density of modes.	**7L**
UNIT-4	**Electrons in Solids:** Free electron gas in metals, periodic potential and Bloch's theorem and Kronig-Penney model	**7L**
UNIT-5	**Defects in Solids:** Lattice vacancies, diffusion, colour centers and elementary idea of dislocation. Magnetism: Langevin theory of dia- and para- magnetism, quantum theory of dia- and para-magnetism, magnetic ordering, Weiss molecular field theory of ferromagnetism and Neel theory of antiferromagnetism.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the concepts of solid state physics and their applications.

CO2: Identify the applications of symmetries.

CO3: Write down the concepts related to solid state physics and material science.

CO4: Learn and to apply concepts learnt in solid sate physics to the problems like electrical conductivity.

Books and References

1. Introduction to Solid State Physics by C. Kittel, Wiley Eastern Ltd..
2. Solid State Physics by N.W. Ashcroft and N.D. Mermin, Holt-Saunders.
3. Solid State Physics by J.R. Hook and H.E. Hall, John Wiley.
4. Solid-State Physics:An Introduction to Principles of Materials Science, by H. Ibach and H. Lüth, Springer.
5. Magnetism in Condensed Matter by S. Blundell, Oxford University Press.

Course Name:	**Electromagnetic Theory**
Course Code:	**PH-213**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- An ability to understand electricity and magnetism
- An understanding of concepts of vector calculus.
- The broad education necessary to understand electrostatic and magnetostatic environment.
- A knowledge of concepts like polarization, magnetization and electromagnetic induction.

Unit Number	Course Content	Lectures
UNIT-1	**Vector calculus:** Vectors in Cartesian, Cylindrical, and Spherical Polar coordinate system and transformation among themselves. Vector calculus: differential length, area, volume, Del operator, line, surface and volume integrals,in all the three coordinate systems. Gradient of a scalar, divergence (Gauss's theorem) and curl of a vector (Stoke's theorem) with their physical interpretations, delta function.	**8L**
UNIT-2	**Electrostatics:** Electric field, Coulomb's law, continuous charge distribution, Gauss's law and its applications. Electric potential, Poisson's equations and Laplace's equation, boundary conditions, electrostatic energy, Laplace equation (boundary value problems in 1D or reducible to 1D and in Spherical coordinates), Boundary conditions and Uniqueness theorems, method of images, multipole expansion.	**7L**
UNIT-3	**Electric field in Dielectrics:** Polarization, bound charges, electric displacement vector, linear dielectrics (susceptibility, permittivity, dielectric constant), energy in dielectric systems, force on dielectrics, boundary conditions.	**7L**
UNIT-4	**Magnetostatics:** Currents, continuity equations, Biot-Savart law, Ampere's law and its applications, magnetic vector potentials, multipole expansion, Magnetization, dia-, para- and ferromagnetism, , bound currents, Ampere's law in magnetized materials, linear media (magnetic susceptibility and permeability, boundary conditions).	**7L**
UNIT-5	**Electrodynamics:** Faraday's Law of induction, self-inductance, transient currents, magnetic energy and mechanical forces, Maxwell equations with corrections, Maxwell equations in matter	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the vector calculus and its applications.

CO2: Identify the applications of laws of electrostatics and magnetostatics in everyday life.

CO3: Learn and to apply concepts learnt in electromagnetic induction.

Books and References

1. Engineering Electromagnetics by Jr. W.H. Hayt and J. A. Buck, Tata McGraw Hill Publishing Company Ltd, New Delhi.
2. Elements of Engineering Electromagnetics by N. O. Sadiku, Oxford University Press.
3. Elements of Engineering Electromagnetics by N. N. Rao, Prentice Hall of India, New Delhi.
4. Introduction to Electrodynamics by D. J. Griffiths, Prentice Hall.

Course Name:	**Data Structures**
Course Code:	**CS-201**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about linear and non-linear data structures as the foundational base for computer solutions to problems.
- To introduce the fundamental concepts relevant to binary trees, binary tree traversals, binary search trees and perform related analysis to solve problems.
- To enable the students to understand various types of sorting algorithms.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Data types, data structures, abstract data types, the running time of a program, the running time and storage cost of algorithms, complexity, asymptotic complexity, big O notation, obtaining the complexity of an algorithm.	**8L**
UNIT-02	**Development of Algorithms:** Notations and Analysis, Storage structures for arrays - sparse matrices - structures and arrays of structures, Stacks and Queues: Representations, implementations and applications. Linked Lists: Singly linked lists, Linked stacks and queues, operations on Polynomials, Doubly Linked Lists, Circularly Linked Lists, Operations on linked lists- Insertion, deletion and traversal, dynamic storage management – Garbage collection and compaction.	**7L**
UNIT-03	**Trees:** Basic terminology, General Trees, Binary Trees, Tree Traversing: in-order, pre-order and post-order traversal, building a binary search tree, Operations on Binary Trees - Expression Manipulations - Symbol Table construction, Height Balanced Trees(AVL), B-trees, B+-trees.	**7L**
UNIT-04	**Graphs:** Basic definitions, representations of directed and undirected graphs, the single-source shortest path problem, the all-pair shortest path problem, traversals of directed and undirected graphs, directed acyclic graphs, strong components, minimum cost spanning tress, articulation points and biconnected components, graph matching.	**7L**
UNIT-05	**Sorting and Searching Techniques:** Bubble sorting, Insertion sort, Selection sort, Shell sort, Merge sort, Heap and Heap sort, Quick sort, Radix sort and Bucket sort, Address calculation, Sequential searching, Binary Searching, Index searching, Hash table methods.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Interpret and compute asymptotic notations of an algorithm to analyze the time complexity.
CO2: Use of linear and non-linear data structures as the foundational base for computer solutions to problems.
CO3: Demonstrate the ability to implement various types of static and dynamic lists.
CO4: Implement binary trees, binary tree traversals, binary search trees and perform related analysis to solve problems.
CO5: Implement various types of sorting algorithms.

Books and References

1. An Introduction to Data Structures with applications by J.P. Tremblay and P.G. Sorenson, Tata McGraw Hill.
2. Data structures, Algorithms ad Applications in C++ by Sartaj Sahni, WCB/McGraw Hill.
3. Data Structures and Algorithms by Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, Addison Wesley.
4. Data Structures using C by Y. Langsam, M. J. Augenstein and A. M. Tenenbaum, Pearson Education.
5. Data Structures – A Pseudocode Approach with C by Richard F. Gilberg and Behrouz A. Forouzan, Thomson Brooks /Cole.

Course Name: **Solid State Physics Lab** Course Code: **PH-214**	
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying the experimental methods to correlate with theory of Solid state.
- To learn the use of electromagnetic systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To identify the crystal structure and to determine the lattice constant using X-ray diffraction.
2. To study the Hall effect in semiconductors and to determine the carrier concentration.
3. To measure the magnetic susceptibility of different materials.
4. To measure the resistivity of semiconductor crystals (Ge & Si) with temperature by Four probe method.
5. To demonstrate dia-para-ferro magnetism in a homogenous magnetic field.
6. To study hysteresis of an iron core.
7. To investigate the elastic and plastic extension of metal wires.
8. To determine unit cells of various crystal classes.
9. To determine value of e/m by bar magnet
10. To perform Frank-Hertz experiment
11. Study of thermoluminscence of F centers in alkali halides
12. To measure the resistivity of insulator with temperature by Two probe method.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.
CO2: Use the different measuring devices and meters to record the data with precision.
CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name: **Electricity and Magnetism Lab** Course Code: **PH-215**	
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To demonstrate the Lenz's law and effects of electromagnetically induced currents.
2. To investigate the equipotential lines of the electric field for different shape electrodes.
3. To measure the force between current carrying conductor and to determine the permeability of air.
4. To measure the force of attraction between charged capacitor plates and to determine the permittivity of air.
5. To determine the dielectric constant of different dielectric materials.
6. To measure the spatial distribution of the magnetic field between a pair if identical coils in Helmholtz arrangement.
7. To investigate the spacing between the coils at which magnetic field is uniform and to measure its spatial distribution.
8. To study the magnetic field along the axis of a current carrying multiturn coil.
9. To study the dependency of a magnetic field on coil diameter and number of turns.
10. To study the Biot-Savart's law.
11. To study the magnetic behaviour of a circular conductor as a function of the current.
12. To study optical phenomena in microwave optics system.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.
CO2: Use the different measuring devices and meters to record the data with precision.
CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name: **Data Structures Lab**
Course Code: **CS-202**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for designing & writing algorithms.
- To provide skills for writing C/C++ programs.
- To enable the students to debug programs.

List of Experiments

1. Write a program to sort an array (make a dynamic array) using Bubble sort. Use 1-bit variable FLAG to signal when no interchange take place during pass. If FLAG is 0 after any pass, then list is already sorted and there is no need to continue.
2. WAP to search an ITEM (integer) in an array using binary search, if FOUND then delete that item from array and if NOT FOUND than insert that item in kth position (Input "k" from user).
3. WAP to enter records of Five students, which should contain fields like roll No., name, CGPI, semester.
   a. List all record of all students having CGPI greater than k.
   b. Insert a new record of student at kth position and print the final record.
4. Implement linked list and insert and delete an element into the list.
5. Evaluate a postfix algebraic expression with the help of stack.
6. Implement a circular queue by adding or deleting few elements. Make sure to incorporate "Queue Empty", "Queue Full" constraints in your program.
7. WAP to implement Binary Search Tree with insertion and deletion operation.
8. Implement any one of the tree traversing techniques.
9. Implement various sorting algorithms like Quick sort, Merge Sort, Insertion Sort, Selection Sort etc.
10. Implement hashing.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: To gain knowledge of popular available data structures.
CO2: To develop programming skills in students.
CO3: To impart knowledge of syntax and sementics of basic languages.

Course Name:	**Engineering Mathematics-III**
Course Code:	**MA-203**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** — Course Credits: **04**

Course Objectives

- To introduce the fundamental concepts relevant to function of complex variable, numerical differentiation and integration and numerical solution of linear, non-linear and system of equations.
- To have the idea of evaluation of real integrals using complex variable.
- To understand the concept of approximating & interpolating polynomials and finding values of function at arbitrary point.
- To impart knowledge of various numerical technique to solve ODE.

Unit Number	Course Content	Lectures
UNIT-01	**Functions of Complex Variable:** Applications of De Moivre's theorem, Exponential, Circular, Hyperbolic and Logarithmic functions of a complex variable, Inverse Hyperbolic functions, Real and imaginary parts of Circular and Hyperbolic functions, Summation of the series-'C+iS' method.Limit and derivative of complex functions, Cauchy-Riemann equations, Analytic functions and its applications, Complex integration, Cauchy's theorem, Cauchy's integral formula, Series of complex function, Taylor series, singularities and Laurent's series, Cauchy's residue theorem and its application for the evaluation of real definite integrals.	**12 L**
UNIT-02	**Interpolation:** Least square curve fit and trigonometric approximations, Finite differences and difference operators, Newton's interpolation formulae, Gauss forward and backward formulae, Sterling and Bessel's formulae, Lagrange's interpolation.	**06L**
UNIT-03	**Numerical Integration:** Integration by trapezoidal and Simpson's rules 1/3 and 3/8 rule, Romberg integration, and Gaussian quadrature rule, Numerical integration of function of two variables.	**05L**
UNIT-04	**Numerical Solution of Ordinary Differential Equations:**Taylor series method, Picard's method, Euler's method, Modified Euler's method, Runge- Kutta method. Predictor corrector methods, Adam Bashforth and Milnes method, convergence criteria, Finite difference method.	**07L**
UNIT-05	**Numerical Solution of Linear and Non Linear Equations** : Non Linear Equations: Bisection Method, Regula Falsi Method, Newton-Raphson Method, Iteration method. Linear Equations: Jacobi and Gauss Seidel Iteration methods, Relaxation method.	**06 L**
		36 L

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO1: Understand and analyze the concept of Numerical Solution of Linear and Non Linear Equations, Ordinary Differential Equations and Function of complex variable.

CO2: Identify an appropriate technique to solve the linear, non-linear equations, ordinary differential equations.

CO3: Formulate the problems on related topics and solve analytically.

CO4: Apply the concepts of linear, non-linear equations, differential equations and complex analysis in various engineering problems.

CO5: Demonstrate the concepts through examples and applications.

Books and References

1. Complex variables and Applications by R. V. Churchill, J. W. Brown and R. F. Verhey, McGraw Hill.
2. A first course in complex analysis with applications by G. Zill Dennis and P. D. Shanahan, Jones and Bartlett.
3. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyenger and R. K. Jain, New Age International Publishers, New Delhi
4. Numerical Methods for Engineers and Scientists (2nd Ed.) by J. D. Hoffman, CRC Press.
5. Numerical Analysis Mathematics and Scientific computing (3rd ed.) by D. Kincaid and W. Cheney, American Mathematical Society.

Course Name:	**Atomic and Molecular Spectroscopy**
Course Code:	**PH-221**
Course Type:	**Core**
Contact Hours/Week: **3L + 1T**	Course Credits: **04**

Course Objectives

- An ability to understand atomic and molecular systems and basics of spectroscopy
- An understanding of concepts of electronic and molecular energy levels.
- The broad education necessary to understand the importance of spectroscopy.
- A knowledge of concepts like coupling of angular momentum, electronic and molecular spectroscopy.

Unit Number	Course Content	Lectures
UNIT-1	**Review of single electron systems:** Quantum States of One Electron Atom: Atomic orbitals -Hydrogen spectrum – The Pauli Exclusion Principal – Ritz combination principle, Spectra of alkali elements, Spin – orbit interaction; Larmor's theorem and the fine structure in alkali spectra.	**8L**
UNIT-2	**Two Electron Systems:** General characteristics of the energy levels of alkaline earth elements; selection rules and intensity rules, Interaction energy in LS or Russell-Saunder's coupling and JJ-coupling, LS-coupling, Hyper fine structure (qualitative) Normal and Anomalous Zeeman effect, Paschen Back effect, Stark effect, Lande's g-factor in LS coupling. Molecular Structure.	**7L**
UNIT-3	**Molecular systems**: Diatomic linear symmetric top, asymmetric top and spherical top molecules, Types of molecular energy states and molecular spectra, Born Oppenheimer approximation-Rotational Spectra, Spectra of diatomic molecules as a rigid rotator-Energy levels and spectra, diatomic molecules as non rigid rotor.	**7L**
UNIT-4	**Vibrational Spectra:** Vibrational energy of diatomic molecule as a simple harmonic oscillator – Energy levels and spectrum, Vibrating molecule as an-harmonic oscillator– Morse potential energy curve - Molecules as vibrating rotator.	**7L**
UNIT-5	**Spectroscopy:** Raman effect - Quantum theory, Pure rotational spectra of diatomic molecules , Vibration rotation Raman spectrum of diatomic molecules – Experimental set up for Raman spectroscopy – Application of IR and Raman spectroscopy in the structure determination of simple molecules, Franck Condon principle.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the electronic and molecular systems and their applications.

CO2: Write down the concepts related to, electronic, rotational and vibrational spectra.

CO3: Learn and to apply concepts of spectroscopy in the determination of atomic and molecular parameters.

Books and References

1. Physics of atoms and molecules by B.H. Bransden and C.J. Joachain, Pearson Education.
2. Fundamentals of molecular spectroscopy by A.N. Banwell and E.M. McCash, Tata McGraw Hill..
3. Introduction to atomic spectra by L.E. White, McGraw Hill..

Course Name:	**Classical Mechanics**
Course Code:	**PH-222**
Course Type:	**Core**
Contact Hours/Week: **3L + 1T**	Course Credits: **04**

Course Objectives

- An ability to understand classical mechanics and the need for non Newtonian formalisms.
- An understanding of concepts of Lagrangian and Hamilton's principles.
- The broad education necessary to understand different classical systems.
- A knowledge of concepts like small oscillations, central force, rigid body and canonical transformations.

Unit Number	Course Content	Lectures
UNIT-1	**Introduction to Constrained Motions:** Principle of virtual work, generalized coordinates, Lagrange's equation of motion, generalized momenta, cyclic coordinates, Legendre's dual transformation, Hamilton's function and Hamilton's equation of motion; Configuration space, phase space and state space.	**8L**
UNIT-2	**Small Oscillations:** Eigenvalue problem, normal coordinates, frequencies of vibrations, forced vibrations, examples.	**7L**
UNIT-3	**Central Force:** Equations of motion, equivalent one body problem, orbits, Virial theorem, Kepler's problem, scattering theory, centre of mass and laboratory frames of reference.	**7L**
UNIT-4	**Rigid Body Motion:** Orthogonal transformation, transformation matrix, Euler angles, Cayley-Klein parameters, Euler's theorem,Finite & infinitesimal rotations; Rotating frames of reference, Coriolis' force; Angular momentum and kinetic energy, dyadic & tensors; Moment of inertia, principal axis transformation, Euler equation of motion and its solutions, tops, precession, satellite orbits.	**7L**
UNIT-5	**Canonical Transformations:** Legendre transformation and Hamilton's equations of motion, cyclic coordinates and conservation theorems, derivation of Hamilton's equations from a variational principle, the principle of least action. The equation of canonical transformations, examples of canonical transformations, Poisson brackets. Equations of motion.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the classical systems and analysis them.

CO2: Identify the applications of Lagrangian and Hamiltonian mechanics.

CO3: Learn and to apply the concepts learnt in classical mechanics in different situations..

Books and References

1. Classical Mechanics by N.C. Rana and P.S. Joag, Tata McGraw-Hill, New Delhi.
2. Classical Mechanics by H. Goldstein, Narosa New Delhi.
3. Classical Mechanics by J. R.Taylor, University Science Books.
4. The Classical Theory of Fields by L.D. Landau and E.M. Lifshitz, Elsevier.
5. Classical Mechanics of Particles and Rigid Bodies by K.C. Gupta, Wiley Eastern.
6. Classical Mechanics by J.C. Upadhyaya, Himalaya Publishing House.

Course Name:	**Mathematical Physics**
Course Code:	**PH-223**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- An ability to understand a mathematical concepts from the perspective of Physics.
- An understanding of concepts of complex variables, special functions and group theory.
- The broad education necessary to understand the different applications of mathematics to understand physics.

Unit Number	Course Content	Lectures
UNIT-1	**Complex variables:** Analytic functions, contour integration, residue calculus, conformal mapping and its applications. Fourier and Laplace transforms, evaluation of integral transforms and their inverses using contour integrals.	**8L**
UNIT-2	**Special Functions:** Special equations of Mathematical Physics; Legendre and associated Legendre equations; Hermite equation; Laguerre and associated Laguerre equations; Bessel's equation; Hypergeometric equation; Beta and gamma functions.	**7L**
UNIT-3	**Green's functions:** Green's functions and solutions to inhomogeneous differential equations and applications.	**7L**
UNIT-4	**Tensors:** Covariant and Contravariant tensors, covariant derivatives, affine connections Christoffel symbols, Curvature tensor.	**7L**
UNIT-5	**Group Theory:** Classification and examples of (finite) groups, homomorphisms, isomorphisms, representation theory for finite groups, reducible and irreducible representations, Schur's Lemma and orthogonality theorem.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the mathematics concepts and their applications to problems of physics.

CO2: Identify the applications of complex variables, tensors and group theory.

CO3: Learn and to apply concepts learnt in Mathematical Physics in Industry and in real life.

CO4: Learn the idea of Green Functions and its uses in different problems in physics.

Books and References

1. Mathematical Methods for Physicists by G.B. Arfken and H. J. Weber, Academic Press.
2. A Course of Modern Analysis by E.T. Whittaker and E.W. Watson, Cambridge University Press.
3. Group Theory and Applications to Physical Problems by M. Hammermesh, Dover publications, NY.
4. Theory of Linear Operator in Hilbert Space by N. I. Akhiezer and I. M. Glazman, Dover Publications.

Course Name:	**Engineering Thermodynamics**
Course Code:	**PH-224**
Course Type:	**Core**
Contact Hours/Week: **3L**	Course Credits: **03**

Course Objectives

- An ability to understand the principles of thermodynamics and its various aspects.
- An understanding of concepts of thermodynamics and its laws.
- The broad education necessary to understand thermodynamics and its applications.
- A knowledge of concepts thermodynamic cycles.

Unit Number	Course Content	Lectures
UNIT-1	**Kinetic theory and Transport phenomena:** Equation of state of a perfect gas, Maxwell velocity distribution, real gases and Vander Wall's equation, Brownian motion, mean free path, viscosity and thermal conductivity.	**8L**
UNIT-2	**Laws of thermodynamics and applications:** Review of thermodynamic systems, state variables, intensive and extensive parameters, thermodynamic processes, Zeroth and first law of thermodynamics; State functions, internal energy and enthalpy, Joule Thomson effect..	**7L**
UNIT-3	**Second law of thermodynamics:** refrigerators and thermodynamic engines; Otto and diesel engines, TdS equations, Third law of thermodynamics; Thermodynamic potentials: Entropy and internal energy as thermodynamic potentials, Legendre transformation, Helmholtz and Gibbs potentials, enthalpy, grand potential, transformation of variables Maxwell relations.	**7L**
UNIT-4	**Properties of steam and thermodynamic cycles**: Properties of steam, Use of property diagram, Steam tables, Processes involving steam in closed and open systems. Ranking cycle Introduction to I.C. Engines: Two, four stoke S.I. and C.I. engines. Otto cycle, Diesel cycle.	**7L**
UNIT-5	**Phase equilibria:** Gibb's phase rule, Clausius-Clapeyron equation, phase equilibrium and Maxwell construction, first order phase transitions.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the thermodynamic systems and their applications.

CO2: Identify the applications of thermodynamics.

CO3: Learn and to apply concepts learnt in thermodynamics in different applications based on thermodynamic principles.

Books and References

1. Thermodynamics and kinetic theory of gases by W. Pauli, Dover Publications.
2. Heat and thermodynamics by M. W. Zeemansky and R. H. Dittman, McGraw Hill.
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics by F. W. Sears and G. L. Salinger, Narosa, New Delhi.
4. Thermal Physics by C. Kittel and H. W. Kroemer, Freeman & Co..
5. Statistical Physics by F. Mandl, John Wiley.
6. Thermodynamics and Statistical Mechanics by W. Greiner, L. Neise, and H. Stocker, Springer.

Course Name: **Spectroscopy Lab** Course Code: **PH-225** Course Type: **Core**	
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To study Zeeman effect.
2. Measurement of the wavelength separation of sodium D-lines using a diffraction grating and to calculate the angular dispersive power of the grating.
3. To determine the wavelength of the Balmer series in the visible region of the hydrogen emission spectrum.
4. To study Raman spectra of a given sample.
5. To observe the Balmer series of Hydrogen using Bunsen-Kirchhoff spectroscope.
6. To study the spectrum of any source (glowing lamp, candle etc.).
7. To observe the neon spectral band's formation in a Frank Hertz tube.
8. To study transmission spectra of a given sample using UV-visible spectroscopy.
9. To measure the value of the Rydberg constant.
10. To study the absorbance and transmittance of different samples in different wavelengths.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.

CO2: Use the different measuring devices and meters to record the data with precision.

CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name: **Thermal Physics Lab**
Course Code: **PH-226**
Course Type: **Core**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying experimental methods to correlate with Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To study linear expansion for different kind of solids.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To study various thermal properties of materials using Differential Scanning Calorimeter.
6. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
7. To determine experimentally the relationship between gas volume and pressure at constant temperature.
8. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
9. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
10. To determine the heat capacity of solids.
11. To calibrate a thermocouple to measure temperature in specified range using Null method.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.

CO2: Use the different measuring devices and meters to record the data with precision.

CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name:	**Numerical Methods Lab**
Course Code:	**PH-227**
Course Type:	**Core**
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying experimental methods to correlate with Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate the sum of finite series and the area under a curve.
3. To find a set of prime numbers and the Fibonacci series.
4. Use bisection method to solve algebraic and transcendental equations.
5. Use Regula Falsi method to solve algebraic and transcendental equations.
6. Use Newton Raphson method to solve algebraic and transcendental equations.
7. Use secant method to solve algebraic and translate dental equations.
8. Use Gauss elimination method to solve systems of linear algebraic equations.
9. Use Jacobi method to solve systems of linear algebraic equations.
10. Use power method to find largest eigenvalues and eigenvectors.
11. To demonstrate the application of Newton forward interpolation formula.
12. To demonstrate the application of Lagrange's interpolation formula.
13. To demonstrate the application of Trapezoidal rule to evaluate definite integrals.
14. To demonstrate the application of Simpsons (1/3) rule to evaluate definite integrals.
15. To perform least square curve fitting into linear equation and polynomials.
16. To demonstrate the use of Runge-Kutta method 2nd and 4th order to solve differential equations.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.
CO2: Use the different measuring devices and meters to record the data with precision.
CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name:	**Nuclear Science & Engineering**
Course Code:	**PH-311**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- An ability to understand the properties of atomic nucleus and its stability.
- An understanding of concepts of nuclear physics and engineering.
- The broad education necessary to understand radioactivity and nuclear reactions.
- A knowledge of concepts like semi empirical mass formula, shell model and nuclear radioactivity.

Unit Number	Course Content	Contact Hours
UNIT-01	**Nuclear Properties:** Nuclear shape, size, radii, matter/charge distributions; Nuclear force; Conc of isospin; Charge Z independence of nuclear forces in the light of isospin. Mass defect and bind energy;	**8L**
UNIT-02	**Nuclear Models:** Liquid drop model; Semi empirical mass formula; Evidence of shell structure; S model with harmonic oscillator and spin-orbit potential and its predictions.	**7L**
UNIT-03	**Radioactivity:** α-decay, its properties, range, range-energy relationship, Geiger- Nuttal law, theory of α-decay, β-Decay and its classifications (only the basics), γ-decay: range, properties, pair production, energy spectra and nuclear energy levels.	**7L**
UNIT-04	**Nuclear Reaction:** Kinematics, Direct nuclear reaction, Compound nuclear reaction, Nuclear fission and fusion.	**7L**
UNIT-05	**Nuclear Detectors and Accelerators:** Gas, Scintillation and Semiconductor detectors. Neutron detectors, Accelerators: Cyclotron and Linac. Industrial, analytical and medical applications; Power from fission, Nuclear reactors; Source of stellar energy	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the atomic nucleus and its properties.

CO2: Identify the applications of nuclear models.

CO3: Write down the concepts related to nuclear structure and nuclear reactions.

CO4: Learn the idea of nuclear detectors and accelerators and their use in nuclear technologies.

Books and References

1. Nuclear Physics by J. S. Lilley, John Wiley & Sons.
2. Nuclear Physics by S.N. Ghoshal, S. Chand & Comp. Ltd.
3. Particles and Nuclei by B. Povh, K. Rith, C. Scholz and F. Zetsch, Springer.
4. From Nucleons to the Atomic Nucleus by K. Heyde, Springer.

Course Name:	**Plasma Physics**
Course Code:	**PH-312**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- An ability to understand plasma and different concepts of electromagnetic fields and their use in plasma physics.
- An understanding of concepts governing the behavior of plasma..
- The broad education necessary to understand plasma stability and propagation of waves in plasma.
- A knowledge of potential applications of plasma.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Plasma Physics:** Plasma definition; Debye shielding; Plasma parameters; Criteria for Plasma stability.	**8L**
UNIT-02	**Motion of Particles in the Presence of Electric and Magnetic Fields**: Motion of charge particle in uniform and non-uniform E and B fields; Time varying E and B fields.	**7L**
UNIT-03	**Plasma as Fluids:** Relation of Plasma Physics with ordinary Electromagnetics; The Fluid Equation of Motion; Fluid drifts perpendicular and parallel to B; The Plasma Approximation.	**7L**
UNIT-04	**Waves in Plasma:** Representation of waves; Plasma oscillations; Electron plasma waves, ion waves; Validity of plasma approximation; Comparison of ion and electron waves, Electrostatic electron oscillations perpendicular to E and B; Electrostatic ion waves perpendicular to B.	**7L**
UNIT-05	**Diffusion and Resistivity**: Diffusion and mobility in weakly ionized gases; Decay of a Plasma by Diffusion; Steady state solution, recombination; Diffusion across a magnetic field; Collision in a fully ionized plasma; The single fluid MHD equation; Diffusion in fully ionized plasma.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe plasma and its applications.

CO2: Identify the role of electrodynamics in plasma physics.

CO3: Write down the concepts related to magnetohydrodynamics.

CO4: Learn and to apply concepts learnt in plasma physics in Industry.

Books and References

1. Introduction to Plasma Physics by F. F Chen, Plenum Press New York.
2. Physics of Non-Neutral Plasmas by C. Davidson, Allied Publishers Pvt. Ltd..
3. The Fourth State of Matter: An Introduction to Plasma Science by S. Eliezer and Y. Eliger, CRC Press.
4. Fundamentals of Plasma Physics by M. B. Paul, Cambridge University Press.

Course Name:	**Statistical Mechanics**
Course Code:	**PH-313**
Course Type:	**Core**
Contact Hours/Week: **3L + 1T**	Course Credits: **04**

Course Objectives

- An ability to understand statistics and its applications to physics problems.
- An understanding of concepts of statistical mechanics.
- The broad education necessary to understand ensemble theory, quantum statistics and phase transition.
- A knowledge of concepts like Ideal Fermi and Bose gas and ensemble theory.

Unit Number	Course Content	Lectures
UNIT-01	**Classical Statistical Mechanics**: Macro and microstates, connection between statistics and thermodynamics, phase space; Liouville's Theorem.	**8L**
UNIT-02	**Ensemble Theory:** Microcanonical, canonical and grand canonical ensembles; Energy and Density fluctuations; equivalence of various ensembles. Equipartition and virial theorem, partition function; Derivation of thermodynamic properties; some examples, including (i) classical ideal gas (ii) system of classical harmonic oscillators, (iii) system of magnetic dipoles in magnetic field.	**7L**
UNIT-03	**Quantum Statistical Mechanics:** Quantum mechanical ensembles theory, the density matrix and partition function with examples, including (i) an electron in a magnetic field (ii) a free particle in a box (iii) a linear harmonic oscillator. Symmetric and Antisymmetric Wavefunctions. Microcanonical ensemble of ideal Bose, Fermi and Boltzmann gases, derivation of Bose, Fermi and Boltzmann statistics; Grand Partition function of ideal Bose and Fermi gases; Statistics of the occupation.	**7L**
UNIT-04	**Ideal Bose and Fermi Systems:** Thermodynamic behaviour of an ideal Bose gas; Bose condensation; Liquid Helium; Blackbody radiation and Planck's law of radiation; Thermodynamic behaviour of an ideal Fermi gas; Electrons in metals, specific heat and Pauli susceptibility of electron gas.	**7L**
UNIT-05	**Phase Transitions and Critical Phenomenon:** Order parameter, Ist and IInd order phase transitions. Ising model in zeroth and first approximation. Critical exponents, thermodynamic inequalities, Landau theory of phase transitions.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe statistical systems and the underlying principles.

CO2: Identify the applications of ensemble theory and different types of statistics.

CO3: Write down the concepts related to classical and quantum statistics.

CO4: Learn to apply the concepts of statistical mechanics in understanding the collective behaviour of physical systems.

Books and References

1. Statistical Mechanics by R.K.Patharia, Pergaman press.
2. Statistical Mechanics by K. Huang, John Wiley & Sons.
3. Statistical Mechanics by Butteworth-Heinemaun, D.A. McQuarrie, Harper & Row.

Course Name:	**Engineering Optics**
Course Code:	**PH-314**
Course Type:	**Core**
Contact Hours/Week: **3L**	Course Credits: **03**

Course Objectives

- An ability to understand an optical system and their applications.
- An understanding of concepts of geometric optics.
- The broad education necessary to understand the applications of geometrical optics.
- A knowledge of concepts like interference, diffraction, polarizations and aberrations. .

Unit Number	Course Content	Lectures
UNIT-01	**Geometrical optics**: Fermat's principle, the ray equation and its solutions, matrix method in paraxial optics, unit planes, nodal planes, system of thin lenses.	**8L**
UNIT-02	**Interference:** Huygen's principle and its applications, interference by division of wavefront, two slit interference, Fresnel's Biprism, interference with white light, displacement of fringes, interference by division of amplitude, thin parallel films, antireflection coatings, wedge shaped films, Newton's rings, Michelson interferometer and its applications, multiple beam interference, Fabry Perot interferometer and etalon.	**7L**
UNIT-03	**Diffraction**: Fraunhofer diffraction, single, double and multiple slit diffraction, diffraction grating, diffraction at a circular aperture, Fresnel diffraction, Fresnel half period zones, the zone plate, diffraction at a straight edge, diffraction of a plane wave by a long narrow slit and the transition to Fraunhofer region.	**7L**
UNIT-04	**Polarization**: Polarization and double refraction, production of polarized light, Brewster's law, Malus's law, double refraction, interference of polarized light, quarter and half wave plates, analysis of polarized light, optical activity, polarimeters, Laurent's half shade and biquartz polarimeters,.	**7L**
UNIT-05	**Aberrations of Optical Systems:** Wave fans and ray fans, spot diagrams, wavefront expansion, effects of aberrations on image quality, image quality criteria, aberration balancing, principle of lens design.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the concepts of optics like interference, diffraction.

CO2: Identify the applications of the wave theory of radiation in understanding phenomena like interference and diffraction.

CO3: Write down the concepts related to geometrical optics

CO4: Learn the idea of aberration in optical instruments.

Books and References

1. Optic by A. Ghatak, Tata McGraw Hill.
2. Optics by E. Hecht, Addison Weseley.
3. Fundamentals of Optics by F. A. Jenkins and H. E. White, McGraw Hill, New York.

Course Name: **Optics Lab**
Course Code: **PH-315**
Course Type: Core

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying experimental methods to correlate with Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. Study of Geometrical optics.
2. To measure the wavelength separation of Sodium-D lines.
3. To study two-beam interference.
4. To study Malus- law.
5. To study the wavelength of a monochromatic light source using Fresnel's bi-prism.
6. To study the polarization of light by using a Half-wave plate.
7. To study the polarization of the light using quarter wave-plate.
8. To study the Kerr effect in the given solution.
9. To study the rotation of the plane of polarization of monochromatic light through glass in the presence of a magnetic field.
10. To determine the speed of light in air.
11. To study the resolving power of a telescope.
12. To study the diffraction of light by using single slit, double slit and circular aperture.
13. Fabrication of optical components like lens, prism, glass slab etc.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.
CO2: Use the different measuring devices and meters to record the data with precision.
CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name:	**Modern Physics Lab**
Course Code:	**PH-316**
Course Type:	**Core**
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying experimental methods to correlate with Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of the material of a filament of directly heated vacuum diode.
3. To determine value of Planck's constant using LEDs of at least 4 different colours.
4. To determine the ionization potential of mercury.
5. To determine the wavelength of H-alpha emission line of the Hydrogen atom.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To study IV characteristics and demonstrate the tunnelling effect in tunnel diode.
8. To determine the absorption coefficient of Al using G.M. Counter.
9. To determine the value of e/m by magnetic focusing.
10. To set up the Millikan oil drop apparatus and determine the charge of an electron.
11. To determine the spectroscopic splitting of DPPH using ESR technique.
12. Study of nuclear magnetic resonance.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.
CO2: Use the different measuring devices and meters to record the data with precision.
CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name:	**Computational Physics Lab**
Course Code:	**PH-317**
Course Type:	**Core**
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying experimental methods to correlate with Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To solve the equation of motion of a projectile fired horizontally and plot the trajectory.
2. To find the solution of Laplace Equation.
3. To solve the diffusion equation.
4. Motion of particle in a central force field and plot the output for visualization.
5. Motion of a projectile using simulation and plot the output for visualization.
6. Numerical solution of equation of motion of simple harmonic oscillator and plotting of output..
7. Plotting trajectory of a projectile projected making an angle with horizontal.
8. To solve the Schrodinger equation to fins energy states of particle confined in a box.
9. To solve Laplace's equations in the depletion layer of p-n junction.
10. To find energies of a harmonic oscillator.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.

CO 2: Use the different measuring devices and meters to record the data with precision.

CO 3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name:	**Fundamentals of Semiconductor Devices**
Course Code:	**PH-321**
Course Type:	**Core**
Contact Hours/Week: **3L + 1T**	Course Credits: **04**

Course Objectives

- An ability to understand concepts of semiconductor physics
- An understanding of concepts of semiconductor junctions and metal semiconductor junction.
- The broad education necessary to solid state electronics.
- A knowledge of concepts / technologies JFET, MOSFET.

Unit Number	Course Content	Lectures
UNIT-01	**Energy bands in solids:** Elemental and compound semiconductors, intrinsic and extrinsic materials, Direct and indirect band-gap semiconductors, Heavily doped semiconductors.	**8L**
UNIT-02	**Charge carrier in semiconductors:** mobility, impurity band conduction, nonlinear conductivity, excess carriers in semiconductors. Semiconductor Bloch equation, transport properties.	**7L**
UNIT-03	**P-N junctions:** fabrication, static and dynamic behavior of p-n junction diodes, Junction breakdown in p-n junctions, tunnel diode, Schottky diode. Bipolar Junction Transistor: fundamentals of BJT operation, BJT fabrication, carrier distribution and terminal current, generalized biasing, switches, frequency limitations of transistors.	**7L**
UNIT-04	**Field Effect Transistors:** JFET, MOSFET. Metal Semiconductor junctions: Schottky effect, rectifying and Ohmic contacts. Integrated circuits, fabrication methods. Power devices: p-n-p-n diode, Silicon controlled rectifiers.	**7L**
UNIT-05	**Optoelectronic Devices:** photodiodes, light emitting diodes, semiconductor lasers, photovoltaic cells.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the semicondutor devices and their applications.

CO2: Identify the applications of p-n junction diode and Schottky diode.

CO3: Learn to apply concepts of solid state electronics in IT.

CO4: Learn the idea of optoelectronic devices and their importance in the advancement of technologies.

Books and References

1. Physics of Semiconductor devices by S. M. Sze, John Wiley.
2. Introduction to Electronic Devices by M. Shur, John Wiley.
3. Semiconductor Devices - Basic Principles by J. Singh, John Wiley.
4. Introduction to Semiconductor Materials and Devices by M. S. Tyagi, John Wiley.

Course Name:	**Analog & Digital Electronics**
Course Code:	**PH-322**
Course Type:	**Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- An ability to understand analog and digital electronics.
- An understanding of concepts of junctions devices, amplifiers and logic families.
- The broad education necessary to understand analog and digital electronics.

Unit Number	Course Content	Lectures
UNIT-01	**Physics of junction devices:** BJT/FET amplifiers; Feedback: effect of negative and positive feedback, basic feedback topologies; Feedback amplifiers: sinusoidal oscillators.	**8L**
UNIT-02	**Different classes of power amplifiers:** differential amplifiers; Operational amplifiers: arithmetic circuits, active filters, voltage controlled oscillators, A/D and D/A converters, sample and hold circuits and other applications of Op-amps; SE/NE 555 timer IC, multivibrators. Review of number systems and their inter conversion,	**7L**
UNIT-03	**Logic families:** MOSFET as switch; CMOS inverter; Combinational logic modules; flip-flops; registers; counters.	**7L**
UNIT-04	**Sequential logic circuits:** design and analysis of synchronous and asynchronous sequential circuits.	**7L**
UNIT-05	**Memories:** Read only memory (ROM), EPROM, Flash, static and dynamic random access memories.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the electronic devices and their applications.

CO2: Identify the applications of junction devices, amplifiers and logic circuits.. .

CO3: Learn and to apply concepts learnt in analog and digital electronics in real life.

CO4: Learn the idea of logic families and their importance in advancement of technologies.

Books and References

1. Microelectronic Circuits by S. Sedra and K. C. Smith, Oxford University Press.
2. Op-Amps and Linear Integrated Circuits by R. A. Gaykwad, Prentice- Hall of India.
3. Digital Principles and Applications by D. P. Leach, A. P. Malvino and G. Saha, Tata McGraw Hill.
4. Digital Design - Principles and Practices by J. F. Wakerly, Prentice Hall of India.

Course Name:	**Lasers & Photonics**
Course Code:	**PH-323**
Course Type:	**Core**
Contact Hours/Week: **3L + 1T**	Course Credits: **04**

Course Objectives

- An ability to understand a Laser system and photonics.
- An understanding of concepts of Lasers and photonics.
- The broad education necessary to understand working of laser and photonics.
- A knowledge of concepts like nonlinear optics and acouto-optics.

Unit Number	Course Content	Lectures
UNIT-01	**Laser Physics:** The Einstein coefficients, light amplification, the threshold condition, laser rate equations, line broadening mechanisms, cavity modes, optical resonator, quality factor, mode selection, Q-switching, mode locking in lasers; gas lasers, solid state lasers, semiconductor lasers and dye lasers.	**8L**
UNIT-02	**Laser systems and Modulators:** Various common laser systems and applications, Laser modulators, Electro-optics, Accousto-optics modulators, deflectors, tunable filters.	**7L**
UNIT-03	**Nonlinear Optics:** Nonlinear optical susceptibilities, harmonic generators, frequency conversion, phase matching, bistable device, optical switching.	**7L**
UNIT-04	**Photonics:** optical properties of anisotropic media, wave refractive index, optical activity and Faraday effect, liquid crystals; principles of electro-optics, magneto-optics, photo refractive materials, acousto-optics and related devices; self-focussing and Kerr effect, Basic principles and applications of holography.	**7L**
UNIT-05	**Optical Fiber:** Step index and graded index optical fibers, attenuation, dispersion; optical fiber communication and its advantages; optical detectors.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the laser systems and their applications.

CO2: Identify the applications of lasers and photonics.

CO3: Learn and to apply concepts learnt in laser and photonics in Industry.

CO4: Learn the idea of optical fiber communications and importance in the advancement of technologies.

Books and References

1. Laser Fundamentals by W.T. Silfvast, Cambridge University Press.
2. Optical Electronics by A. Ghatak, and K. Thyagarajan, Cambridge University Press.
3. Photonics by A. Yariv, and P. Yeh, Oxford University Press.
4. Nonlinear Optics by R.W. Boyd, Academic Press.

Course Name:	**Measurements & Instrumentation**
Course Code:	**PH-324**
Course Type:	**Core**
Contact Hours/Week: **3L**	Course Credits: **03**

Course Objectives

- An ability to understand measurement and instrumentation.
- An understanding of concepts of sensors and transducers.
- The broad education necessary to understand instrumentation and measurement.
- A knowledge of concepts / technologies like sensors, spectrophotometers and interferometers .

Unit Number	Course Content	Lectures
UNIT-01	**Sensors:** Resistive, capacitative, inductive, electromagnetic, thermoelectric, elastic, piezoelectric, piezoresistive, photosensitive and electrochemical sensors, Interfacing sensors and data acquisition using serial and parallel ports.	**8L**
UNIT-02	**Low Pressure:** Rotary, sorption, oil diffusion, turbo molecular, getter and cryo pumps; Mcleod, thermoelectric (thermocouple, thermister and pirani), penning, hot cathode and Bayard Alpert gauges; partial pressure measurement; leak detection; gas flow through pipes and apertures; effective pump speed; vacuum components.	**7L**
UNIT-03	**Low Temperature:** Gas liquifiers; Cryo-fluid baths; liquid He cryostat design; closed cycle He refrigerator; low temperature measurement. Analytical Instruments: X-ray diffractometer	**7L**
UNIT-04	**Spectrophotometers:** FT-IR; DSC; lock-in amplifier; spectrum analyzer, fluorescence and Raman spectrometer, scanning electron microscope, atomic force microscope,	**7L**
UNIT-05	**Interferometers:** Laboratory Component: physical parameter measurement using different sensors; low pressure generation and measurement; calibration of secondary gauges; cryostat design; CCR operation; data collection from analytical instruments in the department.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the measurement and instrumentation and its applications.

CO2: Identify the applications of measurement and instrumentation.

CO3: Write down the concepts related measurement.

CO4: Learn and to apply concepts of measurement and instrumentation to Industry and real life.

Books and References

1. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper, Prentice-Hall of India,.
2. Principles of Measurement Systems by J.P. Bentley, Longman.

Course Name: **Digital Electronics Lab** Course Code: **PH-325** Course Type: **Core**	
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. To understand AND, OR, NOT and XOR gates operations.
2. To study the MOSFET charcterstics.
3. To minimize a given logic circuit.
4. To design an astable multivibrator of given specifications using 555 Timer.
5. To design a monostable multivibrator of given specifications using 555 Timer.
6. To study IV characteristics of PN diode, Zener and Light emitting diode.
7. To study the characteristics of a Transistor Junctions.
8. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
9. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
10. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
11. To study a precision Differential Amplifier of given I/O specification using Opamp.
12. To investigate the use of an op-amp as a Differentiator.
13. To design a Wien Bridge Oscillator using an op-amp.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.
CO2: Use the different measuring devices and meters to record the data with precision.
CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name:	**Lasers and Photonics Lab**
Course Code:	**PH-326**
Course Type:	**Core**
Contact Hours/Week: **2P**	Course Credits: **01**

Course Objectives

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis of the experimental data.
- To develop communication skills and discuss the basic principles of scientific concepts in a group.

List of Experiments

1. Examine the spatial and optical filtering of Laser
2. Characteristics study of Diode Laser.
3. Characteristics study LED and Laser.
4. Measurement of light using Precision interferometer (Michelson interferometer)
5. Study of Fabry Perot interferometer
6. Study of Mach-Zender interferometer
7. Study of low coherence interferrometry for biological and material structure.
8. Measurement of optical parameters of single/ multimode optical fiber using Optical fiber kit.
9. Recording / reconstruction of Hologram using holographic interferrometry.
10. Optical microscope for study of various kinds of samples.
11. To develop the different crystal structures using a laser beam.
12. To study the emission spectra of optical materials.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply the various procedures and techniques for the experiments.
CO2: Use the different measuring devices and meters to record the data with precision.
CO3: Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Course Name: **Materials Synthesis & Characterization** Course Code: **PH-411** Course Type: **Core**		
Contact Hours/Week: **3L**		Course Credits: **03**
Course Objectives • An ability to understand a material synthesis. • An understanding of concepts of material characterization. • The broad education to understand the different concepts of material synthesis.		
Unit Number	**Course Content**	**Lectures**
UNIT-1	**Synthesis techniques:** Top down and bottom up approaches to produce nanomaterials. Overview of self-assembly, inert gas condensation, arc discharge, RF plasma, ball milling, sol-gel synthesis.	**8L**
UNIT-2	**Growth techniques:** Molecular beam epitaxy, chemical vapour deposition method and electro deposition, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis.	**7L**
UNIT-3	**Thin file depositions techniques:** thermal evaporation, electron beam evaporation.	**7L**
UNIT-4	**Structure analysis:** Crystal structure analysis, UV-Vis, IR and Raman spectroscopy, Photoluminescence (PL) spectroscopy.	**7L**
UNIT-5	**Morphology characterization techniques**: scanning electron microscopy (SEM) and EDAX analysis, transmission electron microscopy (TEM), atomic force microscopy (AFM) and scanning tunneling microscopy (STM).	**7L**
Course Outcomes Upon successful completion of the course, the students will be able to CO1: Plan synthesis of different materials. CO2: Identify the structure of materials by different techniques. CO3: learn and to apply concepts learnt in material synthesis to industrial applications.		
Books and References 1.Materials Science of thin films: Deposition and structures by O. Milton, Academic press. 2. Nano Materials by A.K. Bandyopadhyay, New Age International Publishers, New Delhi. 3. Nanomaterials- Synthesis, Properties and Applications by A. A. Edelstein and R. C. Cammarata, Institute of Physics Publishing, London.		

Course Name: **Physics of Nanosystems** Course Code: **PH-412** Course Type: **Core**		
Contact Hours/Week: **3L**		Course Credits: **03**
Course Objectives • An ability to understand nanosystems. • An understanding of concepts of nanosystem. • The broad education necessary to understand nanosystem. • A knowledge of the concepts of nanoscale phenomenon.		
Unit Number	**Course Content**	**Lectures**
UNIT-1	**Introduction:** An overview of quantum mechanical concepts related to low dimensional systems. Hetrostructures – Heterojunctions, Type I and Type II heterostructures, Classification of Quantum confined systems, The unit cell for quantum well, for quantum wire and for quantum dot. Nanoclusters and Nanoparticles – introduction, Metal nanoclusters- Magic numbers, Geometric structures, Electronic structure, Bulk to nano transition.	8L
UNIT-2	**Carbon Nanostructures:** Introduction, Carbon molecules, Carbon clusters, Structure of C60 and its crystal, Small and Large Fullerenes and Other Buckyballs, Carbon nanotubes and their Electronic structure Properties of Nano Materials: Size dependence of properties, Phenomena and Properties at nanoscale, Mechanical/Frictional, Optical, Electrical Transport, Magnetic properties.	7L
UNIT-3	**Nanomaterial Characterization:** Electron Microscopy, Scanning Probe Microscopies, near field microscopy, Micro- and near field Raman spectroscopy, Surface-enhanced Raman, Spectroscopy, X-ray photoelectron spectroscopy.	7L
UNIT-4	**Synthesis of nanomaterials:** Fabrication techniques: Self-Assembly, Self- Replication, Sol-Gels. Langmuir-Blodgett thin films, Nanolithograph, Bioinspired syntheses, Microfluidic processes, Chemical Vapor Deposition, Pulse laser deposition.	7L
UNIT-5	**Applications of Nanomaterials:** Nanoelectronics, Nanosensors, Environmental, Biological, Energy Storage and fuel cells	7L
Course Outcomes Upon successful completion of the course, the students will be able to CO1: Describe the nanosystem. CO2: Understand the principles of nanosystems. CO3: Learn and apply concepts of nanosystems.		
Books and References 1. Nanomaterials-Synthesis,Properties & Applications by A.A.Edelstein, and R.C. Cammarata, Institute of Physics Publishing, London. 2. Quantum Wells:Physics and Electronics of 2-dimensional systems by Ashik, World Sci.. 3. Nanostructured Carbon for advanced Apps by G. Benedek, Kluwer Acad. Publishers. 4. Quantum Wells,Wires, and Dots;Theoretical and Computational Physics by P. Harrison, John Wiley. 5. Introduction to Nanotechnology by C.P. Poole, and F. J. Owens, Wiley India.		

Course Name: **Engineering Economics and Accountancy** Course Code: **HS-404** Course Type: **Core**		
Contact Hours/Week: **3L**		Course Credits: **03**
Course Objectives • To impart knowledge about the Economics and its applicability to the Engineers • To introduce the fundamental concepts of economics • To enable the students to understand the factors that causes the changes in economic conditions of the entrepreneur		
Unit Number	**Course Content**	**Lectures**
UNIT-01	**Introduction to Engineering Economics:** Definitions, Nature, Scope and application; Difference between Micro Economics and Macro Economics; Theory of Demand & Supply: Meaning, Determinants, Law of Demand, Elasticity of demand, Demand Forecasting, Law of Supply, Equilibrium between Demand & Supply.	**06L**
UNIT-02	**Production and Cost**: Production functions, Isoquant, Least Cost combination, Laws of Returns to Scale. Economics and Diseconomies of Scale of production, Cost and Cost curves, Revenue and Revenue curve, Break even analysis.	**06L**
UNIT-03	**Costing and Appraisal:** Cost elements, Economic cost, Accounting cost, Standard cost, Actual cost, Overhead cost, Cost control, Criteria of project appraisal, Social cost benefit analysis	**05L**
UNIT-04	**Markets**: Meaning, Types of Markets, Characteristics (Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly) Price and Output Determination; Product Differentiation; Selling Costs; Excess Capacity.	**05L**
UNIT-05	**Money**: Meaning, Functions, Types; Monetary Policy- Meaning, Objectives, Tools; Fiscal Policy:-Meaning, Objectives, Tools. **Banking:** Meaning, Types, Functions, Central Bank: its Functions, concepts CRR, Bank Rate, Repo Rate, Reverse Repo Rate, SLR.	**04L**
UNIT-06	**Depeciation:** Meaning of depreciation, causes, object of providing depreciation, factors affecting depreciation, Methods of Depreciation: Straight line method, Diminishing balance method, Annuity method and Sinking Fund method	**04L**
UNIT-07	**Financial Accounting:** Double entry system (concept only), Rules of Double entry system, Journal(Sub-division of Journal) , Ledger, Trial Balance Preparation of final accounts-Trading Account. Profit and Loss account, Balance Sheet.	**06L**
Course Outcomes Upon successful completion of the course, the students will be able to CO1: Identify the challenges of the economy as entrepreneur/manufacturer as well as consumer CO2: Describe the economic system at the micro and macro level CO3: Apply principles of economics and accountancy in the professional, personal and societal life CO4: Assess the role of engineering economics and accounting in attaining economic efficiency		
Books and References 1. Principles of Micro Economics by Mceachern and Kaur, Cengage Publication. 2. Managerial Economics by Craig Peterson and W. Cris Lewis, , PHI Publication. 3. Modern Microeconomics by A. Koutsoyiannis, Macmillan. 4. Managerial Economics Theory and Applications by D.M. Mithani, Himalaya Publication House. 5. Fundamental of Managerial Economics by Mark Hirschey, South Western Educational Publishing. 6. Engineering Economics by Degramo, Prentice Hall. 7. Financial Accounting–A Managerial Perspective by R. Narayanaswamy, PHI. 8. Introduction to Accounting by J.R. Edwards, and Marriot, Sage Publication. 9. Cost Accounting by Jawahar Lal, Tata McGraw Hill. 10. Project Planning Analysis, Selection, Implementation and Review by Prasanna Chandra, Tata McGraw Hill.		

Course Name: **Microprocessor & Peripheral Device**
Course Code: **PH-421**
Course Type: Core

Contact Hours/Week: 3L | Course Credits: **03**

Course Objectives

- An ability to understand Microprocessor & Peripheral Device.
- An understanding of concepts of computers.
- A knowledge of operating system.

Unit Number	Course Content	Contact Hours
UNIT-1	Introduction to Microprocessors. The 8085 Architecture, Bus organization, Registers, Memory, I/O devices. Control signals, Machine cycles and Bus timings. Memory	8L
UNIT-2	Interfacing: Memory Read cycle, Address decoding, Interfacing the 8155 memory section. I/O Interfacing: I/O Instructions and executions, Device selection, Interfacing with input and output devices. Memory mapped I/O. 8085	7L
UNIT-3	Instructions and Assembly Language: Arithmetic operations, Logic operations, Branch operations. Controls and time delays.Flowchart and Programming techniques, Stack and Subroutines, Restart, Conditional Call, and Return instructions. Nesting. Code Conversions: BCD-Binary, BCD-seven segment LED, Binary-ASCII. BCD Arithmetic and 16-bit data operations.	7L
UNIT-4	Operating System: Assembler and programming using an Assembler. Interrupts: Instructions, Restart, Trap. Programmable interrupt controller 8259A.	7L
UNIT-5	Interfacing: with D/A and A/D converter. Interfacing I/O ports using 8155. The 8279 keyboard/display interfacing. The 8255 programmable peripheral interface. Serial I/O and Data communication. Microprocessor applications.	7L

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Describe the Microprocessor & Peripheral Device.
CO2: Identify the applications of Microprocessor & Peripheral Device.
CO3: Learn and to apply concepts learnt about Microprocessor & Peripheral Device.

Books and References

1. R. S. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085 , 5th Ed., Penram International/ Prentice Hall, 1999.
2. N. K. Srinath, 8085 Microprocessor Programming and Interfacing, Prentice Hall of India, 2005.
3. D. V. Hall, Microprocessors and Interfacing, Tata McGraw-Hill, 1995.
4. W. Kleitz, Microprocessor and Microcontroller Fundamentals: the 8085 and 8051 Hardware and Software, Prentice Hall, 1997
5. J. Uffenbeck, Microcomputers and Microprocessors: the 8080, 8085, and Z80 Programming, Interfacing, and Troubleshooting, Prentice Hall, 1999.

Course Name: **Laser Metrology**
Course Code: **PH-430**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- An ability to understand the importance of lasers in metrology.
- An understanding of the metrology.
- A knowledge of concepts / laser technologies used in metrology.

Unit Number	Course Content	Lectures
UNIT-1	**Introduction to metrology:** Definition, types, need of inspection, terminologies, methods of measurement, selection of instruments, measurement errors, units, Measurement standards, calibration, statistical concepts in metrology.	10L
UNIT-2	**Linear metrology:** Steel rule, calipers, vernier caliper, vernier height gauge, Vernier depth gauge, micrometers, universal caliper.	9L
UNIT-3	**Advanced measuring machines**: CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares, Nano technology instrumentation, stage position metrology, testing and certification services,	8L
UNIT-4	**Optical system design**: lens design, coating design, precision lens assembly techniques, complex opto-mechanical assemblies, contact bonding and other joining technologies.	9L

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the metrology techniques

CO2: Apply metrology techniques.

CO3: Learn to use metrology techniques.

Books and References

1. Engineering Metrology by K.J. Hume, Macdonald and Co. London.
2. The Metrology Handbook by Jay. L. Bucher, American Society for Quality.
3. Industrial Metrology by G.T. Smith, Spinger.
4. Handbook of industrial metrology by John W. Greve, Frank W. Wilson, PHI – New Delhi.
5. Engineering Metrology by D.M. Anthony, Pergamon Press.
6. Dimensional Metrology by M.K. Khare, OXFORD-IBH Publishers.

Course Name: **Applications of Lasers in Technology** Course Code: **PH-431** Course Type: **Professional Elective-I**		
Contact Hours/Week: **3L**		Course Credits: **03**
Course Objectives • An ability to understand lasers. • An understanding of concepts of lasers in technology. • Impart knowledge about applications of laser technology • Knowledge of applications of lasers in materials processing.		
Unit Number	**Course Content**	**Lectures**
UNIT-1	**Materials Interactions:** Laser Operation Mechanism, Properties of Laser Radiation, Laser Materials Interactions, Absorption of Laser Radiation, Thermal Effects associated with Physical Processes during Laser Material Interaction. Lasers in industry	10L
UNIT-2	**Manufacturing:** Laser Casting, Laser Forming/Shaping, Laser Joining Laser Welding, Laser Marking, Laser Cutting, Laser Drilling, Machining Laser Surface Alloying, Laser Cladding Laser Additive Manufacturing	10L
UNIT-3	**Classification and Processing Philosophy**: Compositional and Microstructural Effects during Surface Modification Innovative	8L
UNIT-4	**Applications of Laser:** Applications of Laser in processes of Manufacturing Design and optimize laser based manufacturing process for potential application	8L
Course Outcomes Upon successful completion of the course, the students will be able to CO1: Describe the optical devices like lasers and their applications. CO2: Know the applications of lasers. CO3: Understand the conceptsof laser technology. CO4: Realize the utility of laser in the industry.		
Books and References 1. Optical Electronics by A. Ghatak and K. Thyagarajan, Cambridge University Press. 2. Photonics by A. Yariv and P. Yeh, Oxford University Press. 3. Principles of Lasers by O. Svelto and D.C. Hanna, Springer.		

Course Name: **Optical Fiber Communication**
Course Code: **PH-432**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- An ability to understand an optical communication system.
- An understanding of concepts of optical communication.
- The broad education necessary to provide knowledge about optical communication.
- A knowledge of concepts / technologies of optics.

Unit Number	Course Content	Lectures
UNIT-1	**Introduction:** Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, Step Index Fiber, concept of TE, TM, hybrid and LP modes. Dispersion- concept of dispersion in fibers, intramodal, intermodal and overall dispersion, attenuation in fiber	8L
UNIT-2	**Fibers materials and fabrication:** Fiber materials, fabrication techniques, fiber optic cables specialty fibers.	7L
UNIT-3	**Optical sources:** Basic principles of LEDs and LDs, modulation characteristics and drive circuits	7L
UNIT-4	**Fibre joints:** Fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers.	7L
UNIT-5	**Optical detectors:** p-n, p-i-n, APD type detectors, principle of operation and performance characteristics, receiver performance, Optical amplifiers, Coherent Optical Communication and WDM Techniques, Radio over fiber links.	7L

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Understand principles of the optical devices and their applications.
CO2: Identify the applications of optical fiber communication.
CO3: Write down the concepts related to optical communication.
CO4: Learn to use optical communication techniques and idea of optical fiber communication.

Books and References

1. Optical Fiber Communications: Principles and Practice by Edition by S. John , Pearson Education.
2. Handbook of Fiber Optic Data Communication: A Practical Guide to Optical Networking by De-Cusatis Casimer**,** Academic Press.

Course Name: **Meta Materials**
Course Code: **PH-450**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- An ability to understand metamaerials.
- An understanding of concepts of electrodynamics used in science of metamaterials.
- The broad education necessary to understand potential uses of metamaterials.

Unit Number	Course Content	Lectures
UNIT-1	**Wave propagation:** Wave propagation in isotropic and anisotropic media, Basics of photonic Band gap materials, Types of Photonic Band Gap Materials. Fabrication techniques of PBG materials Analysis of Photonic band gap materials transfer matrix, plane wave expansion method.	8L
UNIT-2	**Photonic band materials:** Optical properties and Band structure of 1D, 2D & 3D Photonic Band Gap Materials. Optical properties and Band structure of PBG materials with Defects.	7L
UNIT-3	**Applications**: Communication and sensors, Fundamentals of Metamaterials, Optical Properties of Metal-Dielectric Composites.	7L
UNIT-4	**Fabrication of Metamaterials:** Two-Dimensional Optical Metamaterials, Negative-Index materials, left handed materials and Metamaterials.	7L
UNIT-5	**Nonlinear optics:** Nonlinear Optics in Metamaterials, Super Resolution with Meta-Lenses. Other applications of metamaterials.	7L

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Describe the metamaterials.
CO2: Identify the applications of metamaterials.
CO3: Write down the concepts of metamaterials.
CO4: Learn the uses metamaterials.

Books and References

1. Photonics by Yariv Amnon and Yeh Pochi, Oxford University Press.
2. Wave propagation from electron to photonic crystals and metamaterials by P. Markos and C.M. Soukoulis, Princeton University Press.
3. Photonic crystal: Modeling the flow of light by J.D. Jonapolous, Princeton University Press.

Course Name: **Solar Photovoltaic** Course Code: **PH-451** Course Type: **Professional Elective-II**		
Contact Hours/Week: 3L		Course Credits: **03**
Course Objectives • An ability to understand a energy requirements and photovoltaics. • An understanding of concepts of solar photovoltaics. • The broad education to understand solar harvesting of energy through photovoltaics.		
Unit Number	**Course Content**	**Lectures**
UNIT-1	**Energy and Role of Photovoltaic**: World Energy Requirement, renewable Energy Sources, Photovoltaic in Energy Supply, Solar PV production, Fundamentals of solar cell: Semiconductors as basic solar cell material, materials and properties, P – N junction and solar cell, Sources of losses and prevention	**8L**
UNIT-2	**Solar Cell technologies Crystalline Cells**: Mono- crystalline and poly – crystalline cells, Metallurgical Grade Si, Electronic Grade Si, wafer production, Mono – crystalline Si Ingots, Poly – crystalline Si Ingots, Si – wafers, Si – sheets, Solar grade Silicon, Si usage in solar PV, Commercial Si solar cells, process flow of commercial Si cell technology, process in solar cell technologies, Sawing and surface texturing, diffusion process, thin film layers, Metal contact Thin Film Cells: Advantage of thin film, thin film deposition techniques, Evaporation, Sputtering, LPCVD and APCVD, Plasma Enhanced, Hot Wire CVD, closed space sublimation, Ion Assisted Deposition. Common Features: Substrate and Super-state configuration, Thin film module manufacturing, Amorphous Si Solar cell technology, Cadmium Telluride Cell Technology, CIGS solar Cell.	**10L**
UNIT-3	**Concentrators & PV Modules:** Concentration: Advantages & disadvantages, Series Resistance optimization, Concentrating techniques; tracking / non-tracking systems, Cooling requirements, High concentration solar cells.	**8L**
UNIT-4	**Solar PV modules:** Series and Parallel connections, Mismatch between cell and module, Design and structure, PV module power output. Electrical Storage: Battery technology, Batteries for PV systems, DC – DC converters, Charge Controllers, DC – AC inverters; single phase, three phase. Photovoltaic System configuration, standalone system with DC / AC load with and without battery.	**10L**
Course Outcomes Upon successful completion of the course, the students will be able to CO1: Understand the working of solar cells. CO2: Identify the applications of solar cells CO3: Learn and to use solar cells for innovative applications		
Books and References 1. Handbook of Photovoltaic Science and Engineering by Eds. A. Luque and D.S. Hegedus, Wiley. 2. The Physics of Solar Cells by Jenny Nelson, Imperial College Press. 3. Thin Films Solar Cells by K.L. Chopra, McGraw Hill. 4. Solar Energy by Sukhatme, McGraw Hill Education.		

Course Name: **Renewable Energy and Storage Devices**
Course Code: **PH-452**
Course Type: **Professional Elective-II**

Contact Hours/Week: 3L — Course Credits: **03**

Course Objectives

- An ability to understand about renewable energy and energy storage.
- An understanding of concepts of energy storage devices.
- The broad education necessary to understand energy demands and energy storage.

Unit Number	Course Content	Lectures
UNIT-1	**The Present world energy scenario:** renewable Energy Sources, Solar energy, Solar radiation, Solar Thermal Applications, Flat Plate collector, Solar air heater, Solar concentrator.	**7L**
UNIT-2	**Energy storage:** Photovoltaics and its applications, Solar cells, Module, panel and Array constructions. Wind energy, Bio-mass and Bio-gas energy, Geothermal energy, Ocean energy, Hydro resources.	**7L**
UNIT-3	**Emerging technologies:** fuel cells, hydrogen energy. Non-conventional technologies; Magnetohydrodynamics, thermoelectric power conversion, thermionic power conversion.	**7L**
UNIT-4	**Solar Cell technologies Crystalline Cells:** Mono-crystalline and poly– crystalline cells, Metallurgical Grade Si, Electronic Grade Si, wafer production, Mono–crystalline Si Ingots, Poly–crystalline Si Ingots, Si–wafers, Si–sheets, Solar grade Silicon, Si usage in solar PV, Commercial Si solar cells, process flow of commercial Si-cell technology, process in solar cell technologies, Sawing and surface texturing, diffusion process, thin film layers, Metal contact Thin Film Cells	**8L**
UNIT-5	**Solar PV modules:** Series and Parallel connections, Mismatch between cell and module, Design and structure, PV module power output. Balance of Solar PV Systems: Electrical Storage: Battery technology, Batteries for PV systems, DC – DC converters, Charge Controllers, DC – AC inverters; single phase, three phase. Photovoltaic System configuration.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Understand the working of energy storage devices.
CO2: Identify the applications energy storage devices.
CO3: Know the concepts of energy storage devices.

Books and References

1. Non-Conventional Energy Resources by B.H Khan, McGraw Hill Education.
2. Energy for a sustainable world by Jose Goldenberg, Johansson Thomas, A.K.N. Reddy and Robert Williams, Wiley Eastern.
3. Solar Energy by Sukhatme, McGraw Hill Education.
4. Solar Hydrogen Energy Systems by T. Ohta, Pergamon Press.

Course Name: **Quantum Computing** Course Code: **PH-440** Course Type: **Professional Elective-III**		
Contact Hours/Week: 3L		Course Credits: **03**
Course Objectives • An ability to understand a quantum system. • An understanding of concepts of quantum computing. • The broad education necessary to understand quantum computing. • A knowledge of concepts / technologies like quantum computing.		
Unit Number	**Course Content**	**Lectures**
UNIT-1	**Introduction to Quantum Computation:** Quantum bits, Bloch sphere representation of a qubit, multiple qubits.	**8L**
UNIT-2	**Background Mathematics and Physics:** Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.	**7L**
UNIT-3	**Quantum Circuits:** single qubit gates, multiple qubit gates, design of quantum circuits.	**7L**
UNIT-4	**Quantum Information and Cryptography:** Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem.	**7L**
UNIT-5	**Quantum Algorithms:** Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.	**7L**
Course Outcomes: Upon successful completion of the course, the students will be able to CO1: Describe the Optical devices and their applications. CO2: Identify the applications of quantum computing. CO3: Understand the concepts related to quantum computing. CO4: Learn and to understand the use of quantum computing.		
Books and References 1. Quantum Computation and Quantum Information by M. A. Nielsen, Cambridge University Press. 2. Principles of Quantum Computation and Information by G. Benenti, G. Casati and G. Strini, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific. 3. An Introduction to Quantum Computing Algorithms by A. O. Pittenger, Springer.		

Course Name: **Quantum Electronics** Course Code: **PH-441** Course Type: **Professional Elective-III**		
Contact Hours/Week: 3L		Course Credits: **03**
Course Objectives • The goal of this course is to introduce the quantum mechanical concept. • To understand the operation of current nanoelectronics and nanophotonics as well as next generation quantum information processing technologies. • To learn the fundamentals of quantum cryptography.		
Unit Number	**Course Content**	**Lectures**
UNIT-1	Maxwell's Equations of Isotropic Media, Electromagnetic Waves and Interfaces, Mirrors, Interferometers and Thin-Film Structures, Gaussian Beams and Paraxial Wave Equation, Ray Optics and Optical Systems, Optical Resonators	**8L**
UNIT-2	Integrated Optics: Waveguides, Coupled Mode Theory, Optical Fibers, Anisotropic Media: Crystal Optics and Polarization	**7L**
UNIT-3	Quantum Nature of Light and Matter, Schrödinger Equation and Stationary States, Harmonic Oscillator and Hydrogen Atom, Wave Mechanics	**7L**
UNIT-4	Dirac Formalism and Matrix Mechanics, Harmonic Oscillator Revisited, Coherent States, Interaction of Light and Mater the Two-Level Atom: Rabi-Oscillations, Density Matrix, Energy and Phase Relaxation, Rate Equations, Dispersion, Absorption and Gain	**7L**
UNIT-5	Optical Amplifiers and Lasers, Homogenous and inhomogeneous Broadening and Related Effects, Q-Switching and Mode Locking, Electro- and Acousto-Optic Modulation	**7L**
Course Outcomes Upon successful completion of the course, the students will be able to CO1: Students will understand new physical effects. CO2: Understand the operation of current nanoelectronics and nanophotonics. CO3: Learn quantum teleportation for processing quantum information. CO4: Understand basic principles of quantum cryptography.		
Books and References 1. Quantum Electronics by A. Yariv, John-Willey. 2. Optical Electronics by A. K. Ghatak, Cambridge University Press. 3. Laser Fundamentals by T. Silfvast William, Cambridge University Press.		

Course Name: **Thin Film Technology** Course Code: **PH-442** Course Type: **Professional Elective-III**
Contact Hours/Week: 3L Course Credits: **03**
Course Objectives • An ability to understand a physics of thin films. • An understanding of concepts of material in thin film form. • The broad education necessary to understand the use of thin film devices. • A knowledge of concepts / technologies based on thin film techniques.

Unit Number	Course Content	Lectures
UNIT-1	**Vacuum generation:** Basic terms and concepts; Continuum and Kinetic gas theory, Pressure ranges, Types of flow; Conductance. Vacuum pumps – a survey, Principle of operation, Diaphragm pump, Rotary pump, Diffusion Pump, Turbomolecular Pump (TMP), Sputter-ion pumps, Cryogenic Pump.	**8L**
UNIT-2	**Vacuum gauges:** Thermal conductivity vacuum gauges, Ionization vacuum gauges. Analysis of gas at low pressures: Residual gas analyzers, Quadrupole mass spectrometer. Leaks and their detection.	**7L**
UNIT-3	**Thin Film Fabrication:** Nucleation and Growth: Film formation and structure; Thermodynamics of nucleation, Nucleation theories, Capillarity model – homogeneous and heterogeneous nucleations, Atomistic model – Walton-Rhodin theory; Post-nucleation growth; Deposition parameters; Epitaxy; Thin film structure, Structural defects and their incorporation.	**7L**
UNIT-4	**Preparation methods:** Electrochemical Deposition (ECD), Spin coating, Physical Vapor Deposition (PVD)- thermal evaporation, electron beam evaporation, rf-sputtering, Pulsed Laser deposition (PLD), Chemical Vapor Deposition (CVD), Plasma-Enhanced CVD, Atomic Layer Deposition (ALD), Molecular Beam Epitaxy (MBE).	**7L**
UNIT-5	**Thickness measurement and monitoring:** Electrical, mechanical, optical interference, microbalance, quartz crystal methods.	**7L**

Course Outcomes: Upon successful completion of the course, the students will be able to
CO1: Describe the devices based on thin films.
CO2: Identify the applications of thin films.
CO3: Understand the concepts related to thin film properties.
CO4: Learn the formation and growth of thin films.

Books and References

1. Optical Coherence and Quantum Optics by L. Mandel and E. Wolf, Cambridge University Press.
2. Quantum Statistical Properties of Radiation by W. H. Louisell, Wiley.
3. The Quantum Theory of Light by R. Loudon, Oxford University Press.
4. Quantum electronics by A. Yariy, Wiley.
5. Radiation and Noise in quantum Electronics by W. H. Louisell, McGraw-Hill.
6. Quantum Optics by M. O. Scully, and M. S. Zubairy, Cambridge University Press.

Course Name: **Functional Nanomaterials**
Course Code: **PH-460**
Course Type: **Professional elective-IV**

Contact Hours/Week: 3L   Course Credits: **03**

Course Objectives

- An ability to understand nanomaterials.
- An understanding of concepts of functional materials.
- The broad education necessary to understand properties of materials.
- A knowledge of concepts / technologies based on material use.

Unit Number	Course Content	Lectures
UNIT-1	Synthesis, properties and applications of organic, inorganic, hybrid nanomaterials	**8L**
UNIT-2	core-shells, nanoshells, self-assembled nanostructures, superlattices, nanoceramics metallic, polymeric and ceramic nanocomposites, nanoporous materials, nanofluids, nanolayers and carbon based nano materials	**7L**
UNIT-3	Occurrence, production, purification, properties and applications of fullerene, carbon nanotube, graphene, carbon onion, nanodiamond and films, Biomimetic nanomaterials	**7L**
UNIT-4	Introduction to biomimetics, mimicking mechanisms found in nature, synthesis and applications of bioinspired nanomaterials and self-assemblies Applications of nanomaterials-	**7L**
UNIT-5	Application of nanomaterials in healthcare, biosenors, coatings environment, catalysis, agriculture, automotives, sensors, electronics, photonics, information technology, quantum computing, energy and aerospace sectors.	**7L**

Course Outcomes: Upon successful completion of the course, the students will be able to
CO1: learn the application of functional materials.
CO2: identify the properties of functional materials.
CO3: understand to apply the use of materials in the Industry.

Books and References

1. Nanoscale Materials in Chemistry by K. J. Klabunde, and R.M. Richards, John Wiley & Sons.
2. Nano: The Essentials by T. Pradeep, McGraw-Hill..
3. Handbook of Nanotechnology by Bharat Bhushan, Springer.
4. Nanostructured Materials: Processing Properties and Applications by C. Koch Carl, William Andrew Inc..
5. Carbon Materials and Nanotechnology by Anke, Krueger, Wiley-VCH Verlag GmbH & Co. KGaA.

Course Name: **Low Dimensional Physics** Course Code: **PH-461** Course Type: **Professional Elective-IV**		
Contact Hours/Week: 3L		Course Credits: **03**
Course Objectives • An ability to understand low dimension system. • An understanding of concepts of low dimension system. • The broad education necessary to understand the physics of low dimensional system. • A knowledge of complex systems.		
Unit Number	**Course Content**	**Lectures**
UNIT-1	Experimental techniques for characterization of low dimensional materials: Scanning probe microscopy, SEM, TEM, XRD, and light scattering experiments; different methods of preparation of nanomaterials. Top down: UV and electron beam lithography, Ball milling; Bottom up:	**8L**
UNIT-2	Atom manipulation by SPM, Dip pen nanolithography, Microcontact printing; Cluster beam evaporation, Ion beam deposition, chemical bath deposition, Self assembled mono layers.	**7L**
UNIT-3	Ballistic transport, density of states for 1d system; quantized conductance, Landauer formula, conductance behavior of quantum point contact; Landauer Buttiker formula for multileads. Coulomb blockade, Coulomb diamond, single electron transistor (SET), molecular electronics.	**7L**
UNIT-4	Magnetic field effect on low dimensional materials, The Aharonov–Bohm effect, The Shubnikov–de Haas Effect, Quantum Hall effect.	**7L**
UNIT-5	Special carbon solids, fullerenes and tubules, formation and characterization of fullerenes and tubules, single wall and multiwall carbon tubules; Electronic properties of tubules; Carbon nanotubule based electronic devices. Graphene.	**7L**
Course Outcomes: Upon successful completion of the course, the students will be able to CO1: Describe the low dimension system. CO2: Identify the applications of low dimension system. CO3: Write down the concepts related to low dimension system.		
Books and References 1. The Physics of Low-dimensional Semiconductors: An Introduction by J. H. Davies, Cambridge University Press. 2. The textbook of Nanoscience and Nanotechnology by T. Pradeep, Tata McGraw Hill. 3. Materials Characterization by Leng Yang, Wiley-VCH.		

Course Name: **Condensed Matter Physics** Course Code: **PH-462** Course Type: **Professional Elective-IV**		
Contact Hours/Week: **3L**		Course Credits: **03**
Course Objectives • An ability to understand matter. • An understanding of concepts of condensed matter physics. • The broad education necessary to understand condensed matter physics. .		
Unit Number	**Course Content**	**Lectures**
UNIT-1	Structure of solids: Introduction, Common crystal structures,close-packed structure, Zinc blende and Wurtzite structure, Spinel structure; Intensity of scattered X-ray, Friedel's law; Atomic and geometric structure factors; systematic absences; Electron and neutron scattering by crystals.	**8L**
UNIT-2	Band theory of solids: Introduction, Band structures in Copper, GaAs, Silicon and Graphene; Topology of Fermi-surface; Quantization of orbits in a magnetic field, de Haas-van Alphen effect; Boltzmann transport equation -relaxation time approximation.	**7L**
UNIT-3	Magnetic properties of solids: Absence of magnetism in classical statistics; Origin of the exchange interaction; Direct exchange, superexchange, and double exchange; DM interactions, RKKY interactions, Heisenberg and Ising models; Spin-waves in ferromagnets and antiferromagnets (semi classical and quantum treatment using Holstein Primakoff transformation), spontaneous symmetry breaking in magnetic systems with continuous symmetry, thermodynamics of magnons, mean field theory and critical behaviour for large S models.	**7L**
UNIT-4	Superconductivity: Electron-electron interaction via lattice: Cooper pairs; BCS theory; Type II superconductors— characteristic length; Giavertunnelling; Flux quantisation; a.c. and d.c. Josephson effect.	**7L**
UNIT-5	Disordered systems: Disorder in condensed matter — substitutional, positional and topographical disorder; Short- and long-range order; Atomic correlation function and structural descriptions of glasses and liquids; Anderson model; mobility edge; Minimum Metallic Conductivity. Important topics: Mott transition, Stoners criterion for metallic ferromagnet.	**7L**
Course Outcomes: Upon successful completion of the course, the students will be able to CO1: Describe the matter for different properties. CO2: Identify the applications of different materials. CO3: Write down the concepts related to different properties of the materials. CO4: Learn the idea of superconductivity and importance in advancement of technologies.		
Books and References 1. Solid State Physics by N.W. Ashcroft and N.D. Mermin, Harcourt College Publishers. 2. Fundamentals of Solid State Physics by J.R. Christman, Wiley Edition. 3. Solid State Physics by, A.J. Dekker, Macmillan & Co. Ltd. 4. Introduction to Solid State Physics by C. Kittel, Wiley Edition. 5. Elements of Solid State Physics by J.P. Srivastava, Prentice Hall of India. 6. Solid State and Semiconductor Physics by J.P. McKelvey, Krieger Publishing Campus. 7. Principles of the Theory of Solids by J.M. Ziman, Cambridge University Press. .		

Course Name: **Laser and Photonics**
Course Code**: PH-370**
Course Type: **Open Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- An ability to understand a Laser system
- An understanding of concepts of photonics.
- The broad education necessary to understand Laser and photonic systems
- A knowledge of concepts / technologies based on lasers

Unit Number	Course Content	Lectures
UNIT-1	Laser Physics: The Einstein coefficients, light amplification, the threshold condition, laser rate equations, line broadening mechanisms, cavity modes, optical resonator, quality factor, mode selection, Q-switching, mode locking in lasers; gas lasers, solid state lasers, semiconductor lasers and dye lasers.	**8L**
UNIT-2	Photonics: optical properties of anisotropic media, wave refractive index, optical activity and Faraday effect, liquid crystals;	**7L**
UNIT-3	Principles of electro-optics, magneto-optics, photo refractive materials, acousto-optics and related devices;	**7L**
UNIT-4	Nonlinear optical susceptibilities, second harmonic generation, self-focussing and Kerr effect; basic principles and applications of holography;	**7L**
UNIT-5	Step index and graded index optical fibers, attenuation and dispersion; fiber optic communications; optical detectors.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the Optical devices and their applications.

CO2: Identify the applications of lasers.

CO3: Write down the concepts related to lasers and photonics.

CO4: Learn to apply concepts learnt in lasers and photonics.

CO5: Learn the importance in the advancement of technologies.

Books and References

1. Laser Fundamentals by W. T. Silfvast, Cambridge University Press.
2. Fundamentals of Photonics by B.E.A. Saleh and M.C. Teich, Wiley.
3. Photonics by A. Yariv and P. Yeh, Oxford University Press.
4. Principles of Lasers by O. Svelto and D.C. Hanna, Springer.

Course Name: **Physics of Semiconductor Devices**
Course Code: **PH-371**
Course Type: **Open Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- An ability to understand the principles of semiconductors
- An understanding of concepts of semiconductor devices.
- The broad education necessary to understand semiconductor devices
- A knowledge of concepts / technologies based on semiconductor devices

Unit Number	Course Content	Lectures
UNIT-1	Idea of atomic structure, crystalline structure, Bonding in semiconductors, crystal structure of semiconductors, Miller indices, crystal structure, Semiconductor materials, Elemental and compound semiconductors, Band model of semiconductors, Carrier concentration in energy bands, Fermi level and energy distribution of carriers inside band, extrinsic semiconductors, concept of effective mass, heavily doped semiconductors	**8L**
UNIT-2	Doping mechanism, ion implantation, doping by diffusion, Fick's law of diffusion, diffusion profiles, diffusion constant and diffusion length	**7L**
UNIT-3	Drift and diffusion of charge carriers in semiconductors, Variation of mobility with temperature and doping level, conductivity, Hall effect, Einsteins relations, Temperature dependence of carrier concentration and resistivity in semiconductors,	**7L**
UNIT-4	P-n junction formation, constancy of Fermi level across junction, abrupt junctions, graded junctions and diffused junctions, current conduction across p-n junction, temperature dependence of I-V characteristic of junction, breakdown in p-n junctions.	**7L**
UNIT-5	deposition techniques, etching and ion milling, sputtering, thermal evaporation, electron beam evaporation, flash evaporation, laser ablation, chemical vapour deposition (CVD), molecular beam epitaxy (MBE), metal oxide chemical vapour deposition (MOCVD).	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the concepts of semiconductor devices.

CO2: Identify the applications of semiconductor devices.

CO3: Write down the concepts related to semiconductor devices.

CO4: Learn and to apply concepts learnt in semiconductor devices in Industry and in real life.

Books and References

1.Introduction to Semiconductor Materials and Devices by M.S.Tyagi, John Wiley & Sons.

2.Physics of Semiconductor Devices by S. M. Sze, Wiley Eastern Limited.

3.The Science and Engineering or Microelectronics fabrication by Stephen A.Campbell, Oxford University Press.

4. Electronic Materials Science by W. Mayer James and S. S. Lau, Macmillan publishing Co..

5. Semiconductor Devices An Introduction by Jasprit Singh, McGraw Hill.

Course Name: **Nuclear Technology**
Course Code:**PH-380**
Course Type: **Open Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- An ability to learn nuclear technology
- An understanding of concepts of nuclear science and engineering .
- To impart education necessary to understand nuclear science and engineering
- To make students understand the use of nuclear technologies.

Unit Number	**Course Content**	**Lectures**
UNIT-1	Review of nuclear physics: general nuclear properties, models of nuclear structure, nuclear reactions,nuclear decays and fundamental interactions; Nuclear radiation: radioactivity, radiation dosimetry, dosimetry units and measurement; radiation protection and control; applications of radiation: medical applications, industrial radiography, neutron activation analysis, instrument sterilization, nuclear dating;	**8L**
UNIT-2	Nuclear fission: nuclear energy, fission products, fissile materials, chain reactions, moderators neutron thermalization, reactor physics, criticality & design; nuclear power engineering; energy transport and conversion in reactor systems, nuclear reactor safety;	**7L**
UNIT-3	Nuclear fusion: controlled fusion, nuclear fusion reactions, fusion reactor concepts, magnetic confinement, tokamak, inertial confinement by lasers;	**7L**
UNIT-4	Nuclear waste management: components and material flow sheets for nuclear fuel cycle, waste characteristics, sources of radioactive wastes, compositions, radioactivity and heat generation waste treatment and disposal technologies; safety assessment of waste disposal;	**7L**
UNIT-5	Particle accelerators and detectors: interactions of charged particles, gamma rays and neutrons with matter, electrostatic accelerators, cyclotron, synchrotron, linear accelerators, colliding beam accelerators, gas-filler counters, scintillation detectors, and semiconductor based particle detectors.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Understand nuclear technologies.
CO2: Identify the applications of nuclear techniques.
CO3: Use the concepts of nuclear technologies in useful applications.

Books and References

1. Introductory Nuclear Physics by K. S. Krane, John Wiley.
2. Nuclear and Particle Physics by R. J. Blin-Stoyle, Springer.
3. Nuclear Energy by R. L. Murray, Butterworth-Heinemann.
4. Nuclear Reactor Analysis by J. J. Duderstadt and L. J. Hamilton, Wiley.
5. Introduction to Nuclear Engineering by J. R. Lamarsh and A. J. Baratta, Prentice Hall.

Course Name: **Microwave Physics** Course Code: **PH-381** Course Type: **Open Elective-II**		
Contact Hours/Week: **3L**		Course Credits: **03**
Course Objectives • An ability to learn microwave physics • An understanding of concepts microwave devices. • The broad education necessary to understand microwave technology		
Unit Number	**Course Content**	**Lectures**
UNIT-01	Introduction to Microwaves: History of Microwaves, Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC.Mathematical Model of Microwave Transmission: Concept of Mode, Features of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission.	**8L**
UNIT-02	Analysis of RF and Microwave Transmission Lines: Coaxial line, Rectangular waveguide, Circular waveguide, Strip line, Micro strip line. Microwave Network Analysis: Equivalent voltages and currents for non- TEM lines, Network parameters for microwave circuits, Scattering Parameters.	**7L**
UNIT-03	Passive and Active Microwave Devices: Microwave passive components, Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator, Microwave active components, Diodes, Transistors, Oscillators, Mixers. Microwave Semiconductor Devices, Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes, Klystron, TWT, Magnetron.	**7L**
UNIT-04	Microwave Design Principles: Impedance transformation, Impedance Matching,Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design.	**7L**
UNIT-05	Microwave Measurements: Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal.	**7L**
Course Outcomes Upon successful completion of the course, the students will be able to CO1: Describe the microwave devices and their applications. CO2: Identify the applications of microwaves CO3: Write down the concepts related to microwaves. CO4: Learn and to apply concepts learnt in microwaves.		
Books and References 1. Introduction to Electromagnetic Compatibility by C. Paul, John Wiley & Sons. 2. Electronic Communications Systems by G. Kennedy, McGraw-Hill. 3. Noise Reduction Techniques in Electronic Systems by H. W. Ott, John Wiley & Sons.		