### PONDICHERRY UNIVERSITY

**Department of Physics – Integrated M.Sc (Physics) Program**

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1. Young’s modulus – Cantilever
2. Young’s modulus – Non-uniform bending
3. Young’s modulus – Uniform bending
4. Young’s modulus – Single Optic lever
5. Study of damping of a bar pendulum under various kinds of damping mechanisms.
7. Study of torsion of a wire; dependence on radius, length, torque and material (static method)
8. Study of torsion of a wire or fiber; dynamic method
9. Study of flow of liquids through capillaries; laminar and turbulent flow stages, capillaries.
10. Study of surface tension of a liquid by three different methods.
11. Comparison of Viscosities
12. Simple Pendulum
13. Viscosity of Liquid (\( \eta \))
14. Moment of Inertia - Fly Wheel

**Text Books**

2. B. Saraf et.al., Physics through experiments, (Vikas publishing house)
UNIT – I: Motion in 1D and 2D 8 hours

UNIT – II: Central forces 8 hours

UNIT – III: Particles under Friction 5 hours
Basic concepts – Static friction – Kinetic friction – Climbing on ladder – Banking of curves – Application of Newton's laws – Analytical problems solving.

UNIT – IV: Systems of Particles 10 hours
Basic concepts – Concept of center of mass – Calculation of center of mass of certain geometrical objects like an arc of a circle, rectangle, triangle, solid hemisphere, solid cone and similar simple objects – Conservation laws for a system of particles – Variable mass problems – Analytical problems solving.

UNIT – V: Mechanics of Rigid bodies 10 hours
Definition of moment of inertia – Calculation of moment of inertia of simple objects like a triangle about different axes, a cone and similar objects – Angular momentum of a rigid body – Observables in terms of moment of inertia – Ballistic pendulum – Definition of pure rolling – Problems involving rolling down of simple objects – Analytical problems solving.

UNIT – VI: Collisions 8 hours

Textbooks

Supplementary Reading
1. Thermal conduction in poor conductor; temperature distribution using thermocouples in cases of linear
genera or sheets), cylindrical geometry, spherical geometry.
2. Study of different thermocouples for temperature measurements
3. Young’s modulus – Koening’s method (Non-uniform bending)
4. Studying the fall of solids through liquid.
5. Joules Calorimeter
6. Latent Heat of fusion of Ice method of mixture
7. Specific heat of bad conductor method of mixture
8. Specific heat of Liquid method of mixture
9. Young’s modulus – Uniform bending using a Single optic lever
10. Rigidity modulus-Static torsion method
11. Study of the impedance of an inductor at varying frequencies to measure R and L
12. Study of the impedance of a capacitor at varying frequencies to measure C
13. Response curve for LCR circuits series resonances
14. Using an AC bridge to measure L or C
15. Potentiometer for precision measurement of thermo-emf or low resistance

Text Books
1. D.P. Khandelwal, A laboratory Manual of Physics for Undergraduate Classes, (Vani Publishing House,
   New Delhi)
2. B. Saraf el.al., Physics through experiments, (Vikas publishing house)
UNIT – I:  10 hours

UNIT – II:  10 hours

UNIT – III:  12 hours

UNIT – IV:  13 hours

UNIT – V:  13 hours

Textbooks

Supplementary Reading
1. Study of a harmonic oscillation and its relaxation; rigid pendulum or torsional oscillations
2. Oscillations on a bifilar suspension
3. Study of transverse wave speed on a string; dependence on density and tension (sonometer)
5. Melde’s experiment using metallic string.
6. Study of magnetic field using a vibration magnetometer
9. Analyzing a given wave-form for its harmonic components; (a computer may be used)
10. Study of characteristics of ballistic galvanometer
11. Study of magnetic field using a vibration magnetometer
12. Study of the rise and decay of current in RC circuit
13. Study of the rise and decay of current RL circuits

Text Books
2. B. Saraf et.al., Physics through experiments, (Vikas publishing house)
Unit I: Simple Harmonic Motion 10 hours

Unit II: Transverse and Longitudinal Waves 12 hours

Unit III: Waves in more than one dimension 12 hours
Plane wave representation in two and three dimensions – Wave equation in two dimensions – Solution by method of separation of variables – Introduction to normal modes in two dimensional case – Reflection and transmission of a three-dimensional wave at a plane boundary – Example of total internal reflection and evanescent waves.

Unit IV: Continuous Media 20 hours

Textbooks

Supplementary reading
UNIT – I: Electrostatics 11 hours
Review of vector calculus – Divergence, Curl and Gradient operators – Vector identities – Coulomb’s law – Electric flux and flux density – Discrete and continuous charge distributions – Electric field due to discrete and continuous charge distributions – Calculation of electric field due to the following: an infinitely long line charge, a sheet of charge, a ring of charge, a charged disk – Electric field due to an electric dipole – Gauss’s law – Applications of Gauss’s law for the following symmetric charge distributions: Point charge, Infinite line charge, Infinite sheet of charge, Uniformly charged sphere (solid and shell) and cylinder – Electric dipole in an electric field – Torque – Motion of point charges in electric fields – Problems solving.

UNIT – II: Work and energy in electrostatics 11 hours
Work and energy in electrostatic systems – Electric potential – Definition of potential difference and potential – Calculating the potential from the field and vice-versa – Potential inside and outside of a spherical shell of charge – Equipotential lines and surfaces – Energy expended in moving a point charge in an electric field – Calculation of electric potential due to a system of discrete charges and continuous charge distributions – Potential gradient – Derivation of energy density in an electrostatic field – Potential energy of an electric dipole in an electric field – Calculation of energy density due to symmetric charge distributions – Problems solving.

UNIT – III: Conductors, Dielectrics and Capacitors 13 hours

UNIT – IV: Magnetic fields 13 hours
Biot-Savart’s law – Motion of charged particles in magnetic fields – Circulating charged particle and helical paths – Magnetic force on a current carrying wire – Torque on a current loop – Magnetic dipole moment of a magnetic dipole – Calculation of magnetic field due the following: a long straight wire, a circular arc of wire – Force between two parallel currents – Non-existence of magnetic monopoles – Ampere’s law – Applications of Ampere’s law to calculate magnetic field due to following symmetric current distributions: a long straight current carrying wire, a solenoid and toroid – Equivalence of current carrying loop and a magnetic dipole – Faraday’s law of induction – Lenz’s law – Induction and energy transfers – Motional e.m.f – Eddy currents – Inductance of a solenoid – Self-induction of a coil – Mutual induction – Energy stored in a magnetic field – Calculation of magnetic energy density – Problems solving.

UNIT – V: Maxwell’s equations 8 hours
Introduction to Maxwell’s equation in vacuum and in material media – Derivation of electromagnetic wave equation from Maxwell’s equations.

Textbook

Supplementary reading
PHYS-240: PHYSICS LABORATORY

(2 CREDITS)

ELECTRONICS
1. Construction of a stabilized power supply (using diode)
2. P-N characteristics (forward & reverse)
3. Zener as a voltage regulator
4. N-P-N, P-N-P characteristics
5. Single stage amplifier (voltage gain)
6. Op-amp characteristics
7. Logic gates (OR, AND, NAND, NOR, Truth table)

OPTICS
1. Determination of Wavelength for first order spectra (using minimum deviation method)
2. Dispersive power of material and linear dispersion in prism spectrum using a graticule in the eyepiece
3. Study of interference fringes in biprism arrangement
4. Use of Newton’s rings to determine the radii of curvature of surface
5. Use of fringes in a wedge film (to compare the thickness of different sheets of paper or tissues or hair or diameter of a wire)
6. Fresnel diffraction at straight edge and a slit
7. Fraunhofer diffraction at a single slit
8. Minimum deviation setting and first order spectrum for two wavelengths

Text Books
2. B. Saraf et.al., Physics through experiments, (Vikas publishing house)
Unit-I: Dual nature
10 hours

Unit-II: Atomic structure
10 hours

Unit-III: Quantum mechanics
12 hours

Unit-IV: Hydrogen atom
12 hours

Unit-V: Atoms and Molecules
12 hours

Textbook

Supplementary reading
UNIT – I: Series-Parallel Networks  10 hours

UNIT – II: Network Theorems  8 hours

UNIT – III: Capacitative, Inductive and Magnetic Circuits  10 hours
Transients in capacitative networks – Time constant – Capacitor networks – Energy relations – Introduction to Magnetic circuit – Reluctance – Series and parallel magnetic circuits – Analogy between electromotive force (e.m.f) and magnetomotive force (m.m.f) – Inductors – resistor-inductor (RL) transients – Time constant – Problems solving.

UNIT – IV: AC circuits  10 hours

UNIT – V: Resonance  10 hours

Textbook

Supplementary reading
PHYS-330: PHYSICS LABORATORY

1. Measurement of Milliken’s method
2. Determination of e/m by Thompson’s method
3. Determination of Plank’s constant
4. Constant deviation prism
5. Obtaining B-H curve for a ferromagnetic sample (any method)
6. Magnetic susceptibility of (say) ferric chloride solution and deducing magnetic moment of the ion
7. Magnetic susceptibility of Solids (Guoy method)
8. Hall probe in magnetic field measurement
9. Magnetic circuits – Determination of magnetic flux of electromagnet

Text Books
2. B. Saraf et.al., Physics through experiments, (Vikas publishing house)
4. Olon; Experiments in Modern physics
UNIT – I: GEOMETRICAL OPTICS
Fermat’s principle: Principle of extreme path: the aplanatic points of a sphere and other applications - General theory of image formation: Cardinal points of an optical system; general relationships, thick lens and lens combinations, telephoto lenses. Aberration in images: chromatic aberrations; achromatic combination of lenses in contact and separated lenses. Monochromatic aberrations and their reduction; aspherical mirrors and Schmidt corrector plates, oil immersion objectives, meniscus lenses. Optical instruments: Entrance and exit pupils, need for a multiple lens eyepiece, common type of eyepieces.

UNIT – II: INTERFERENCE
Interference: The principle of superposition; two-slit interference, coherence requirements for the sources, localized fringes in thin films, transition from fringes of equal thickness to those of equal inclination - Michelson interferometer; its uses for determination of wavelength, wavelength difference and standardization of the meter. Intensity distribution in multiple beam interference; Tolansky fringes, Fabry-Perot interferometer and etalon.

UNIT – III: DIFFRACTION

Textbooks
2. E Hecht “Optics” 3rd Edition Addison Wesley

Reference Books
2. Born and Wolf; “Optics” (Pergamon Press)
4. Jenkins and White; “Fundamental of Optics” (McGraw-Hill)
6. R S Longhurst “Geometrical and Physical Optics” (Longmans, 1966)
Unit I:  Semiconductor Diodes  
Basis of Semiconductor Physics: Semiconductor diodes: p-n junction diode, I-V characteristics, Schockley model, application in rectifiers, clippers and limiters, Zener diode and its applications, optoelectronic diodes: LED, photodiodes, optocouplers.

Unit II:  Transistor Characteristics  
Bipolar junction transistors (BJT): pnp and npn structures; active and saturation regions, characteristics of BJT, common-emitter configuration, input and output characteristics, B-parameter, common-base configuration, output characteristics, Common-collector configuration.

Unit III:  Transistor- low frequencies & Biasing and Stabilization  

Unit IV:  Field Effect Transistor  
Field effect transistor (FET): Classification of various types of FETs, constructional details of junction field-effect transistor, drain characteristics of JFET, biasing of JFET, operating regions, pinch-off voltage, idea of metal-oxide-semiconductor transistor (MOS transistor).

Unit V:  Amplifiers  
Classification of Amplifiers, Distortion in Amplifiers, frequency response of amplifiers: LC and CR response, band with and rise time, amplifier, flat band equivalent circuits with and without input and output loading, cascade connections. Decibel power, gain and loss. Conversion to voltage and current gain.

Unit VI:  Feedback amplifiers & Oscillators  
Classification of Amplifiers, Feedback concept, General characteristics of Negative feedback amplifiers, Oscillators and wave-form generators: Positive feedback, Barkhausen criterion, RC oscillator, Wein Bridge oscillator, Phase shift oscillator, Colpitt’s oscillator, Hartley oscillator.

Text Book  

Supplementary Reading  
Unit I: Special theory of Relativity  

Unit II: Statistical Mechanics  
11 hours

Unit III: Nuclear physics:  
11 hours

Unit IV: Introduction to Particle physics:  
15 hours
Introduction – Properties of elementary particles – Classification and names of elementary particles – Introduction to hadrons and leptons – Introduction to conservation laws in elementary particles – Introduction to fundamental interactions.

Textbook


Supplementary reading

PHYS – 340: PHYSICS LABORATORY
(2 CREDITS)

1. Sensitivity of a cathode ray oscilloscope
2. Study of fall of a magnet through a metallic cylinder
3. Study of plane of polarization using quarter and half wave plates
4. Study of Michelson-Morley experiment using Michelson Interferometer
5. Simulation study of variation of mass with velocity
6. Simulation study of length contraction
7. Study of counting statistics in radioactive emissions
8. Thickness gauging by beta rays
9. Efficiency and dead time of G.M tube
10. Resolution of scintillator counter and its application
11. Computer simulation of Lennard- Jones potential; binding parameters, elastic constants
12. Computer simulation of 1-D and 2-D lattice vibrations
13. Computer simulation of Kronig-Penney model
14. Numerical simulation of wave-functions of simple harmonic oscillator
15. Computation of wave functions and their interpretation for various potentials
16. Computation of transmission coefficients for barriers of different shapes
17. Simulation of wave functions for a particle in critical box

Text Books
2. B. Saraf et.al., Physics through experiments, (Vikas publishing house)
4. Olon; Experiments in Modern physics
UNIT – I: 9 hours

UNIT – II: 10 hours

UNIT – III: 9 hours

UNIT – IV: 10 hours

UNIT – V: Laboratory Exercise Session (1 hour per week) 10 hours
The laboratory exercise involves writing programs in C / C++ / FORTRAN / MATLAB to solve problems of numerical techniques for the topics listed above.

Textbook

Supplementary Reading
UNIT – I 10 hours

UNIT – II 10 hours
Introduction to crystals – Classification of crystal systems – Introduction to Bravais lattice – Calculation of distance between crystal planes – Miller indices – ionic crystals-covalent crystals- Vander wall-Metallcic bonds.

UNIT – III 8 hours

UNIT – IV 10 hours

UNIT – V 10 hours
Material preparation and characterization – Different techniques of growing crystals –Melt growth - Growth of thin films- Characterisation by X-ray and optical methods

Textbooks
1. Material Science and Engineering V. Raghavan, Prentice-Hall
2. Material Science and Engineering, W.D.Callistin, John Wiley Sons
Unit I:
Double refraction and optical rotation: Double refraction in uniaxial crystals, explanation in terms of electromagnetic theory, phase retardation plates. Rotation of plane of polarization, origin of optical rotation in liquids and in crystals.

Unit II:
Introduction to Laser as Coherent Source of light: Purity of a spectral line; coherence length and coherence time, spatial coherence and directionality, estimates of beam intensity. Temporal coherence and spectral energy density.

Unit III
Statistical properties of random light, concept of coherence, interference of partially coherent light. Coherence Time and Line width via Fourier Analysis– Spatial Coherence and Temporal Coherence
Michelson Stellar Interferometer Fourier Transform Spectroscopy
Holography- Introduction Theory Requirements and some applications

Unit IV:
Nonlinear Optics –Introduction Nonlinear Polarization- Various second order and third order Nonlinear Optical process

Text
2. E Hecht “Optics” 3rd Edition (Addison Wesley)
3. F L Pedrotti and L S Pedrotti “Introduction to Optics” (Prentice Hall International)
4. K K Sharma “Optics” (Elsevier)

Reference Books
2. Born and Wolf; “Optics” (Pergamon Press)
4. Jenkins and White; “Fundamental of Optics” (McGraw-Hill)
7. R S Longhurst “Geometrical and Physical Optics” (Longmans,1966)
PHYS-430 Laboratory  [3 credits]

General Experiments
1. Determination of Semiconductor Bandgap
2. Magnetic Susceptibility of Solids
3. Magnetic Susceptibility of Liquids
4. Hall Effect
5. Curie Temperature
6. Geiger Muller Counter
7. Dielectric constant

Opamp Experiments
1. Opamp Characteristics
2. Frequency response of opamp
3. Opamp Configurations
4. Opamp Integrator
5. Opamp Differentiator
6. Opamp – Weinbridge Oscillator
7. Opamp – Comparator
8. Opamp – Multivibrator
9. Opamp – First-order Active Filters
UNIT – I: Linear Algebra
Linear vector spaces – Dual space – Basis sets – Orthogonality and completeness – Hilbert space – Linear operators – Self-adjoint and unitary operators – Families of orthogonal polynomials as basis sets in function space – Rotation group in 2 and 3 dimensions – Pauli matrices – Generators of rotations.

UNIT – II: Vectors and Tensors

UNIT – III: Complex Variables

UNIT – IV: Special Functions

Textbooks

Supplementary Reading
Unit I:

Unit II:

Unit III:

Unit IV:
Special theory of relativity: Inertial frames – Lorentz transformations – length contraction, time dilation and Doppler effect – Minkowski space – Energy momentum four vectors – Introduction to general relativity.

Text Books
1. Classical Mechanics
   H. Goldstein
   Narosa
2. Introduction to Classical Mechanics
   T. G. Takwale & P. S. Purnaik
   Tata McGraw Hill
3. Classical Dynamics
   Donald T. Greenwood
   Prentice Hall
4. Classical Mechanics
   A. K. Raychaudhuri
   Oxford University Press
5. Principles of Mechanics
   Synge and Griffith
   McGraw Hill
6. Classical Mechanics of Particles and Rigid Bodies
   K. G. Gupta
   Wiley Eastern
Unit I: Ensemble and equilibrium
Fundamental concepts of phase space, microstate (semiclassical) Liouville’s theorem- Classical treatment – introduction to the concept of density of states.
Statistical systems and ensembles – ergodicity microstates and macrostates – equilibrium states – microcanonical ensemble- Derivation for equation of state using microcanonical ensemble.

Unit II: Partition function and its application

Unit III: Quantum Statistics

Unit IV: Advanced topics
Phase transitions- First and second order phase transitions- critical point- order parameter- Scaling hypothesis- critical exponents - ferromagnetic phase transition- Ising model- Bragg William approximation- fluctuations in ensembles- One dimensional random walk- power spectrum- electrical noise- Non-equilibrium statistical mechanics- Onsager reciprocity relations, thermo-electric phenomena.

Text Books:
01 Introduction to statistical and thermal Physics  F. Reif  McGraw Hill
02 Statistical Physics (Berkeley series in Physics)  F. Reif  McGraw Hill
03 Molecular Physics  A.N. Matveev  Mir Publications
04 Statistical Mechanics & Properties of Matter  E.S.R. Gopal  Macmillan
05 Statistical Mechanics  Agarwal & Grisner  Wiley Eastern
06 Statistical Physics  F. Mandl  ELBS

Reference:
01 Introduction to Statistical Physics (and solution manual)  D. Chandler  Oxford University Press
02 Lectures on statistical phycs  R.P. Feynman
03 Statistical physics  K. Huang  John Wiley & Sons
04 Statistical physics  Kubo e. al.  Springer Verlag Solid State Science Series
05 Statistical Physics  Landu and Lifshitz  Addison-Wesley
06 Order out of chaos  I. Prigogine  Fontanta paper backs
07 The principles of statistical mechanics  R. C. Tolman  Oxford University Press
Unit I

Unit II

Unit III
Analog circuits: Linear circuits – operational amplifiers – parameters and their importance applications – Summing, difference, inverting, non-inverting, integrating, differentiating amplifiers – Non-linear circuits – absolute rectifiers, Clipping, Clamping circuits, logarithmic amplifiers, Filters, modulation and demodulation circuits, Timers and Phase-locked loop.

Unit IV
Digital circuits: Combinational logic circuits using standard TTL and CMOS LSI chips- gates, latches, multiplexer/demultiplexer, decoder and encoders, Half and full adder, ALU. Sequential logic circuits – Counters – synchronous, asynchronous, binary and decade, divide by N counters, Shift registers – Serial to parallel and vice-versa.

Unit V

Textbooks
1. Unit I & III – Integrated Electronics by Millman & Halkias
2. Unit II (Half Portion) – Physics of Semiconductor devices by Simon M.Sze.
3. Unit II (Another Half on microwave) – Electronic and Radio Engineering by Terman
4. Unit IV – Digital Principles by Malvino & Leach
5. Unit V – Microprocessor Architecture and Programming 8085 by Ramesh S. Gaonker.
UNIT – I: 10 hours

UNIT – II: 10 hours

UNIT – II: 10 hours

UNIT – III: 10 hours

UNIT – IV: Laboratory Exercise Session (1 hour per week) 10 hours
The laboratory exercise involves writing programs in C / C++ / FORTRAN / MATLAB to solve problems of numerical techniques for the topics listed above.

Textbook

Supplementary Reading
UNIT – I: Unix Operating System 12 hours

UNIT – II: Fortran-90 12 hours

UNIT – III: C++ 12 hours

UNIT – IV: Laboratory Exercise Session (1 hour per week) 12 hours
The following exercises have to be done in Fortran 90 or in C++ : Swapping of two numbers – Counting – Factorial Computation – SINE computation – Base Conversion – Factoring Methods – Array Techniques – Display the Pascal Triangle – Generate prime numbers between 1 to N – Generate Fibonacci series up to N number – Concatenating two strings – Reversing the string – Finding the substring of a given string – Summation of a sin, cos and exponential series – Matrix computations – Random number generation.

Textbooks

Supplementary Reading
UNIT – I: Ordinary Differential Equations

UNIT – II: Partial Differential Equations

UNIT – III: Laplace Transforms

UNIT – IV: Fourier Transforms

Textbooks

Supplementary Reading
General Experiments
1. Thickness of Mesh wire using a He-Ne Laser
2. Pitch of the Screw using a He-Ne Laser
3. Michelson Interferometer
4. Zeeman setup
5. Frank-Hertz Experiment
6. Electron spin Resonance
7. Microwave Bench setup
8. Microprocessor

Digital Electronics Experiments
1. Combinational Logic Circuits – Logic Gates
2. Combinational Logic Circuits – Boolean algebra
3. Binary Addition – Half Adder & Full Adder
4. Decoders – 2 bit binary, 2 bit Decoder and 7447 decoder
5. Flip-flops
6. Counters & Registers
7. Decade Counting Unit
Unit I: Quantum theory of spherically symmetric systems (12 Lectures)

Unit II: Symmetry in Quantum Mechanics (12 Lectures)
Symmetries, Conservation laws, and Degeneracies – Discrete symmetries, Parity, or Space Inversion – Lattice translation as a discrete symmetry – Time reversal discrete symmetry.

Unit III: Pictures of Quantum Mechanics (8 Lectures)

Unit IV: Time independent perturbation theory (12 Lectures)

Unit V: Variational Principle and WKB approximation (12 Lectures)

Text Books:

1. Quantum mechanics
   Ghatak & Loganathan
   McMillan
2. Quantum mechanics
   L. I. Schiff
3. Introduction to quantum mechanics
   Dicks and Witke
4. Quantum mechanics
   J. L. Powell and B. Craseman
   Addison-Wesley
5. Quantum mechanics
   V. K. Thankappan
   Wiley-Eastern
6. Quantum mechanics
   Gordon Baym
7. Fenyman lectures on Physics
   Vol. III
   Narosa

Reference:

1. Advanced quantum mechanics
   J. J. Sakurai, Benjamin/Cummings
2. Intermediate quantum mechanics
   H.A. Bethe and R. Jackiw
3. Quantum mechanics
   Benjamin/Cummings
   Merc Backe
4. Quantum mechanics
   Vol. I & II, Messiah
5. Quantum mechanics
   Davy dov.
6. The principles of quantum mechanics
   P.A.M. Dirac
7. Advanced quantum theory
   P. Roman
UNIT – I: Boundary value problems & Special techniques  
Boundary conditions and uniqueness theorems — Conductors and second uniqueness theorem — Boundary value problems with linear dielectrics — Multipole expansion — Origin of coordinates in multipole expansions.

UNIT – II: Magnetostatics and Electrodynamics  
Lorentz force law and Biot-Savart law — Scalar and vector potentials — Multipole expansion of vector potential — Calculation of field of a magnetized object — Amperes law in magnetized materials and Auxiliary field $H$ — Magnetostatic boundary conditions — Faraday’s law and Lenz’s law — Calculation of energy density in magnetic fields — Electrodynamics before Maxwell — Maxwell’s correction of Ampere’s law — Derivation of Maxwell’s equations in vacuum and in matter.

UNIT – III: Electromagnetic waves  

UNIT – IV: Potentials and Radiation  

Textbook

Supplementary Reading
**Unit I:**
Classification of solids – liquids – amorphous glassy states, characteristics and structure.

**Unit II: Crystal structure:**

**Unit III: Crystal Binding:**
Ionic cohesive energy – Covalent – Metallic Vander Waals and hydrogen bonded crystals.

**Unit IV: Lattice Dynamics:**

**Unit V: Free Electron Theory:**

**Unit VI: Semiconductor Theory:**

**Unit VII: Superconductivity:**

**Unit VIII: Electric and Magnetic Properties:**

**Text Books:**
01 Introduction to solid state physics C. Kittel
02 Introduction to solid state physics A. J. Dekker
03 Elementary solid state physics M. Ali Omar
04 Introduction to solids L. V. Azoroff
05 Solid state physics N. W. Aschroft and N. D. Mermin Holt, 1987
Introduction to synergetics – examples from Physics, Chemistry, Biology, Computer Science, Economics, Ecology and Sociology.


**Text Books**

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Synergetics – An Introduction</td>
<td>H. Haken</td>
<td>Springer-Verlag</td>
</tr>
<tr>
<td>02</td>
<td>Advanced Synergetics</td>
<td>H. Haken</td>
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<td>Order out of chaos</td>
<td>Ilya Prigogine</td>
<td>Fontana</td>
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<td>04</td>
<td>Non-Linear Dynamical systems</td>
<td>Peter A. Cook</td>
<td>Prentice-Hall</td>
</tr>
<tr>
<td>05</td>
<td>Introduction to the Physics of Complex Systems</td>
<td>Roberto Serra</td>
<td>Pergamon Press</td>
</tr>
</tbody>
</table>
UNIT – I: Basic concepts 12 hours

UNIT – II: Transducers and Measurement Systems 12 hours

UNIT – III: Signal conditioning and circuits 12 hours

UNIT – IV: Data acquisition and Virtual Instrumentation 12 hours

Textbooks

Supplementary reading
Unit I: Architecture of 8 bit Microprocessor:

Unit II: Assembly Language Programming:

Unit III: Digital Interfacing:

Unit IV: Trends in Microprocessor Technology:

Text Books
1. Microprocessor architecture, programming and applications with 8085/8085A
   Ramesh S. Ganokar
   Wiley Eastern Ltd.
2. Microprocessors and interfacing
   Dauglaus V. Hall
3. Assembly language programming
   Lance A. Leventhal
   Prentice Hall of India Pvt. Ltd.
4. Microprocessors and programmed logic
   Kenneth L. Sherl
   Prentice Hall of India Pvt. Ltd.
5. Microprocessors and microcomputer system
   Guthikonda V. Rao
Condensed Matter

1. Microwave Bench.
2. X-Ray Diffraction.
3. Impedance Spectroscopy.
4. High Filed Magnetic Hysterisis.
5. Superconductivity.
6. Nuclear laboratory.

Electronics

1. Write Subroutines for addition and Multiplication.
2. Use these Subroutines to evaluate given expression.
3. Write Subroutine to generate a given time delay.
4. Use the Subroutine to set up Hexadecimal & Decimal counters.
5. Set up a real time clock.
6. Generate a square wave of given frequency using DAC interface.

Laser-Optics

2. To study the Fraunhoffer diffraction through circular apertures.
3. To demonstrate the transmission of Light through optical fibre and measure its numerical aperture.

Computer

1. Monte Carlo of 2D Ising model on a square lattice.
2. Fast Fourier Transform of a given signal.
### Unit I: Time dependent perturbation theory (15 Lectures)

### Unit II: Semiclassical theory of Radiation (7 Lectures)
Interaction of Light with Matter: Electric dipole Hamiltonian, absorption and stimulated emission, absorption spectroscopy, Raman scattering.

### Unit III: Identical Paricles (12 Lectures)

### Unit IV: Quantum theory of Scattering (12 Lectures)

### Unit V: Relativistic Quantum Mechanics (12 Lectures)

### Text Books:

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<td>01</td>
<td>Quantum mechanics</td>
<td>Ghatak &amp; Loganathan</td>
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<td>Quantum mechanics</td>
<td>Gordon Baym</td>
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<td>07</td>
<td>Feneyman lectures on Physics</td>
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<td>H.A. Bethe and R. Jackiw</td>
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<td>Benjamin/Cummings</td>
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<td>Vol. I &amp; II, Messiah</td>
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<td>P.A.M. Dirac</td>
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<td>Advanced quantum theory</td>
<td>P. Roman</td>
<td></td>
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</table>
Unit I: Basics The Breadth of Spectrum Lines:
Electromagnetic spectrum – Absorption or Emission of radiation – Line width- Natural line broadening- Doppler broadening – Pressure broadening – Removal of line broadening.

Unit II: Spectroscopy of Inner Electrons
a) X-ray Spectra: Emission and absorption spectra of X-rays. Regular and irregular doublet laws – X-ray satellites. (3 hours)
b) Photoelectron spectroscopy Ultraviolet photoelectron spectrometers XPS techniques and Chemical information from photoelectron spectroscopy- Auger electron spectroscopy (3 hours)

Unit III: Molecular Spectroscopy
a) Microwave Spectroscopy: Classification of Molecules -The rotation of Molecule – Rotational spectra of Rigid Diatomic molecule- Isotope Effect in Rotational Spectra- Intensity of Rotational Lines- Non-rigid Rotator- Vibrational Excitation Effect- Linear Polyatomic molecules- Symmetric top molecules- Asymmetric top molecules – Stark effect- Quadrupole Hyperfine interaction – Microwave spectrometer – Information derived from Rotational spectra. (6 hours)

Unit IV: Raman Spectroscopy:

Unit V: Resonance Spectroscopy
c) NQR Spectroscopy: Quadrupole Hamiltonian- Nuclear Quadrupole energy level for axial and non-axial symmetry – Experimental techniques and applications. (5 hours)
d) Mossbauer Spectroscopy: Principles of Mossbauer spectroscopy – Chemical shifts – Quadrupole splitting and Zeeman splitting – applications of Mossbauer spectroscopy – applications. (5 hours)

Unit VI: Laser Spectroscopy: Basic principles: Comparison between conventional light sources and lasers-Saturation-Excitation methods-Detection methods-Laser Wavelength Setting-Doppler Limited Techniques. (5 hours)

Books for Study:
1. Introduction to Atomic Spectra
   H. E. White
2. Spectroscopy Vol. 1 to 3
   B. P. Straughan and S. Walker
3. Raman Spectroscopy
   D. A. Long
4. Microwave Spectroscopy of Gases
   T. M. Sugdan & C. N. Kennay
5. Microwave Spectroscopy
   Tores and Schawlow
   McGraw Hill
6. High Resolution NMR
   Schnoider and Berstin
   McGraw Hill
7. Introduction to ESR
   Assenheim
   Plenum Press
8. Nuclear Quadrupole Resonance Spectroscopy
   T. P. Das and E.E. Hahn
   Academic Press
9. Mossbauer effect and its application to Chemistry
   Goldanskil
   Von Nestrnad
Unit I: Liquid State
Classification of liquids (ionic, molecular and simple) – potential functions – structural determinations – molecular motions in liquids.

Unit II: Equilibrium Structure of Dense Fluids

Unit III: Liquid Solutions

Unit IV: Liquid Crystal
Classification of liquids crystals and phase transitions (nematic, smectic, cholesteric) – Marier-Saupe theory – detection by microscopic techniques – phases of the lyotropic system and their application in Biological systems – thermotropic liquid crystal and its applications.

Unit V: Polymer Physics

References:
1. Introduction to Liquid State Physics
   C. A. Croxton
   John Wiley & Sons, 1975
2. Theory of Simple Liquids
   N. Pierre Hausen and Ion R. McDonald
   Academic Press, 1986
3. Text Book of Polymer Science
   Fred W. Billmeyer
   John Wiley & Sons 1984
4. Polymer Science
   V.R. Gowarikar, N. V. Vishwanath & Jayadev and Sreedhar
   Wiley Eastern Ltd., 1987
5. Liquid Crystals
   S. Chandrasekar
   Academic Press
6. Physical Chemistry
   R. A. Abbery
   John Wiley & Sons
Unit I: Advanced Electronic Devices – (10 lecture hours)
Advanced Electronic Devices: Schottky diodes, MESFET, IGBT, Thyristors, Diac, Triac, Charge-coupled devices – Structure and working, V-I characteristics and applications.

Unit II: Other Electronic Devices (10 lecture hours)
Other Electronic Devices: Electro-optic, magneto-optic, Acousto-optic, Piezo-electric, Electro-strictive, magneto-strictive effects, related material properties for these effects – application in sensor and actuator devices.

Unit III: Programmable devices (16 lecture hours)
Programmable devices: PAL, PLA, PLD, CPLD and FPGA – Structure and working, comparison with standard logic devices and application – Memories – Classification of memories, Static and dynamic shift register ROM, PROM, EPROM – Principle and operations, Read/write memories – SRAM, DRAM, DDRAM – Principle and operations – recent advancement in solid-state memories.

Unit IV: Dataconversion circuits (12 lecture hours)

Text Books
1 Microprocessor architecture, programming and applications with 8085/8085A Ramesh S. Ganokar Wiley Eastern Ltd.
2 Microprocessors and interfacing Dauglaus V. Hall
3 Assembly language programming Lance A. Leventhal Prentice Hall of India Pvt. Ltd.
4 Microprocessors and programmed logic Kenneth L. Sherl Prentice Hall of India Pvt. Ltd.
5 Microprocessors and microcomputer system Guthikonda V. Rao
UNIT : 1 BRIEF REVIEW OF WAVE & PARTICLE NATURE OF LIGHT 10 hours
Maxwell’s equations; Wave equations, Origin of refractive index; Coherence; Quantum theory of Atomic energy levels & selection rules for single electro & multi-electron atoms.

UNIT : 2 RADIATIVE TRANSISTION, PROPERTIES OF MOLECULES, LIQUIDS, SOLIDS 10 hours
Decay of excited states, Emission broadening & line width due to radiative decay, Different broadening mechanism of emission spectra, Radiation laws- cavity radiation, absorption and stimulated emission- Einstein’s A & B Coefficient.

UNIT : 3 INTRODUCTION TO LASERS 10 hours
Condition for producing a laser – population inversion, gain & gain saturation; Saturation intensity, Threshold requirement for a laser, laser oscillation above threshold. Requirements for obtaining population inversion- 2, 3 and 4 level systems; Steady state and transient population process that destroy population Inversion.

UNIT : 4 LASER PUMPING REQUIREMENTS & TECHNIQUES 8 hours
Excitation threshold requirement, pumping pathway, Specific excitation parameters associated with optical & particle pumping.

UNIT : 5 LASER RESONATORS 10 hours

Textbooks
3. Amnon Yariv. Quantum Electronics
Maxwell Equations, Wave Equations in various media and its propagation- (Brief Survey) Origin of Complex Refractive Index -Classical theory of Optical Absorption (Electron Oscillator Model) and Dispersion (Lorentz Oscillator Model). Classical theory of anharmonic oscillators.

Wave equations description of nonlinear optical susceptibilities Quantum mechanical treatment of nonlinear optical susceptibilities, Frequency and intensity dependence of polarization and dielectric susceptibility First order and higher order susceptibilities

**Second order optical nonlinearities**
Second harmonic generation –sum and difference frequency generation, parametric processes- Simple theory and calculation of nonlinear polarization –Various phase matching technique in SHG

**Third order optical nonlinearities**

**Nonlinear optical materials** (Structure property relations and its applications):
Nonlinear Optics of Organics and Polymers, Liquid Crystal, Photorefractive materials, Organic doped glasses, Rare earth doped glasses and crystals, Semiconductors, Optical Fibers and Photonic Crystals Fibers, Ferroelectric Materials and other Novel optical materials

**Text Book and References**
Nonlinear Optics– Robert W Boyd
Nonlinear Photonics-Y Guo, C K Kao, E.H.Li, K. S.Chiang
Principles of Nonlinear Optics- Y R Shen
Nonlinear Optics – N. Bloembergen
Nonlinear Optics of Organic Molecules and Polymers- H S Nalwa and S Miyata
Optical Phase Conjugation-R A Fischer
Quantum Electronics–A Yariv
Handbook of Nonlinear Optics-R Sutherland
Growth and Characterization of Nonlinear Optical Materials – N B Singh
UNIT – I: 18 hours

UNIT – II: 15 hours

UNIT – III: 15 hours

Textbooks

Supplementary reading
Unit – I:
Introduction: Effect of size on material properties, Quantum size effect and density of states, low dimensional systems and their applications. Introduction to microscopy: SEM, STM, AFM, TEM and their application in nanotechnology. (12 hours)

Unit – II:
Ion – Solid interactions: Stopping and range of ions in solids, elastic collisions and kinematics, swift heavy ions, Coulomb explosion and thermal spike models, Nanotrack formation and its applications in nanotechnology. (10 hours)

Unit – III:
Ion beam techniques: RBS, ERDA, NRA and PIXE, Ion channeling, defect analysis, lattice location and lattice strain measurements, Quantum well intermixing and band-gap tuning. (12 hours)

Unit – IV:
Ion beams in nano-technology: Ion irradiation of surfaces, surface roughness, formation of nanopores, hillocks and self assembled nanodots, embedded nanoparticles and their applications in optoelectronics, Focused ion beams, nano-scale fabrication, ion beam milling and nanolithography. (14 hours)

Textbooks:
Unit I: Nuclear Models:

Unit II: Nuclear Forces:

Unit III: Nuclear Decay:

Unit IV: Nuclear Reactions:

Unit V: Elementary Particles:
Classification – symmetries and violations of symmetry – properties and decay models of Baryons, Mesons, Hardons. Tau-Theta Puzzle – stangeness and charm, SU(3) classification – strong interaction – idea of Quarks electro weak and GUT(introductory idea).

Text Books:
1 Nuclear Physics Roy & Nigam Wiley, 1986
2 Nuclear Physics D. C. Tayal Himalaya, 1987
3 The Atomic Nucleus J. M. Reid Manchester University Press, 1984
4 Fundamental Particles B. G. Dutt Taylor Fransis, London, 1986
5 Idea of Particle Physics J. E. Dodd Cambridge University Press, 1984
6 Concept of Modern Physics Beiser McGraw Hill, 1988
7 Modern Physics Mani and Metha Tata McGraw Hill, 1988

References:
2 Nuclear Physics Irving Kaplan Narosa, 1987
4 Theoretical Nuclear Physics Blatt & Weiskosf Wiley, New York, 1952
5 Introduction to Nuclear Physics H. A. Enge Addison Wesley Pub. 1966
6 Elementary Particles I. S. Hughes Cambridge, 1985
7 Elementary Nuclear Theory H. A. Bethe & D. Morrison John Wiley & Sons, New York, 1956
UNIT : 1
SPECIAL LASER CAVITIES & CAVITY EFFECTS
Unstable resonator, Q-switching, Mode locking, Ring laser, Cavities for producing spectral narrowing of laser output, laser cavities requiring small-diameter gain region- astigmatically compensated cavities.

UNIT : 2
SPECIFIC LASER SYSTEM -1

UNIT : 3
SPECIFIC LASER SYSTEM – 2

UNIT : 4
ULTRA SHORT PULSE LASER
Concept of measuring brief intervals of time- Pico seconds & femto second Techniques. Method of generating pulses-optical pulse properties & methods of measurement of pico & femto second pulses.

UNIT : 5
FREQUENCY MULTIPLICATION OF LASER BEAMS

Books
3. Femto second laser pulses Claude Rulliere (Springer Verlag Publications)
4. Ultra short light pulses- Picosecond techniques & applications—S.L. Shapiro
Unit I: Amorphous Materials  
Definitions – preparations of amorphous materials (a) thermal evaporation (b) sputtering (c) melt quenching (d) Gel desiccation (e) solid state diffusional amorphization – Glasses: The glasses transition – theories of glass transition – glass forming systems.

Unit II: Microscopic Structure of Amorphous Materials  

Unit III: Atomic Transport  
Theory of ionic conductivity – ionic conductivity in crystalline solids and amorphous solids – electrode polarization – solid electrolyte and fast ion conductors – criterion for fast ion conductors – frequency dependence transport.

Unit IV: Dielectric Properties of Amorphous Materials  

Unit V: Electronic Properties of Amorphous Materials  

Unit VI: Applications of Amorphous Materials  

Text Books:
2. Chemistry of Glasses A. Paul Chapman and Hall 1990  
Unit I: Materials Preparation and Characterization:
Different techniques of growing crystals – characterization techniques – X-ray diffraction, transmission electron microscope, Auger electron spectroscopy and ESCA.

Unit II:
Structure of the solid phase – structural disorder – imperfections in crystals – point defects – dislocations and grain boundaries.

Unit III:
Phase diagram for one and two components – solid solutions – interstitials and substitutional solid solutions.

Unit IV:

Unit V:

Unit VI:
Type I and type II superconductors – high temperature superconductors – ceramic superconductors – synthesis of \( \text{YBa}_2\text{Cu}_3\text{O}_{7-x} \) compounds and their applications.

References:

01 Introduction to Crystal Growth
P. Harmon
North Holland, 1973

02 Materials Science for Engineers
Van Vlack
Addison Wiley, 1970

03 Materials Science and Engineering
V. Raghavan
Prentice Hall

04 Solid State Phase Transitions
V. Raghavan
Prentice Hall

05 Handbook of Thin Film Technology
Meissel & Glong
McGraw Hill

06 Introduction to Solid State Physics
C. Kittel
Unit I: Signals (5 lectures)
Signals, classification of signals, basic operation on signals, elementary signals, systems, properties of systems, linear time invariant systems and their properties.

Unit II: Fourier Representation (13 lectures)
Fourier representation for four class of signals, discrete – time periodic signals, discrete- time Fourier series, continuous time periodic signals and the Fourier series, discrete time non-periodic signals, and the discrete time Fourier transform, continuous time non periodic signals and the Fourier transform

Unit III: properties of Fourier representation (10 lectures)
Linearity and symmetry property, convolution property, differentiation and integration, time and frequency shift property, Parseval relationship, Time-Bandwidth product, Duality.

Unit IV: sampling (8 lectures)
Sampling continuous time signals, sampling a sinusoid, aliasing, sub-sampling, sampling theorem, ideal reconstruction and practical reconstruction: zero order hold.

Unit V: Communication (6 lectures)
Types of modulation, full amplitude modulation, generation, frequency domain representation of amplitude modulation, spectral overlap and demodulation.

Text Books:
2. Signal processing and linear systems; B.P.Lathi, Oxford University Press Inc.(USA),2003.
4. Signals, systems and signal processing; S.P.Eugene Xavier
UNIT – I: Introduction
Overview of power electronics – Historical development of power electronics – Classification power semiconductor devices – Power diodes – Thyristors – power MOSFETs – IGBTs – Ratings of power semiconductor devices – Symbols and characteristics – Ideal and practical characteristics – Switching specifications – Block diagram of an uninterrupted power supply.

UNIT – II: Power Diodes and Circuits

UNIT – III: Power MOSFET and IGBT

UNIT – IV: The 8051 Microcontroller
Introduction and features of 8086, 8088, 80186, 80286, 80386 and 80486 – Comparison between a microprocessor and microcontroller – Key features and architecture of 8051 microcontroller – Memory organization – SFR – Counter and timers – Assembly language programming of 8051 – Software time delay – Interfacing of microcontroller – Keyboard and stepper motor control.

Textbooks
UNIT – I: 10 hours

UNIT – II: 10 hours

UNIT – III: 10 hours

UNIT – IV: 10 hours

UNIT – V: Laboratory Exercise Session (1 hour per week) 10 hours
The laboratory sessions involve exercise on the following: Creation of files and file handling – Classes with primitive data members – Classes with arrays as data members – Classes with pointers as data members – String Class – Classes with constant data members – Classes with static member functions – Operator Overloading – Function Overloading – Writing code for keyboard and mouse events – Creating Dialog Based applications – Creating SDI and MDI applications.

Textbooks