

**ADIKAVI NANNAYA UNIVERSITY**  
**UNIVERSITY COLLEGE OF SCIENCE & TECHNOLOGY**  
**RAJAMAHENDRAVARAM – 533296**



**DEPARTMENT OF PHYSICS**  
**M.Sc PHYSICS SYLLABUS**

(W.e.f 2019-2020 A.B)

**PROGRAM STRUCTURE -2019-20 AB onwards**


S.No	Course Code	Title	Total Marks	Internal Exam Marks	Sem End Exam Marks	Teaching/ Practical Hours/ week	Credits
<b>SEMESTER I</b>							
1		Classical Mechanics	100	25	75	4+1(T)	4
2		Atomic and molecular physics	100	25	75	4+1(T)	4
3		Mathematical methods of physics	100	25	75	4+1(T)	4
4		Electronic Devices & circuits	100	25	75	4+1(T)	4
5		Electronics Lab- I	100		100	6	4
6		Modern Physics Lab-I	100		100	6	4
<b>SEMESTER II</b>							
7		Statistical Mechanics	100	25	75	4+1(T)	4
8		Electrodynamics	100	25	75	4+1(T)	4
9		Numerical methods & programming with C	100	25	75	4+1(T)	4
10		Nuclear & particle physics	100	25	75	4+1(T)	4
11		Electronics Lab-II	100		100	6	4
12		Modern Physics Lab-II	100		100	6	4
<b>SEMESTER III</b>							
13		Introductory quantum mechanics	100	25	75	4+1(T)	4
14		Solid State Physics	100	25	75	4+1(T)	4
15		Lasers & Non-linear optics	100	25	75	4+1(T)	4
16		Digital Electronics & Microprocessors	100	25	75	4+1(T)	4
17		Digital Electronics Lab	100		100	6	4
18		Solid State Physics Lab	100		100	6	4
<b>SEMESTER IV</b>							
19		Advanced Quantum Mechanics	100	25	75	4+1(T)	4
17		Properties & Characterization of Materials	100	25	75	4+1(T)	4
20		Communication electronics	100	25	75	4+1(T)	4
21		Antenna theory & Radio Wave Propagation	100	25	75	4+1(T)	4
22		Microprocessor Lab	100		100	6	4
23		Communication Electronics Lab	100		100	6	4
T -Tutorial Hour							



**BREAKUP DETAILS OF INTERNAL/LAB/PROJECT**

For Ex: Internal Theory Examination marks be given in the following manner.

- a. Two mid-exams average : 10 Marks
- b. Attendance Marks : 05 Marks
- b. Presentations/Assignments : 05 Marks
- c. Swatchhata Marks : 05 Marks

  
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**Mapping of Courses having focus on Employability/ Skill Development/  
Course Possess Entrepreneurship**

S.No	Course Code	Title	Course Possess Employability	Course Possess Skill Development	Course Possess Entrepreneurship
1		Classical Mechanics	.....	.....	.....
2		Atomic and molecular physics	√	.....	.....
3		Mathematical methods of physics	.....	.....	.....
4		Electronic Devices & circuits	.....	.....	.....
5		Electronics Lab- I	.....	.....	.....
6		Modern Physics Lab-I	.....	.....	.....
7		Statistical Mechanics	.....	.....	.....
8		Electrodynamics	.....	.....	.....
9		Numerical methods & programming with C	.....	.....	.....
10		Nuclear & particle physics	√	.....	.....
11		Electronics Lab-II	.....	.....	.....
12		Modern Physics Lab-II	.....	.....	.....
13		Introductory quantum mechanics	.....	.....	.....
14		Solid State Physics	√	.....	.....
15		Lasers & Non-linear optics	.....	.....	.....
16		Digital Electronics & Microprocessors	.....	.....	.....
17		Digital Electronics Lab	.....	.....	.....
18		Solid State Physics Lab	.....	.....	.....
19		Advanced Quantum Mechanics	.....	.....	.....
17		Properties & Characterization of Materials	√	.....	.....
20		Communication electronics	.....	.....	.....
21		Antenna theory & Radio Wave Propagation	.....	.....	.....
22		Microprocessor Lab	.....	.....	.....
23		Communication Electronics Lab	.....	.....	.....

  
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## **M.Sc PHYSICS**

### **PROGRAM OUTCOME**

Physics as a discipline has existed for three hundred years and has a large 'core' body of knowledge.

At the same time, it provides the base for maximum part of the technology that we take for granted in the 21<sup>st</sup> century, like computers, artificial satellites, mobile phones, TV, microwave oven. Indeed, it will not be an exaggeration to say that modern human life is shaped by technologies that are largely based on the foundation of physics. This aims to attract students with a bachelor's degree into a career in physics. All the courses of the program focus on fundamental and advanced areas of physics. While pursuing programme, students will be able to build a strong foundation in the fundamental principles of physics as well as acquire mastery over specific domain areas. After completion of this programme, they will be well trained to pursue teaching and research careers in academia or industry.

- Understanding the basic concepts of physics particularly, the concepts of classical mechanics, quantum mechanics, statistical mechanics, Atomic and Molecular physics, Solid state physics, Molecular Spectroscopy, Antennas, lasers, non linear optics, Numerical methods, electrodynamics, electronics (analog, digital and Communication) and microprocessors will enable the students to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical and mathematical reasoning. Hence, after completing the program students will be able to :

- Apply conceptual understanding of the physics to general real world situations.
- Learn to carry out experiments in basics as well as certain advanced areas of physics such as condensed matter physics, lasers, Modern physics, electronics (analog, digital and communication) and microprocessors.
- Understand the basic concepts of certain sub fields such as nuclear and high energy physics, atomic and molecular physics, solid state physics, and general theory of relativity, nonlinear dynamics, Electronics and communication systems.
- Gain hands on experience to work in applied fields.
- Gain a thorough grounding in the subject to be able to teach it at college as well as school level.
- View physics as a training ground for the mind developing a critical attitude and the faculty of logical reasoning that can be applied to diverse fields.



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**Scheme of Examination**  
**M.Sc., Physics**  
(W.e.f. 2019-20 Admitted batch)

S. No	Evaluation	Total marks
<b>I</b>	<b>Theory</b>	
	Internal assessment (Two mid-exams average: 15 Class tests/ assignments/ Presentation/Comprehensive viva: 5 Attendance: 5)	25
	Semester end examination	75
<b>II</b>	<b>Practical/Lab</b>	
	Semester practical end examination	100
<b>III</b>	<b>Comprehensive viva</b>	100

**Scheme of Examination at the end of each semester:**

Theory pass Minimum - 40%  
Practical pass minimum - 50%

Proceedings No.ANUR/LS/BoS/Physics/2019 dated on 31-10-19:

- Practical examination marks(100 Marks) break up:  
Record -20 marks  
Theory cum Experimental viva-20 marks  
Lab Experiments-60 marks (i.e. Procedure-40, graph-10, result-10)
- Comprehensive viva(100 Marks) break up:  
Semester -wise evaluation 25 marks -conducted at the end of second year only



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**SEMESTER –I**  
**COURSE– I**  
**CLASSICAL MECHANICS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the student will be familiar with:

- (1) How to overcome the limitations existing in the Newtonian mechanics by using Lagrangian and Hamiltonian Approach
- (2) The complete description about Central Force problem
- (3) The Concepts of Rigid body Dynamics

**PRE-REQUISITES**

Basic concepts of Mechanics, Vector Algebra, Partial and Ordinary Differential Concepts

**UNIT-I**

Mechanics of a particle. Mechanics of a system of particles, constraints, D'Alembert's principle and Lagrange's equations, Velocity Dependent potentials and the Dissipation function Simple applications of the Lagrangian Formulation

Chapter: 1. Section: 1, 2, 3, 4,5 & 6 .

Hamilton's principle, some techniques of the calculus of variations. Derivation of Lagrange's equations from Hamilton's principle. Conservation theorems and symmetry properties, Energy function and the conservation of Energy

Chapter: 2. Section: 1, 2, 3, 5, 6

**UNIT-II**

Reduction to the equivalent one body problem. The equation of motion and first Integrals, The equivalent One – Dimensional problem and classification of orbits, The differential equation for the orbit, and Integrable power – law potentials, Conditions for closed orbits (Bertrand's theorem), The Kepler problem inverse square law of force , The motion in time in the Kepler problem, Scattering in a central force field.

Chapter : 3. Section. 1, 2, 3, 5, 6, 7, 8

Legendre transformations and Hamilton's equations of motion. Cyclic Coordinates and conservation theorems, Derivation of Hamilton's equation of motion from variational principle, Principle of Least Action.

Chapter : 7 Section: 1, 2,3,4 5 .

**UNIT-III**

Equations of canonical transformation, Examples of Canonical transformations, The harmonic Oscillator, Poisson brackets and other Canonical invariants, Equations of motion, Infinitesimal canonical transformations, and conservation theorems in the poisson bracket formulation, the angular momentum poisson bracket relations.

Chapter : 8. Section : 1 , 2 ,4, 5, 6 & 7.



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Hamilton – Jacobi equation of Hamilton's principal function, The Harmonic oscillator problem as an example of the Hamilton – Jacobi Method, Hamilton – Jacobi equation for Hamilton's characteristic function. Action – angle variables in systems of one degree of freedom.

Chapter : 9. Section : 1, 2, 3, & 5.

#### UNIT-IV

Independent coordinates of rigid body. , The Euler angles, Euler's theorem on the Motion of a rigid body, Infinitesimal rotations, Rate of change of a vector, The Coriolis Effect.

Chapter : 4. Section : 1, 4, 6, 8, 9 .

The Inertia tensor and the moment of inertia, The Eigenvalues of the inertia tensor and the principal axis transformation, Solving rigid body problems and Euler equations of motion, Torque – free motion of a rigid body

Chapter 5 Section: 3, 4, 5 & 6.

The Eigenvalue equation and the principal axis transformation, Frequencies of free vibration, and normal coordinates, Free vibrations of a linear triatomic molecule

Chapter 10 Section: 2, 3 & 4 .

#### Suggested Reading:

1. H.Goldstein (2011) "Classical Mechanics"(1<sup>st</sup> & 2<sup>nd</sup>ed) Pearson India publishers
2. J.B.Marion(2015) "Classical Dynamics of Particles and Systems"(1<sup>st</sup>ed) willey eastern limited

### SEMESTER –I COURSE – II ATOMIC AND MOLECULAR PHYSICS

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

#### Course Outcome:


At the end of the course, the student will acquire basic knowledge in:

1. The simple atomic spectrums to Complex spectrum Formation and Mathematical Analysis
2. Atomic Spectrum Variations in Various Types of External Excitations
3. Fundamental Concepts of Molecular Spectroscopy

After completion of the course students will have chances to get absorbed as research fellows in various Central Research organizations like CCMB, DRDO. etc.,

#### PRE-REQUISITES

Atomic Concepts, Vector Algebra, Basic theory of Chemical Bonding Concepts

  
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## UNIT-I

**ONE ELECTRON ATOMS :** Quantum numbers, Term values . Relation between Magnetic dipole moment and angular momentum of an orbiting electron. Stern–Gerlach experiment and electron spin. Spin-orbit interaction, relativistic kinetic energy correction and dependence of energy on J value only. Selection rules. Fine structure of Balmer series of Hydrogen and Fowler series of ionized Helium. Hyperfine structure of  $H_{\alpha}$  line of hydrogen ( $I = \frac{1}{2}$ ).

**ONE VALENCE ELECTRON ATOMS:** Modified term values (quantum defect) due to lifting of orbital degeneracy by core penetration (penetrating orbits) and core polarization (non-penetrating orbits) by nl electrons. Term values and fine structure of chief spectral series of sodium. Intensity rules and application to doublets of sodium. Hyperfine structure of  $^2P-^2S$  of sodium ( $I = 3/2$ ).

## UNIT-II

**MANY ELECTRON ATOMS :** Indistinguishable particles, bosons, fermions. Pauli's principle. Ground states. LS coupling and Hund's rules based on Residual coulombic interaction and spin-orbit interaction. Lande's interval rule. Equivalent and non-equivalent electrons. Spectral terms in LS and JJ coupling ( $ss, s^2, pp, p^2$  configurations). Exchange force and Spectral series of Helium.

## UNIT- III

**ATOMS IN EXTERNAL MAGNETIC FIELD:** Normal and Anomalous Zeeman Effects, Experimental study of Zeeman effect, Explanation of Normal and Anomalous Zeeman Effects, Quantum theory of Zeeman and Paschen-Back effects and its applications, Transition from weak to strong field, Examples of Zeeman effect in some transitions

**ATOMS IN EXTERNAL ELECTRIC FIELD:** Linear stark pattern of  $H_{\alpha}$  line of hydrogen, weak field and strong field Stark effects in Hydrogen, Quadratic stark pattern of  $D_1$  and  $D_2$  lines of Sodium.

## UNIT-IV

**DIATOMIC MOLECULES:** Molecular quantum numbers. Bonding and anti-bonding orbitals from LCAO's. Explanation of bond order for  $N_2$  and  $O_2$  and their ions. Rotational spectra and the effect of isotopic substitution. Effect of nuclear spin functions on Raman rotation spectra of  $H_2$  (Fermion) and  $D_2$  (Boson). Vibrating rotator. Spectrum. Combination relations and evaluation of rotational constants (infrared and Raman). Intensity of vibrational bands of an electronic band system in absorption. (The Franck-Condon principle). Sequences and progressions. Deslandre's table and vibrational constants.

### Suggested Reading:

1. Rajkumar(2014) "Atomic and Molecular Spectra"Kedarnath publishers
2. C.N.Banwell., "Fundamentals of Molecular Spectroscopy"(5ed)New Delhi, McGraw-Hill
3. H.E.White (1934) "Introduction to Atomic Spectra" mc Graw-Hill publishers

**SEMESTER –I**  
**COURSE – III**  
**MATHEMATICAL METHODS OF PHYSICS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the students will be familiar in:

1. The Complex Function Concept, Analytic Nature of Complex function  
Evaluation of Integrals over irregular objects, Series Expansions of complex functions
2. The approach of solving Complicated functions by using Special functions like Legendre, Bessels, Laguerre Polynomials
3. Conversion of Functions from One Domain to another domain by using Fourier and Laplace Transformation Techniques

**PRE-REQUISITES**

Elementary Knowledge in Complex Analysis, Differential Equations and Integration formulas

**UNIT-I**

**Complex Variables**

Function of complex number- definition-properties, analytic function-Cauchy –Riemann conditions- polar form-problems, Complex differentiation, complex integration –Cauchy's integral theorem- Cauchy's integral formulae-multiply connected region- problems, Infinite series-Taylor's theorem-Laurent's theorem-Problems, Cauchy's Residue theorem- evaluation of definite integrals-problems.

**Text Book:** 1. Mathematical Methods of Physics-G.Arffen,Academic Press

2. Mathematical Physics-Satya Prakash, Sultan Chand &co,New Delhi

3. Complex Variables ( Schaum'sout line series) MurrayR.Spiegel

**Ref Book:** Mathematical Methods B.D.Gupta

**UNIT-II**

**Beta , Gamma functions &Special functions**

Beta & Gamma functions -definition, relation between them- properties-evaluation of some integrals  
Special Functions- Legendre Polynomial, Hermite Polynomial, Laguerre Polynomial-Generating function-recurrence relations-Rodrigue's formula-orthonormal property-associated Legendre polynomial- simple recurrence relation-orthonormal property-spherical harmonics

**Suggested Reading:**

1. Mathematical Methods of Physics-G.Arffen,Academic Press

2. Mathematical Physics-Satya Prakash, Sultan Chand &co,New Delhi

3. Mathematical Physics B S Rajput



### UNIT-III

#### Laplace Transforms

Laplace Transforms – definition- properties – Laplace transform of elementary functions-Inverse Laplace transforms-properties- evaluation of Inverse Laplace Transforms-elementary function method-Partial fraction method-Heavyside expansion method-Convolution method-complex inversion formula method-application to Differential equations

#### Suggested Reading:

1. Mathematical Methods of Physics-G.Arken,Academic Press
2. Mathematical Physics-Satya Prakash, Sultan Chand &co,New Delhi
3. Laplace n Fourier Transforms Goyal& Gupta,

**Ref books:** Integral Transforms M.D.Raisinghanna  
Integral Transforms Goyal& Gupta  
Mathematical Physics B S Rajput

### UNIT-IV

#### Fourier series, Fourier Transforms

Fourier series-evaluation of Fourier coefficients- Fourier integral theorem-problems-square wave-rectangular wave-triangular wave  
Fourier Transforms- infinite Fourier Transforms-Finite Fourier Transforms-Properties-problems-application to Boundary value problem

#### Suggested Reading:

1. G.Arken, Academic“Mathematical Methods of Physics”(2ed) Press publications
2. Prakash, Satya, “Mathematical physics: with classical mechanics”., Sultan Chand &co,New Delhi
3. Goyal, J.K. & Gupta, K.P.(2010), “Laplace n Fourier Transforms” Meerut, PragatiPrakashan publishers

  
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**SEMESTER –I**  
**COURSE – IV**  
**ELECTRONIC DEVICES AND CIRCUITS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the student will be able to Design:

1. Simple Electronic Circuits containing LED, Photo Diode, Varactor Diode.
2. Able to Understand the Microwave concepts and their unique features
3. Able to design Electronic circuits based on the Op-Amps for various Mathematical and Scientific Applications

**PRE-REQUISITES**

Elementary Knowledge of Semiconductor Devices, Basic functional behavior of Electrical circuit elements like Inductor, Capacitor and Resistors, applications of KCL and KVL to the circuit

**UNIT-I**

**SEMICONDUCTOR DEVICES:**

Tunnel diode, photo diode, solar cell, LED, APD, PIN Diode, Schottky Barrier Diode, Silicon controlled Rectifier, Uni Junction Transistor, Field Effect Transistor, (JFET & MOSFET), CMOS (Principle, working and Applications for all devices)

**UNIT-II**


**MICROWAVE DEVICES:**

Varactor diode, Parametric Amplifier, Thyristors, Klystron, Reflex Klystron, Gunn Diode, Magnetron, CFA,TWT, BWO, IMPATT, TRAPATT (Principle, working and Applications for all devices)

**UNIT-III**

**OPERATIONAL AMPLIFIERS:**

The ideal Op Amp – Practical inverting and Non inverting Op Amp stages. Op Amp Architecture – differential stage, gain stage, DC level shifting, output stage, offset voltages and currents Operational Amplifier parameters- input offset voltage, input bias current, Common Mode Rejection Ratio, Slew Rate

  
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## UNIT-IV

### OP- AMP APPLICATIONS:

Summing amplifier, Integrator, Differentiator, Voltage to Current converter, Current to Voltage converter  
Oscillators – Phase shift oscillator, Wien-Bridge Oscillator, Voltage Controlled Oscillator, Schmitt Trigger  
Special applications – Mono stable and Astable multi vibrators using 555, Phase locked Loop, Voltage regulators.

### Suggested Reading:


1. Jacob Millman & C.C. Halkies (2013) "Integrated Electronics" New Delhi, Tata McGraw-Hill
2. Ramakant A. Gayakwad (2015) "Op.Amps and Linear Integrated Circuits" – PHI learning publishers
3. George Kennedy "Electronic Communication Systems" – PHI learning publishers

## SEMESTER –I COURSE – V ELECTRONICSLAB -I

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

### LIST OF EXPERIMENTS

1. FET amplifier (BFW 10/11)
2. Negative feedback amplifier (BC 147)
3. Colpitts Oscillator (BF 194)
4. Phase shift Oscillator (BC 147)
5. A stable Multi vibrator (BF 194)
6. Op.Amp.Characteristics (IC 741 )
7. Power Supply
8. UJT Characteristics (2 N 2646)
9. R.F.Amplifier (BF 194)
10. Boot-strap time based generator (2N 2222)

  
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**SEMESTER –I**  
**COURSE– V**  
**MODERN PHYSICS LAB-I**

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

**LIST OF EXPERIMENTS**

1. Atomic Spectrum of Zinc.
  - a) Verification of Lande's interval rule
  - b) Study of relative intensities
2. Grating spectrometer
  - a) Wavelengths of Hg spectrum,
  - b) Wavelength of Balmer series, Rydberg constant
3. Reciprocal dispersion curve
4. Application of Point Groups.
  - a) Identification of symmetry operations in  $H_2O$ ,  $BH_3$ ,  $NH_3$  and  $H_2CO$
  - b) Reducible representations and Vibrational modes of  $H_2O$ .
5. Determination of Planck's constant, work function and threshold frequency
6. Band gap of a semiconductor.( Two Probe Method)
7. Thermo emf
8. The Franck-Hertz experiment
9. Band spectrum of CN in the violet
  - a) conversion of given wavelengths to wave numbers and assignment of ( $\nu'$ ,  $\nu''$ )
  - b) Deslandres' table and Vibrational constants.

  
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**SEMESTER –II**  
**COURSE– II**  
**STATISTICAL MECHANICS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the students will acquire good knowledge in:

1. The behavior of the system under Various Equilibrium conditions, Concepts of Various Ensembles
2. Concepts of Partition function and various applications of partition function for different types of systems
3. Fundamental Concepts of Quantum Statistics and Their probability expressions and evaluation of various statistical parameters
4. Basic concept of Relativity and four vector concept

**PRE-REQUISITES**

Probability Concepts, Basics of Mechanics

**UNIT-I**

**Basic Methods and Results of Statistical Mechanics:**

Specification of the state of a system, phase space and quantum states, Liouville's theorem, Basic postulates, Probability calculations, concept of ensembles, thermal interaction, Mechanical interaction, quasi static process, distribution of energy between systems in equilibrium, statistical calculations of thermodynamic quantities, Isolated systems (Microcanonical ensemble). Entropy of a perfect gas in microcanonical ensemble. Canonical ensemble - system in contact with heat reservoir, system with specified mean energy, connection with thermodynamics, Energy fluctuations in the canonical ensemble. Grand canonical ensemble, Thermodynamic function for the grand canonical ensemble. Density and energy fluctuations in the grand canonical ensemble. Thermodynamic equivalence of ensembles. Reif Ch:2, 3.3, 3.12 Ch:6

**UNIT-II**

**Simple Applications of Statistical Mechanics:**

Partition functions and their properties. Calculation of thermodynamic quantities to an ideal monoatomic gas. Gibbs paradox, validity of the classical approximation. Proof of the equipartition theorem. Simple applications – mean K.E. of a molecule in a gas. Brownian motion. Harmonic Oscillator, Specific heats of solids (Einstein and Debye model of solids), Paramagnetism, Partition function for polyatomic molecules, Electronic energy, vibrational energy and rotational energy of a diatomic molecule. Effect of Nuclear spin-ortho and para Hydrogen. Reif Ch:7, Ch:9.12

### UNIT-III

#### Quantum Statistics:

Formulation of the statistical problem. Maxwell–Boltzmann statistics. Photon statistics, Bose-Einstein statistics, Fermi–Dirac statistics, Quantum statistics in the classical limit, calculation of dispersion for MB, BE & FD statistics Equation of state of an Ideal Bose Gas, Black body radiation, Bose-Einstein condensation, Equation of state for a weakly degenerate and strongly degenerate ideal Fermi gas. Thermionic emission. The theory of white dwarf stars. Reif Ch:9

### UNIT – IV

#### Relativistic Mechanics

Introduction: Postulates of relativistic mechanics. Minkowski Space, Geometrical representation of Lorentz transformation of space and time. Application to Lorentz transformation. Geometrical representation of Simultaneity, length-contraction and time dilation. Space like and time like intervals. Relativistic classification of particle, Basic ideas of general theory of relativity. (SathyaPraksah)

#### Suggested Reading:

1. F. Reif (2010)-“Fundamentals of Statistical and Thermal Physics”Kolkata, Levant Books.
2. S.K. Sinha (2014) “Statistical Mechanics, Theory and Applications”New Delhi, New Age.
3. B.K. Agarwal and M. Eisner (2007) “Statistical Mechanics” New International (P) Ltd., New Dehi,.
4. Satya Prakash(1987)-““Relativistic Mechanics”,PragathiPrakashan , Meerut,.

### SEMESTER –II COURSE– II ELECTRO DYNAMICS

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

#### Course Outcome:

At the end of the course, the students will acquire knowledge in :

1. Evaluate the Static Electric field, Electric Potential and Magnetic field produced by various type of sources
2. Concepts of Maxwell Equations of Electromagnetism, Electromagnetic Wave Equation, wave equation modification in various Media
3. Fundamental Concepts of Various types of Potential problems, Radiation concepts, Plasma Concept
4. Basic concept of Modifications of Electromagnetic Field Equations modification as per Relativity



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## PRE-REQUISITES

Vector and Vector Calculus Concepts, Basics of Electrostatics

**UNIT-I:** Gauss Theorem, Poisson's equation, Laplace's equation, solution to Laplace's equation in cartesian coordinates, spherical coordinates, cylindrical coordinates, use of Laplace's equation in the solutions of electrostatic problems.

Ampere's circuital law, magnetic vector potential, displacement current, Faraday's law of electromagnetic induction,

**UNIT-II:** Maxwell's equations, differential and integral forms, physical significance of Maxwell's equations. Wave equation, plane electromagnetic waves in free space, in nonconducting isotropic medium, in conducting medium, electromagnetic vector and scalar potentials, uniqueness of electromagnetic potentials and concept of gauge, Lorentz gauge, Coulomb gauge. Charged particles in electric and magnetic fields: charged particles in uniform electric field, charged particles in homogeneous magnetic fields, charged particles in simultaneous electric and magnetic fields, charged particles in non homogeneous magnetic fields.

**UNIT-III:** Lienard-Wiechert potentials, electromagnetic fields from Lienard-Wiechert potentials of a moving charge, electromagnetic fields of a uniformly moving charge, radiation due to non-relativistic charges, radiation damping, Abraham-Lorentz formula, Cherenkov radiation, radiation due to an oscillatory electric dipole, radiation due to a small current element. Condition for plasma existence, occurrence of plasma, magnetohydrodynamics, plasma waves

**UNIT-IV:** Transformation of electromagnetic potentials, Lorentz condition in covariant form, invariance or covariance of Maxwell field equations in terms of 4 vectors, electromagnetic field tensor, Lorentz transformation of electric and magnetic fields.

### **Suggested Reading:**

1. J.D. Jackson "Classical Electrodynamics" PHI publishers
2. D.R. Griffiths (2010) "Introduction to Electrodynamics" New Delhi, New Age
3. Satyaprakash (2006) "Electromagnetic Theory and Electrodynamics"-Kedar Nath Ram Nath & CO
4. K.L. Kakani "Electrodynamics" New Delhi, Tata McGraw-Hill

  
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**SEMESTER –II**  
**COURSE – II**  
**NUMERICAL METHODS & PROGRAMMING WITH C**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the students will acquire knowledge in:

1. Evaluate the roots of transcendental equations, Various Interpolation Techniques
2. The Concepts of Numerical Differentiation and Numerical Integration, Solving methods for Simultaneous algebraic equations and differential equations
3. Fundamental Concepts of C- Program, and simple C programs based on Conditional structure
4. Basic concept of C program based on arrays, pointers

**PRE-REQUISITES**

Basics of Matrices, Interpolation Concepts, Basics of flow chart

**UNIT- I**

**NUMERICAL TECHNIQUES**

Solution of algebraic and transcendental equations: Bisection method, Method of false position and Newton-Raphson method. Principle of least squares – fitting of polynomials.

Interpolation: Finite differences(forward, backward and central difference), Newton's formula for Interpolation, Central difference Interpolation formula (Gauss's & Sterling formula), Lagrange's Interpolation formula, Inverse Interpolation.

**(Sastry)**

**UNIT-II**

**NUMERICAL DIFFERENTIATION & INTEGRATION**

Differentiation: Cubic Spline Method, Maximum and Minimum values of a Tabulated function

Numerical Integration: Trapezoidal Rule, Simpson's 1/3 Rule and 3/8 Rule. Solutions of linear systems- Direct methods: Matrix Inversion method, Gaussian Elimination method, Modification of Gaussian Elimination method(Gauss-Jordan Method). Iterative methods: Jacobi method, Gauss Seidel method. Numerical solutions of ordinary differential equations: Solution by Taylor's series, Picard's method of successive approximations, Euler's method (Error estimates for the Euler's method, Modified Euler's method) and Range-Kutta method.

**(Das & Sastry)**



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### UNIT- III

#### INTRODUCTION TO 'C' LANGUAGE

Character Set, C tokens, Key words and Identifiers, Constants and Variables, Data types, Declaration of variables. Operators and expressions: Arithmetic, Relational, Logical, Assignment, Increment and Decrement operators, Conditional, Bitwise and special operators. Precedence in evaluating arithmetic operators. Reading and Writing a character. IF, IF-ELSE, Nesting IF-ELSE, ELSE IF ladder and GOTO statements, WHILE, DO, FOR loop statements. Simple programs

(Balaguruswamy&Kanethkar)

### UNIT- IV

#### PROGRAMMING IN C -LANGUAGE

Arrays:One and Two dimensional arrays, Declaring and initializing string variables. Reading strings from terminal and writing strings to screen. User defined functions: definition of functions, Return values and their types. Function calls and function declaration. Pointers: Declaring and initializing pointers, Accessing a variable through its pointer. C- Programming: Linear regression, Sorting of numbers, Calculation of standard deviation and matrix multiplication

(Balaguruswamy&Kanethkar)

#### Suggested Reading:

1. B.S.Gopal&S.N.Mittal "Numerical Methods" New Delhi, PHI Learning Pvt Ltd
2. H.K.Das, S.Chand& Co."Mathematical Physics" New Delhi, PHI Learning Pvt Ltd
3. E Balaguruswamy(2004) "Programming in ANSI C" TMH New Delhi,.
4. YashavantKanetker(1999.),"Let us C" BPB Publications, New Delhi,

### SEMESTER –II

#### COURSE – II

#### NUCLEAR AND PARTICLE PHYSICS

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

#### Course Outcome:

At the end of the course, the students will acquire knowledge in:

1. Various parameter of the Nucleus and the concept of stability of the Nucleus based on Nuclear Forces
2. The Nuclear Models Explains how nucleons in the Nucleus distributed
3. Fundamental Concepts of Nuclear Decay and Nuclear Reactions
4. Basic concept of Elementary Particles
5. Nuclear Energy concepts and nuclear radiation detection techniques

  
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After completion of the course, students will have chances to absorb as research fellows in various Central Research organizations like BARC, NFCL.

### **PRE-REQUISITES**

Elementary Knowledge in Atomic theory, Quantum numbers

### **UNIT – I**

#### **INTRODUCTION:**

Objective of Studying Nuclear Physics, Nomenclature, nuclear radius, mass & Binding energy, angular momentum, magnetic dipole moment, Electric quadrupole moment, parity and symmetry, domains of instability, mirror nuclei.

#### **NUCLEAR FORCES :**

Simple theory of the deuteron, scattering cross-sections, qualitative discussion of neutron- proton and proton- proton scattering, exchange forces, Yukawa's Potential, Characteristics of Nuclear Forces.

### **UNIT – II**

#### **NUCLEAR MODELS:**

Liquid drop model:, Weissacker's semi-empirical mass formula, Mass – parabolas. Nuclear shell model : Spin orbit interaction, magic numbers, prediction of angular momenta and parities for ground states, Collective model

#### **NUCLEAR DECAY\_:**

Fermi's Theory of  $\beta$  - decay, parity violation in  $\beta$  -decay, detection and properties of neutrino. Energetic of gamma decay, selection rules, angular correlation, Mossbauer Effect.

#### **NUCLEAR REACTIONS:**

Types of reactions and conservation laws, the Q – equation, Optical model.

### **UNIT – III**

#### **NUCLEAR ENERGY:**

Stability limit against spontaneous fission, Characteristics of fission, delayed neutrons, four factor formula for controlled fission, nuclear fusion, prospects of continued fusion energy.

#### **ELEMENTARY PARTICLE PHYSICS:**

Particle interactions and families, conservation laws

( energy and momentum, angular momentum, parity, Baryon number, Lepton number, isospin, strangeness quantum number( Gellmann and Nishijima formula) and charm), Elementary ideas of CP and CPT invariance, Quark model.

  
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## UNIT – IV

### DETECTING NUCLEAR RADIATION:

Interaction of radiation with matter. Gas filled counters, scintillation detectors, semiconductor detectors, energy measurements, bubble chamber, and magnetic spectrometers.

### ACCELERATORS:

Electrostatic accelerators, cyclotron accelerators, synchrotrons, linear accelerators, colliding beam accelerators

### Suggested Reading:

1. Kenneth S. Krane(2008) "Introductory Nuclear Physics" –Wiley publications
2. Bernard L.Cohen.(2010) "Concepts of Nuclear Physics"-Wiley publications
- 3.D.H. Perkins"Introduction to High Energy physics" -New Delhi, PHI Learning

## SEMESTER –II COURSE– V ELECTRONICSLAB -II

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

### LIST OF EXPERIMENTS

1. Active Low pass and High Pass filters (IC 741)
2. Twin -T filter (IC 741)
3. Logarithmic Amplifier (IC 741)
4. Wein Bridge Oscillator (IC 741)
5. Mono stable multi vibrator (IC 555)
6. Voltage Regulator (IC 723)
7. Phase Shift Oscillator (IC 741)
8. A stable multi vibrator (IC 555)
9. Active band pass filter (IC 741)
10. Voltage controlled oscillator (IC 741, IC 555)

  
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**SEMESTER –II**  
**COURSE– V**  
**MODERN PHYSICS LAB-II**

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

**LIST OF EXPERIMENTS**

1. Atomic Spectrum of Sodium.
  - a) Identification of sharp and diffuse doublets
  - b) Doublet separation
  - c) Assignment of principal quantum numbers
2. Raman Spectrum of Carbon Tetrachloride
  - a) Raman shifts
  - b) Fermi resonance
3. Vibrational analysis of AIO Green system.
  - a) identification of sequences, assignment of vibrational quantum numbers,
  - b) Deslandre's table and Vibrational constants.
4. Determination of Specific Charge of an electron by Thomson's Method.
5. Experiments with He- Ne laser.
  - a) Polarization of laser light
  - b) Divergence of laser beam and mono chromaticity.
6. Band gap of a semiconductor (Four probe method).
7. Dielectric constant as a function of temperature and determination of Curie Temperature
8. Susceptibility of a substance Gouy's method
9. Dissociation energy of Iodine molecule from the given data.

  
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**SEMESTER –III**  
**COURSE– I**  
**INTRODUCTORY QUANTUM MECHANICS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the students will acquire knowledge in:

1. Wave Particle duality, wave function and its properties, wave equation, concept of wave packet
2. Understanding the basic mathematical concepts needed for Quantum Mechanics
3. Wave equations of the particle in one and Three dimensional Various type of physical potentials
4. Basic concept of Angular Momentum operator and various Commutative relations of Angular momentum
5. Various approximation techniques for few physical problems where wave mechanical concepts could not solve

**PRE-REQUISITES**

Elementary Knowledge in Vectors, Special functions, Differential equations, Matrices

**UNIT-I**

The Conceptual aspect :Wave particle duality, Uncertainty principle, Principle of superposition - Wave packets – phase velocity and group velocity- Schrodinger Wave Equation - , wave function interpretation and admissibility conditions, probability current density, expectation value, Erhenfest theorem, stationary states.

**UNIT-II**

Bracket notation, orthonormal functions, linear operators and their properties, - Hermitian operator, Schmidt orthogonalisation, Postulates of quantum mechanics, simultaneous measurability of observables, commutator algebra, equation of motion of an operator ( Schrodinger representation ), Momentum representation- - Dirac delta function and properties.

**UNIT-III**

One dimensional problems - Particle in a potential well with (i) infinite walls, (ii) finite walls. Potential step, Potential Barrier. Linear Harmonic Oscillator (Schrodinger method ). Free particle. Particle moving in a spherically symmetric potential, spherical harmonics, radial equation,. Eigen values and eigen functions of rigid rotator, hydrogen atom, hydrogenic orbitals, angular momentum operators, commutation relations, eigen values and eigen functions of  $L^2$ ,  $L_z$ ,  $L_+$  and  $L_-$  spin angular momentum, general angular momentum..

  
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#### UNIT-IV

Time- independent perturbation theory for (i) non degenerate systems and application to ground state of helium atom., effect of electric field on the ground state of hydrogen, spin orbit coupling ii) degenerate systems, application to linear stark effect in hydrogen.. Variation method and its application to helium atom. exchange energy and low lying excited states of helium atom. WKB method, barrier penetration.

#### Suggested Reading:

1. Aruldas "Quantum Mechanics" Mumbai, Himalaya Publishing House
2. B.H.Bransden and C.J.Joachain "Quantum Mechanics"(2ed) New Delhi, Pearson Education
3. E. Merzbacher(2008)"Quantum Mechanics" -New Delhi, Pearson

#### SEMESTER –III COURSE – II SOLID STATE PHYSICS

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

#### Course Outcome:

At the end of the course, the students will have knowledge in

1. Crystal Structure and its Classifications, Crystal parameters and Determination of crystal parameters, Reciprocal lattice concept
2. Understanding the Lattice vibrations and phonon concept
3. Concept of Metals and Free electron theory of Metals
4. Classification of materials and band theory support for classification of materials
5. Super conducting materials and their properties

After completion of the course Solid State physics students have a chance to absorb as research fellow in various Central Research organizations like NPL, SSRL (DRDO).

#### PRE-REQUISITES

Elementary Knowledge in Vectors, Differential equations, Matrices, concepts of elementary physics

  
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## UNIT-I

### CRYSTAL STRUCTURE:

Periodic array of atoms—Lattice translation vectors and lattices, symmetry operations, The Basis and the Crystal Structure, Primitive Lattice cell, Fundamental types of lattices—Two Dimensional lattice types, three Dimensional lattice types, Index system for crystal planes, simple crystal structures--sodium chloride, cesium chloride and diamond structures.

### CRYSTAL DIFFRACTION AND RECIPROCAL LATTICE:

Bragg's law, Experimental diffraction methods-- Laue method and powder method, Derivation of scattered wave amplitude, indexing pattern of cubic crystals and non-cubic crystals (analytical methods). Geometrical Structure Factor, Determination of number of atoms in a cell and position of atoms. Reciprocal lattice, Brillouin Zone, Reciprocal lattice to bcc and fcc Lattices.

## UNIT-II

### PHONONS AND LATTICE VIBRATIONS:

Vibrations of monoatomic lattices, First Brillouin Zone, Group velocity, Long wave length, Lattice with two atoms per primitive cell, Quantization of Lattice Vibrations-Phonon momentum.

### FREE ELECTRON FERMI GAS:

Energy levels and density of orbitals in one dimension, Free electron gas in 3 dimensions, Heat capacity of the electron gas, Experimental heat capacity of metals, Motion in Magnetic Fields- Hall effect, Ratio of thermal to electrical conductivity.

## UNIT-III

### THE BAND THEORY OF SOLIDS:

Nearly free electron model, Origin of the energy gap, The Bloch Theorem, Kronig-Penny Model, wave equation of electron in a periodic potential, Crystal momentum of an electron-Approximate solution near a zone boundary, Number of orbitals in a band--metals and isolators. The distinction between metals, insulators and semiconductors

## UNIT IV

### SUPERCONDUCTIVITY:

Concept of zero resistance, Magnetic behavior, distinction between a perfect conductor and superconductor . Meissner effect, Isotope effect--specific heat behavior. Two-fluid model. Expression for entropy difference between normal and superconducting states. London's equations. Penetration depth. BCS theory. Josephson junctions--SQUIDS and its applications . Applications of superconductors. High  $T_c$  superconductors, Preparation, Properties.

### Suggested Reading:

- 1.C.Kittel "Introduction to Solid State Physics", 5<sup>th</sup> edition New Delhi, Wiley India.
- 2.A.J.DEKKER(2010)"Solid State Physics" New Delhi, Pearson Education.

  
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**SEMESTER –III**  
**COURSE – III**  
**LASERS AND NON LINEAR OPTICS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the students will acquire knowledge in:

1. LASER works and the required conditions and set up for LASER Formation
2. Understanding the optical fiber concepts and its classifications
3. Concept of Optical Fiber Losses
4. Concept of Holography

**PRE-REQUISITES**

Elementary Knowledge in optics, Elementary Mathematics

**UNIT-I**

**LASER SYSTEMS:** Light Amplification and relation between Einstein A and B Coefficients. Rate equations for three level and four level systems. Laser systems: Ruby laser, Nd-YAG laser, CO<sub>2</sub> Laser, Dye laser, Excimer laser, Semiconductor laser.

**UNIT – II**

**LASER CAVITY MODES:** Line shape function and Full Width at half maximum (FWHM) for Natural broadening, Collision broadening, Doppler broadening, Saturation behavior of broadened transitions, Longitudinal and Transverse modes. ABCD matrices and cavity Stability criteria for confocal resonators. Quality factor, Q-Switching, Mode Locking in lasers. Expression for Intensity for modes oscillating at random and modes locked in phase. Methods of Q-Switching and Mode locking.

**UNIT-III**

**OPTICAL FIBER WAVEGUIDES :** Basic optical laws and Self focusing. Optical fiber modes and configurations Fiber types, Rays and Modes, Step-index fiber structure. Ray optics representation, wave representation. Mode theory of circular step-index wave guides. Wave equation for step-index fibers, modes in step-index fibers and power flow in step-index fibers. Graded – index fiber structure, Graded-index numerical aperture, modes in Graded-index fibers.

**FIBER CHARACTERISTICS :**Signal Degradation In Fibers - Attenuation, Absorption, Scattering and Bending losses in fibers, radiative losses, Core and Cladding losses. Signal distortion in optical



wave guides: Group delay, material dispersion, waveguide dispersion and intermodal dispersion. Pulse broadening in optical fibers. Power launching in Optical fibers, Source-output pattern, Lensing schemes. Fiber-to-fiber joints: Mechanical misalignment, fiber related losses, Fiber and face preparation. fiber splicing techniques, fiber connectors.

#### UNIT-IV

##### HOLOGRAPHY AND FOURIER OPTICS

Introduction to Holography: Basic theory of Holography, Recording and reconstruction of Hologram, Fourier transform Holography, Acoustic and Holographic Microscopy, Pattern recognition and Applications of Holography.

Fringe contrast variation. Fourier Transformation spectroscopy. Michelson interferometer. Advantages of Fourier transforms. Optical data processing. Diffraction. (Meyer, Fowles)

##### **Suggested Reading:**

1. K.Thyagarajan and A.K. Ghatak "Lasers -Theory and Applications" MacMillan
2. Gerd Keiser "Optical fiber Communications" Mc Graw-Hill
3. B.B.Laud "Lasers and Non Linear Optics" New Age International Publishers
4. Grant R. Fowles, Holt, Rinehart and Winston (1968) "Introduction to Modern Optics" Inc New York

**SEMESTER –III**  
**COURSE – IV**  
**DIGITAL ELECTRONICS AND MICROPROCESSORS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

##### **Course Outcome:**

At the end of the course, the students will have knowledge in:

1. Various types of Number systems and conversion process of one Number system to the another Number system
2. Designing of Simple Combinational and Sequential circuits
3. Designing of Counters, Registers and various types of Data converters and characteristics
4. Complete Concept of 8085 Microprocessor – Architecture, Address modes, Data Transfer schemes,.
5. Description about Interfacing IC's namely 8255, 8251, 8253

##### **PRE-REQUISITES**

Elementary Knowledge in Number systems, Elementary idea of Electronic devices

  
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## UNIT – I

**Digital Circuits** (i) **Number Systems and Codes:** Binary, Octal, Hexadecimal number systems, Gray code, BCD code, ASCII code. (ii) **Logic Gates and Boolean Algebra:** OR, AND, NOT, NOR, NAND gates, Boolean theorems, DeMorgan laws.

**II) Combinational Logic Circuits:** (i) Simplification of Boolean Expressions: Algebraic method, Karnaugh Map method, EX-OR, EX-NOR gates, ENCODER, DECODER, Multiplexer, Demultiplexers.

(ii) Digital Arithmetic Operations and Circuits: Binary addition, Design of Adders and Subtractors, Parallel binary adder, IC parallel adder. (iii) Applications of Boolean Algebra: Magnitude Comparator, Parity generator, Checker, Code converter, Seven-segment decoder/ Driver display.

## UNIT – II

**Sequential Logic Circuits:** (i) Flip-Flops and Related Devices: NAND latch, NOR latch, Clocked flip-flops, Clocked S-C flip-flop, J-K flip-flop, D flip-flop, D latch, Asynchronous inputs, Timing problem in flip-flops. (ii) Counters: Asynchronous counters (Ripple), Counters with MOD number  $< 2^N$ , Asynchronous down counter, Synchronous counters, Up-down counter, Presettable counter.

(iii) Registers: Shift Register, Integrated Circuit registers, Parallel In Parallel Out (PIPO), SISO, SIPO, PISO

(iv) Applications of Counters: Frequency Counter and Digital clock.

**A/D and D/A Converter Circuits:** D/A Converter, Linear weighted and ladder type, An integrated circuit DAC; Analog-to-Digital Conversion, Digital Ramp ADC, Successive Approximation Method, Sample and Hold Circuit, Digital Voltmeter.

## UNIT – III

**Intel 8085 Microprocessor:**

Architecture, Functional diagram, Pin description, Timing Diagram of Read Cycle and write Cycle.

**Programming the 8085 Microprocessor:**

(i) Addressing Methods, Instruction set, Assembly language programming.

(ii) Examples of Assembly Language Programming: Simple Arithmetic - Addition/Subtraction of two 8-bit/16-bit numbers, Addition of two decimal numbers, Masking of digits, word disassembly.

(iii) Programming using Loops: Sum of series of 8-bit numbers, Largest element in the array, Multiple byte addition, Delay sub-routine.


## UNIT – IV

**Data Transfer Technique:**

Serial transfer, Parallel transfer, Synchronous, Asynchronous, DMA transfer, Interrupt driven Data transfer.

**8085 Interfacing:**

I/O Interfacing: Programmable Peripheral Interfacing, 8255, Programmable Peripheral Interval Timer 8253, Programmable Communication Interface 8251, DAC 0800 and ADC 0800 interfacing.

  
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**Suggested Reading:**

1. Ronald.J.Tocci (2012)“Digital Systems – Principles and applications”New Delhi, PHI Learning Pvt Ltd
2. P.K.Ghosh&P.R.Sridhar“ Introduction to Microprocessors for Engineers and Scientists”New Delhi, Pearson Education
3. Ramesh. S. Gaonkar. “Microprocessor Architecture, Programming and Applications with the 8085 /8080A” –New Delhi, PHI Learning

**SEMESTER –III**  
**COURSE – V**  
**Digital Electronics Lab**

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

**LIST OF EXPERIMENTS**

**Digital electronics**

1. Verification of Gates: AND, OR, NOT, NAND, NOR, EX –OR, EX – NOR gates
2. Encoder and Decoder
- 3 .Multiplexer and De multiplexer
4. Adders: Half adder, Full Adder, Paraller Adder
5. Flip Flops (7400, 7402, 7408, and 7446)
- 6 Decade Counter (IC 7490)
7. Seven segment Decoder/ Driver (7490, 7447)
- 8 .UP/DOWN Counter IC 74193
9. Digital Comparator (7485)
10. Microprocessor 8085
  - a. Addition/ subtraction of 8 bit numbers
  - b. Sum of series of 8 – bit numbers

  
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**SEMESTER –III**  
**COURSE– VI**  
**Solid State Physics Lab**

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

**LIST OF EXPERIMENTS**

1. Hall Effect: Determination of Hall co-efficient and estimation of charge carrier concentration and mobility.
2. ESR Studies – DPPH - Determination of 'g' value of an electron.
3. X-ray diffraction studies : Determination of lattice constant and number of atoms per unit cell
4. Lattice Dynamics: Study of Phonon Dispersion characteristics.
5. Study of Magnetic Hysteresis loops of ferromagnetic materials (B-H Curve)
6. Measurement of Magnetoresistance of Semiconductors (Four probe arrangement).
7. Coupled Oscillators: Study of the normal modes of vibrations of coupled pendulum, strength of the coupling constant and exchange energy.
8. Determination of Dielectric constant – Determination of wavelength of the microwaves in the guide of an x-band test bench and determination of dielectric constant.
9. Measurement of magnetic susceptibility of Paramagnetic solution by Quink's Method.
10. Measurement of magnetic susceptibility of Paramagnetic solids by Gouy's Method.
11. Thermoe.m.f: Calculations of thermo electric power, Fermi energy and carrier concentration of a given sample.
12. Ultrasonic Diffraction study in Liquids

  
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**SEMESTER –IV**  
**COURSE – I**  
**QUANTUM MECHANICS-II**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the course, the student will procure knowledge in:

1. The Concepts of symmetric and antisymmetric wave functions, Pauli's exclusion principle
2. Various types of approximation systems where exactly Schrodinger and Heisenberg approaches could not fit
3. Description of scattering phenomena by using quantum mechanical approaches
4. Relativistic approach for Quantum Mechanics

**PRE-REQUISITES**

Introductory Quantum Mechanics

**UNIT-I**

**IDENTICAL PARTICLES AND MOLECULES**

Identical Particles: Symmetric and anti symmetric wave functions, Indistinguishability of identical particles, Pauli's exclusion principle. Hydrogen molecule ion, Hydrogen molecule: Hitler London treatment. Oscillations and Rotations of  $H_2$ . Concept of Ortho and Para Hydrogen.

(Gupta Kumar and Sharma, Pauling and Bright Wilson)

**UNIT-II**

**APPROXIMATION METHODS**

Time-independent perturbation method. Effect of anharmonicity on the solution of harmonic oscillator problem. Time-dependent perturbation theory, transition probabilities. Variation technique: application to solve the ground state energy of He atom. WKB approximation method:  $\alpha$ -particle decay. Sudden and Adiabatic perturbations. (Gupta Kumar and Sharma)



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### UNIT-III

#### THEORY OF SCATTERING

The scattering experiment. The method of partial waves. Scattering by a central potential. Zero energy scattering. Scattering by square-well potential, effective range. Resonance scattering. Born Approximation, Validity of Born Approximation. (Aruldas)

### UNIT-IV

#### RELATIVISTIC QUANTUM MECHANICS

Klein-Gordanequation, Probability and current density, Inadequacies of Klein-Gordanequation. Dirac matrices, Dirac relativistic equation for free particles and solution. Concept of negative energy states. Theory of holes. (Gupta Kumar and Sharma)

#### Suggested Reading:

1. S.L.Gupta, V.Kumar, H.V.Sharma and R.C. Sharma (1996) "Quantum Mechanics" Jai Prakash Nath & Co. Meerut
2. G. Aruldas (2002) "Quantum Mechanics", Prentice Hall of India Pvt. Ltd, New Delhi
3. Linus Pauling and E. Bright Wilson, Jr (1935) "Introduction to Quantum Mechanics with applications to chemistry". McGraw Hill, Book Company, New York and London.

### SEMESTER –IV

#### COURSE – II

#### PROPERTIES AND CHARACTERIZATION OF MATERIALS

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

#### Course Outcome:

At the end of the course, the students will acquire knowledge in:

1. Concepts of Thermal Analysis of materials and Vacancies and Color Centres
2. Fundamental Concepts of Ferromagnetic Materials
3. Microscopic analysis of Materials like SEM, TEM
4. ESR, NMR and Mossbauer Spectroscopic Analysis
5. Electrical and Magnetic Characterization Techniques for Materials
6. Optical Spectroscopic Techniques such as IR Spectroscopy

After completion of the course Properties and Characterization of Materials students have a chance to absorb as **research fellow in various Central Research organizations which have Instrumentation facility**



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## **PRE-REQUISITES**

Solid State Physics

## **UNIT – I**

### **THERMAL PROPERTIES:**

Anharmonic crystal interactions-thermal expansion, thermal conductivity, lattice thermal resistivity, umklapp processes, and imperfections.

### **OPTICAL PROPERTIES:**

Lattice Vacancies, Diffusion, Color Centers—F Centers, other centers in alkali halides, Alloys, Order-disorder transformations, Elementary theory of Order.

## **UNIT – II**

### **FERROMAGNETISM AND ANTI-FERROMAGNETISM**

Ferromagnetism: Introduction – Weiss molecular field theory – Temperature dependence of spontaneous magnetization – Heisenberg model – Exchange interaction – Ferromagnetic domains – Magnetic bubbles – Bloch wall – Thickness and energy – Ferromagnetic spin waves – Magnons – Dispersion relations.

Anti-ferromagnetism: Introduction – Two sub lattice model of anti-ferromagnetism – Ferri magnetism - Ferrites – Structure – Applications – Multiferroics.

### **MICROSCOPIC EXAMINATION:**

Fundamentals of Transmission electron microscopy and scanning electron microscopy, study of crystal structure using TEM, study of microstructure using SEM.

## **UNIT – III**

### **RESONANCE METHODS:**

Spin and an applied field—the nature of spinning particles, interaction between spin and a magnetic field, population of energy levels, the Larmor precession, relaxation times—spin- spin relation, spin-lattice relaxation,

Electron Spin Resonance: Introduction, g-factor, experimental methods.

Nuclear Magnetic Resonance—equations of motion, line width, motional narrowing, hyperfine splitting,

Nuclear Gamma Ray Resonance: Principles of Mossbauer Spectroscopy, Line Width, Resonance absorption, Mossbauer Spectrometer, Isomer Shift, Quadrupole Splitting, magnetic field effects, Applications.

## **UNIT – IV**

### **ELECTRICAL AND MAGNETIC CHARACTERIZATION TECHNIQUES:**

DC & AC Conductivity, Curie temperature, Saturation Magnetization and Susceptibility

### **OPTICAL SPECTROSCOPY:**

Fundamentals of Infra-red Spectroscopy and Applications.

  
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### **Suggested Reading:**

1. C.Kittel "Solid State Physics" 5<sup>th</sup> edition, New Delhi, PHI Learning
2. C.N.Banwell., "Fundamentals of Molecular Spectroscopy" (5ed) New Delhi, McGraw-Hill

## **SEMESTER –IV COURSE– III COMMUNICATION ELECTRONICS**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

### **Course Outcome:**

At the end of the course, the students will be able to understand the:

1. Analog communication Techniques like AM, FM, and PM
2. Pulse modulation Schemes, Line coding Techniques, and Digital Modulation schemes
3. RF Communication related Issues RF Amplifier, Mixers, Filters, PLL, Local Oscillators
4. Noise and its sources, calculation of Noise in various modulation schemes

### **PRE-REQUISITES**

Fourier Transformations, Basics Electronics

### **UNIT-I**

#### **CW Modulation:**

Amplitude Modulation (AM):

Introduction, Amplitude modulation, modulation index, Frequency spectrum, Average power for sinusoidal AM, Amplitude modulator and demodulator circuits, Double side band suppressed carrier (DSBSC) Modulation, Super heterodyne receiver.

Single Side Band Modulation (SSB):

SSB principles, Balanced Modulator, SSB generation

Angle Modulation:

Frequency modulation (FM), sinusoidal FM, Frequency spectrum for sinusoidal FM

frequency deviation, modulation index, Average power in sinusoidal FM, FM generation

Phase Modulation: Equivalence between PM and FM, FM detectors: Slope detector, Balanced slope detector, Foster – Seely discriminator, Ratio detector, Amplitude limiter, FM receiver.

  
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## UNIT-II

### Pulse Modulation:

Digital Line Codes: Symbols, Functional notation for pulses, Line codes and wave forms: RZ, NRZ, Polar, Unipolar, AMI, HDBn and Manchester codes, M-ary encoding, Differential encoding

8 periods

Sampling theorem, Principles of pulse Amplitude Modulation (PAM) and Pulse Time Modulation (PTM), Pulse code modulation (PCM), quantization, Nonlinear quantization, companding, differential pulse code modulation (DPCM), Delta Modulation (DM).

Digital Carrier Systems:

8 periods

ASK, PSK, FSK and DPSK

## UNIT-III

### Special Communication Circuits:

6 periods

Tuned amplifiers: Single tuned amplifier-Hybrid  $\pi$  – equivalent for the BJT, Short circuit Current gain for the BJT in CE and CB amplifiers, CE and CB tuned amplifiers, Cascode amplifier, Mixer Circuits: Diode mixer, IC balanced mixer.

Filters: Active filters, Ceramic, Mechanical and crystal filters.

Oscillators: Crystal oscillator, Voltage controlled oscillator, phase locked loop (PLL).

## UNIT-IV

### Noise in Communication Systems:

8 periods

Thermal Noise, Shot Noise, Partition noise, Signal - to - Noise ratio, Noise factor, Amplifier input noise in terms of F, Noise factor of amplifiers in cascade (Friss formula), Noise temperature, Noise in AM, Noise in FM systems. Noise in pulse modulation systems: Intersymbol interference (ISI), eye Diagrams.

### Suggested Reading:

1. D. Roody and John Coolin "Electronic Communications" (5ed) New Delhi, McGraw-Hill
2. G. Kennedy "Electronic Communications Systems" New Delhi, PHI Learning
3. B.P. Lathi (2010) "Modern Analog & Digital Communications" New Delhi, PHI Learning

  
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**SEMESTER –IV**  
**COURSE– IV**  
**ANTENNA THEORY AND RADIOWAVE PROPAGATION**

Teaching hours per week	Credits	Internal marks	External marks	Maximum marks
4+1(T)	4	25	75	100

**Course Outcome:**

At the end of the, the students will have an understanding of :

1. Antenna Fundamentals, Antenna Radiating power calculations and Antenna Parameters
2. Various types of Antenna Arrays and Power, Directionality and efficiencies for different Arrays
3. Antenna Impedance Matching Techniques
4. Different types of Practical Antennas
5. How electromagnetic wave propagating in various regions of the Earth Atmosphere and Ionosphere

**PRE-REQUISITES**

Electromagnetics

**UNIT-I**

**Radiation**

Potential functions of electromagnetic fields. Potential function for sinusoidal oscillations. Fields radiated by an alternating current element. Power radiated by a current element and radiation resistance. Radiation from a quarter wave monopole or a half wave dipole. EM field close to an antenna and far field approximation.

*(Chapter 10 in Jordan and Balmain)*

**Antenna Fundamentals**

Definition of an antenna. Antenna properties – radiation pattern, gain, directive gain and directivity. Effective area. Antenna beam width and band width. Directional properties of dipole antennas.

*(Chapter 11 in Jordan and Balmain and Chapter 2 in Kraus)*

**UNIT- II**


**Antenna Arrays**

Two element array. Linear arrays. Multiplication of patterns and binomial array. Effect of Earth on vertical patterns. Mathematical theory of linear arrays. Antenna synthesis – Tchebycheff polynomial method. Wave polarization.

*(Chapter 11 and 12 in Jordan and Balmain and Chapter 4 in Kraus)*

**Impedance**

Antenna terminal impedance. Mutual impedance between two antennas. Computation of mutual impedance. Radiation resistance by induced emf method. Reactance of an antenna. Biconical antenna and its impedance.

  
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(Chapter 14 in Jordan and Balmain and Chapters 8.1 –8.5 in Kraus)

### UNIT – III

#### Frequency Independent (FI) Antennas

Frequency Independence concept. Equiangular spiral. Log Periodic (LP) antennas. Array theory of LP and FI structures.

(Chapter 15 in Jordan and Balmain and Chapter 15 in Kraus)

#### Methods of excitation and Practical Antennas

Methods of excitation and stub matching and baluns. Folded dipole, loop antennas. Parasitic elements and Yagi-Uda arrays and Helical antenna.

(Chapter 11, 15 in Jordan and Balmain)

### UNIT – IV

#### Radio Wave Propagation

Elements of Ground wave and Space wave propagation. Tropospheric propagation and Troposcatter. Fundamentals of Ionosphere. Sky wave propagation – critical frequency, MUF and skip distance.

(Chapter 16 and 17 in Jordan and Balmain)

#### Suggested Reading:

1. E.C. Jordan and K.G. Balmain (2ed) "Electromagnetic waves and Radiating Systems" New Delhi, McGraw-Hill

2. J.D. Kraus "Antennas" (Second Edition) New Delhi, PHI Learning

### SEMESTER –IV COURSE– V MICROPROCESSOR LAB

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

#### LIST OF EXPERIMENTS

1. Decimal addition of 8 – bit numbers
- 2 Addition of two 16 – bit numbers
- 3 Multibyte addition
4. Sum of series of 16 – bit numbers



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5. Word Disassembly
6. Largest number in an array
7. Ascending order of array of 8 - bit number
8. Interfacing of 8255 PPI: generation of square wave and rectangular waves
9. Interfacing of 8253 programmable timer: Mode 1, Mode2, Mode3, Mode 4, Mode5
- 10 0800 DAC interfacing : generation of square, triangular and stair case wave forms

**SEMESTER –IV**  
**COURSE – V**  
**COMMUNICATION ELECTRONICS LAB**

Practical hours per week	Credits	Internal marks	External marks	Maximum marks
6	4		100	100

**LIST OF EXPERIMENTS**

1. AMPLITUDE MODULATION
2. FREQUENCY MODULATION AND DETECTION
3. MIXER
4. BUTTERWORTH FIRST ORDER LOWPASS AND HIGHPASS FILTERS
5. CHEBYSHEV SECOND ORDER LOWPASS FILTER
6. PHASE LOCKED LOOP (PLL)
7. PULSE MODULATION-PAM-AND SAMPLING
8. STUDY OF PRE- EMPHASIS AND DE- EMPHASIS CIRCUITS
9. GENERATION OF PWAM, AND PPM USINGPLL AND 555 TIMER
10. STUDY OF FSK TRANSMISSION AND RECEPTION
11. OPTICAL FIBRE –BENDING LOSSES AND NUMERICAL APERTURE
12. MEASUREMENT OF BIT ERROR RATE (BER)
13. MEASUREMENT OF SPEED OF LIGHT IN OPTICAL FIBRE
14. DETERMINATION OF FREQUENCY AND WAVELENGTH IN A RECTANGULAR WAVEGUIDE IN  $TE_{1,0}$
15. DETERMINATION OF STANDING WAVE RATIO AT REFLECTION COEFFICIENT
16. STUDY OF ISOLATOR /CIRCULATOR



17. MEASUREMENT OF GAIN , FRONT TO BACK RATIO,BEAM WIDTH OF RADIATION PATTERN IN HALF WAVE DIPOLE
18. FIVE ELEMENT YAGI UDA ANTENNA
19. HELICAL ANTENNA
20. CUT -PARABOIDAL REFLECTOR ANTENNA



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