	GOVERNMENT COLLEGE (AUTONOMOUS) RAJAMAHENDRAVARAM *(Re-Accredited by NAAC with grade "A+")* **DEPARTMENT OF PHYSICS**	**Program & Semester** **I M.Sc., PHYSICS SEMESTER I**			
Course Code **PHY 101**	**TITLE OF THE COURSE** **MATHEMATICAL METHODS OF PHYSICS**				
Teaching	Hours Allocated: 60 (**Theory**)	L	T	P	C
Pre-requisites:		4	1	0	4

UNIT – I **15Hrs**

Fourier series and Fourier transformations: Properties of Fourier series - Evaluation of Fourier coeffi
Problems - square wave, rectangular wave, triangular wave; Fourier integral transforms, developm
Fourier integrals, Fourier transforms-infinite, Finite Fourier transforms-properties-problems-applicat
boundary value problem.

Laplace transformations: Laplace transforms - definition-properties - Laplace transform of elem
functions - Laplace transform of derivatives, Evaluation of Inverse Laplace transforms-elementary fu
method-partial fraction method-Heavy side expansionmethod-convolution method-complex inversion fo
method-application to differential equations.

UNIT – II **15Hrs**

Linear vector spaces: Linear operators – Vectors in n-dimensions – Matrix representation ofvecto
operators in a basis - Linear independence, dimension - Inner product - Schwarz inequality – Orthonorma
- Gram-Schmidt Process;

Matrices and tensors: Matrices, Eigenvalues and Eigen vectors, The Cayley-Hamilton the
Diagonalization of Matrices, Application to Physics problems. Introduction to TensorAnalysis, Additic
Subtraction of Tensors, summation convention, Contraction, Direct Product, Levi-Civita Symbol

UNIT – III **15Hrs**

Complex variables: Function of complex number-definition-properties, Analytic function- Cauchy-Ri
conditions-polar form problems, complex differentiation, complex integration-cauchy's integral the
cauchy's integral formulae-multiply connected region- problems, Limit- Continuity, Derivatives, Har
functions, Infinite series-Taylor's theorem-Laurrent's theorem-problems, Cauchy's Residue the
Evaluation of definite integrals-problems, Principal part of the functions, Residues, Residues at poles,
and poles of order m, Contour Integrals, Evaluation of improper real integrals, improper integral inv
Sines and Cosines, Definite integrals involving sine and cosine functions.

UNIT – IV **15Hrs**

Beta & Gamma functions-definition-Relation between them-properties-evaluation of some integrals S
Functions-Legendre, Hermite and Laguerre polynomials, Generating function-Recurrence for
Rodrigue's formulae, Orthonormal property Bessel equations, Partial differential equations, separat
variables, wave equation and heat conduction equation. Green's functions in one dimension.

Additional Inputs:

1. Convolution in Fourier transformations
2. Convolution in Laplace transformations

Text books:

1. M.L. Boas, Mathematical methods in the Physical Sciences, Wiley India 2006.
2. Sathyaprakash, Mathematical Physics, 2012, 6th Edition,Sultan Chand and Sons, India.
3. A. W. Joshi, 1995, Matrices and Tensors in Physics, 3rd Edition, Wiley Eastern, Madras.
4. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Ed. (2015).

Reference books:

1. G. Arfken: Mathematical Methods for Physicists, Academic Press
2. E. Kreyszig, 1999, Advanced Engineering Mathematics, 8th Edition, Wiley, New York.
3. Mathematical Methods for Physics and Engineering: *K.F. Riley, M.P. Hobson and S.J. Bence(Cambridge University Press, Cambridge)* 3rd *ed., 2006.*
4. Laplace and Fourier Transformations, Dr. J. K. Goyal and K. P. Gupta, Pragathi Prakashan,29th Ed. (2016).
5. Fourier Series and Fourier Transfoms and their applications, J. K. Goyal, K. P. Gupta, Pragathi Prakashan, 6th Ed. (2007).

<table>
<tr><td rowspan="1"></td><td colspan="1">GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade “A⁺”)
DEPARTMENT OF PHYSICS</td><td colspan="4" rowspan="2">Program & Semester
I M.Sc., PHYSICS
SEMESTER I</td></tr>
<tr><td>Course Code
PHY 102</td><td>TITLE OF THE COURSE
CLASSICAL MECHANICS</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td>0</td><td>4</td></tr>
</table>

UNIT-I:

Review of Newtonian mechanics, generalized coordinates, and constraints, principle of virtual work, D’Alembert’s principle and Lagrange’s equations, Velocity Dependent potentials and the Dissipation function and Simple applications of the Lagrangian Formulation. (**7Hrs.**)

Calculus of variations, Hamilton’s principle, Lagrange’s equation from Hamilton’s principle. Cyclic coordinates, conservation theorems and symmetry principles, Conservation of Energy (**8Hrs.)**

UNIT-II

Reduction to one body problem; equation of motion and first integral; one dimensional problemand classification of orbits; Kepler's laws; Stability of orbits, Viral theorem, Scattering in central force field; Transformation to laboratory frames. **(7Hrs.)**

Legendre transformations and Hamilton’s equations of motion, Cyclic coordinates, Derivation of Hamilton’s equation of motion from variational principle and the Principle of Least Action.**(8Hrs.)**

UNIT-III

Equations of canonical transformation, Examples of Canonical transformations - the harmonic oscillator, Lagrange and Poisson bracket as canonical invariants, Infinitesimal canonical transformations, Poisson brackets and equations of motion, the angular momentum Poisson bracket relations. **(8Hrs.)**

Hamilton- Jacobi equations for principal and characteristic functions, Harmonic oscillator problem, Action-angle variables for systems with one-degree of freedom. The Eigenvalue equation and the principal axis transformation, frequencies of free vibration and normal coordinates and free vibrations of a linear triatomic molecule; Phase trajectories – singular points, Phase trajectories of simple harmonic oscillator, Simple pendulum. **(7Hrs.)**

UNIT-IV

Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler’s theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation,Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top. (**8Hrs.)**

Internal frames, principle and postulate of relativity, Lorentz transformations; length contraction, time dilation and the Doppler effect; velocity addition formula; four-vectornotation, energy-momentum – four-vector for a particle, relativistic invariance of physical laws; Covariant formulation of Lagrangian and Hamiltonian. **(7Hrs.)**

Additional Inputs:

Binary stars, Relativistic velocity dependent potentials, Gyroscope, Lowville's theorem, Lorentz model of nonlinear system.

Prescribed books:

1. H. Goldstein, Classical Mechanics, 2nd edition, Addison & Wesley (1980).
2. J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, 2nd edition, (2003).
3. SatyaPrakash, Electromagnetic theory & Electrodynamics, KedarNath Ram Nath and Co, Meerut, 11th Edition, (2005).

References:

1. N.C.Rana and P.S.Joag,Classical Mechanics, Tata McGraw. Hill, 1st edition, (1991).
2. W. Greiner, Classical Mechanics - systems of particles and Hamiltonian dynamics, Springer-Verlag (2003).
3. G.Aruldhas, Classical Mechanics, PHI Learning Pvt.Ltd 1st edition, (2008).
4. Joseph L. McCauley, Classical Mechanics, Cambridge University Press, 1st edition, (1997).
5. John R. Taylor, Classical Mechanics, University Science Books, (2005).
6. Gupta, Kumar, Sharma, Classical Mechanics, Pragathi Prakashan, 1st Ed. (2010)

<table>
<tr><td></td><td colspan="1">GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade “A⁺”)
DEPARTMENT OF PHYSICS</td><td colspan="4" rowspan="2">Program & Semester
I M.Sc., PHYSICS
SEMESTER I</td></tr>
<tr><td>Course Code
PHY 103</td><td>TITLE OF THE COURSE
INTRODUCTORY QUANTUM MECHANICS</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td></td><td>4</td></tr>
</table>

UNIT-I **12 Hr**

Wave nature of particles, the uncertainty Principle, the principle of superposition, wave packet, Time Dependent Schrodinger wave equation, Interpretation of wave function, Ehrenfest's Theorem, Time Independent Schrodinger Equation, Stationary states, Admissibility conditions onwave function, equation of continuity.

UNIT –II **13 Hr**

Linear Vector Space, Linear Vector operators, Eigen Values and Eigen functions, Hermitian Operator, Postulates of Quantum mechanics, Dirac Notation, Equations of motion, Momentum representation,

Heisenberg method, Matrix representation of wave function, Matrix representation of operator, Properties of Matrix Elements, Schrodinger Equation in Matrix form, Eigen value problems, Unitary Transformations, Schrödinger picture, Heisenberg picture, interaction picture.

UNIT –III **13 Hr**

ONE DIMENSION PROBLEM:

Free Particle, Square well potential with rigid walls, square well potential with finite walls, squarepotential barrier, Linear Harmonic Oscillator- Schrodinger as well as operator method

THREE DIMENSIONAL PROBLEMS:

System of two interacting particles, Hydrogen Atom, Free Particle in Three dimensions, three dimensional square well potential, double well potential.

UNIT –IV **12 Hr**

The Angular momentum operators, Angular momentum commutation relations, Eigen values and Eigen functions of L^2 and Lz , General Angular momentum, Eigen values of J^2 and Jz , Angular Momentum Matrices, Spin angular Momentum, Spin Vector for spin (1/2) system, Addition of Angular Momenta.

TEXT BOOKS:

1. Quantum Mechanics Aruldhas
2. Quantum Mechanics R.D. RATNA RAJU

Reference Books:

1. Quantum Mechanics G. S. Chaddha
2. Quantum Mechanics B.H.Bransden and C.J.JoachainQuantum Mechanics E. Merzbacher
3. Quantum Mechanics Richard Liboff

<table>
<tr><td rowspan="1"></td><td>GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade "A⁺")
DEPARTMENT OF PHYSICS</td><td rowspan="2" colspan="4">Program & Semester
I M.Sc., PHYSICS
SEMESTER I</td></tr>
<tr><td>Course Code
PHY 104</td><td>TITLE OF THE COURSE
ELECTRONIC DEVICES AND CIRCUITS</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td></td><td>4</td></tr>
</table>

UNIT-I (15 Hrs)

Introduction, Constant voltage source, Constant current source, Maximum Power Transfer Theorem, Thevinins equivalent circuit, Norton's equivalent circuit, Semiconductor diode No bias, Forward Bias, Reverse Bias; Ideal versus Practical diodes, Resistance levels, Transition & diffusion Capacitors parallel -Series Configurations, AND/OR Gates, Clippers, Clampers, Voltage multipliers, Diode Full wave rectifier, Half wave rectifier, Bridge rectifier, Zener diodes, Applications.

UNIT – II (15 Hrs)

Transistor CB, CE CC configurations, DC load line, fixed bias, Emitter bias, Collectorfeedback, Voltage divider bias, emitter follower(Quantitative), Darlington pair, Current mirrors, Constant current source, Transistor switching networks .AND/OR/NOT logic gates, Hybrid parameters.

UNIT – III (15 Hrs)

Power amplifiers, Class-A, class-B, class-C classification, class-B amplifier circuits, JFET characteristics, D- MOSFET, E-MOSFET, Schottky diode, Varactor diode, Solar cell, Photo diode, Photo conductive cells, Tunnel diode, SCR, Voltage regulator, fixed, adjustable voltage regulators.

UNIT – IV (15 Hrs)

Operational Amplifiers Block diagram, Parameters- Offset voltage & Currents, Gain, Band width, Slew rate, CMRR, Inverting and non-inverting, Unit follower, Summing amplifier , Integrator, Differentiator, Controlled sources, Active filters, A/D, D/A converters, 555 Astable multivibrator, Monostable multivibrator, Voltage controlled oscillator, Phase locked loop, feedback, effect of negative feedback on gain & band width, Phase shift oscillator, Wien bridge oscillator.

Additional Inputs:

Application of diode as AM Demodulator, Varactor diode in OLED, hybrid- π model, Diac, Triac, Photo detector, RC filters, series, Shunt voltage regulator

Prescribed books:

1. Electronic devices & circuit theory, 11th edition, Robert.L.Boyslestad, Louis Nashelsky, Pearson(2013)
2. Principles of electronics, V.K.Mehta, Rohit Mehta, S.Chand(2005)(Multicolour edition)
3. A text book of applied electronics, R.S.Sedha, S.Chand (2006)
4. Op-Amps and Linear integrated circuits, Ramakant A. Gayakwad, Pearson, 4th Ed. (2015)

References:

1. Electronic devices-conventional current version, Thomas L Floyd, 9th edition Prentice hall

(2012)
2. OP- AMPS and linear integrated circuits-Ramakanth.A Gayakwad, 4th Edition, Pearson hall (2015)
3. Linear integrated circuits-D.Roy chowdary Shaili BJani, 4th edition, (2011).
4. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition. (1998)
5. Integrated Electronics- Jacob Millman, C. Halkies, C.D.Parikh, Tata Mc-Graw Hill, 2nd Ed. (2009

UNIT 1: Statistical description of systems of particles (15 Hrs)

Specifications of the state of a system, phase space and quantum states, Liouvilles theorem, basic properties, probability calculations, concept of ensembles, thermal interaction, mechanical interaction, general interaction, quasi static process, distribution of energy between systems in equilibrium, statistical calculations of thermo dynamic quantities, reversible and irreversible processes, thermal interaction between macroscopic states, sharpness of probability distribution, properties of the entropy. The four potentials, Maxwell's relation among the four potentials, Exact and inexact differentials.

	GOVERNMENT COLLEGE (AUTONOMOUS) **RAJAMAHENDRAVARAM** ***(Re-Accredited by NAAC with grade "A$^+$")*** **DEPARTMENT OF PHYSICS**	**Program & Semester**			
Course Code **PHY 201**	**TITLE OF THE COURSE** **STATISTICAL MECHANICS**				
Teaching	Hours Allocated: 60 (**Theory**)	L	T	P	C
Pre-requisites:		4	1		4

UNIT 2: Basic methods and results of statistical mechanics (15 Hrs)

Isolated systems (micro canonical ensemble), Entropy of a perfect gas in micro canonical ensemble. Canonical ensemble-system in contact with heat reservoir, system with specified mean energy, connection with thermodynamics, energy fluctuation in the canonical ensemble, grand canonical ensemble, thermodynamic function for the grand canonical ensemble, densityand energy fluctuations in grand canonical ensemble, thermodynamic equivalence of ensembles.

UNIT 3: Simple applications of statistical mechanics (15 Hrs)

Partition functions and their properties, calculation of thermodynamic quantities to an ideal mono atomic gas, Gibbs paradox, validity of the classical approximation, proof of the Equi partition theorem, simple applications- mean kinetic energy of a molecule in a gas, Brownian motion, harmonic oscillator, specific heats of solids (Einstein and Debye model of solids), Para magnetism, partition function for poly atomic molecules, electronic energy, Vibrational energy and rotational energy of a diatomic molecule, effect of `nuclear spin Ortho and Para hydrogen.

UNIT 4: Quantum statistics (15 Hrs)

Formulation of the statistical problem, Maxwell-Boltzmann statistics, photon statistics, Bose-Einstein statistics, Fermi Dirac statistics, quantum statistics in the classical limit, calculation ofdispersion for MB, BE and FB statistics equation of state of an ideal Bose gas, black body radiation, Bose- Einstein condensation, equation of state for a weakly degenate and strongly degenerate ideal Fermi gas. Thermionic emission, the theory of white dwarf stars.

TEXT BOKS;

1. Fundamentals of statistical and thermal physics – F. REIF
2. Statistical mechanics, theory and applications – S.K. SINHA
3. Statistical mechanics –R.K. PATHRIA
4. Statistical mechanics- B.K. AGARWAL AND M.EISNER
5. Relativistic mechanics –SATYAPRAKASH, PRAGATHI PRAKASHAN

UNIT – I **15 hr**

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

	GOVERNMENT COLLEGE (AUTONOMOUS) RAJAMAHENDRAVARAM *(Re-Accredited by NAAC with grade “A+”)* DEPARTMENT OF PHYSICS	**Program & Semester** **I M.Sc., PHYSICS** **SEMESTER II**			
Course Code **PHY 202**	**TITLE OF THE COURSE** **NUCLEAR AND PARTICLE PHYSICS**				
Teaching	Hours Allocated: 60 (**Theory**)	L	T	P	C
Pre-requisites:		4	1		4

Nuclear Forces.

UNIT – II **15 hr**

NUCLEAR MODELS: Liquid drop model: Weissacker’s semi-emperical 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: β-decay**,** Fermi’s Teory of - β decay, parity violation in - β decay, detection and properties of neutrino. Energetics of gamma deacay, selection rules, angular correlation, Mossbauer effect.

UNIT – III **15 hr**

NUCLEAR REACTIONS: Types of reactions and conservation laws, the Q – equation, Optical model, Compound Nucleus.

NUCLEAR ENERGY Stability limit against spontaneous fission, Characteristics of fission, delayed neutrons, four factor formula for controlled fission, Nuclear fusion, prospects of continuedfusion energy.

DETECTING NUCLEAR RADIATION: Interaction of radiation with matter, Gas filled counters- Ionization Chamber, GM Counter, scintillation detectors, semiconductor detectors, energy measurements, buble chamber, magnetic spectrometers.

UNIT – IV **15 hr**

ACCELERATORS: Electrostatic accelerator-Vandegraff accelerator, cyclotron accelerators, synchrotrons, linear accelerators, colliding beam accelerators.

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.

TEXT BOOKS:

1. “Introductory Nuclear Physics” Kenneth S. Krane

REFERENCE BOOKS:

1. “Introduction to Nuclear Physics “ Harald A.Enge

UNIT-I **12 Hrs**

ONE ELECTRON ATOMS: Quantum numbers, Term values, Relation between Magnetic dipole moment and angular momentum of an orbiting electron. Stern–Gerlach experiment andelectron spin, Spin- orbit interaction, relativistic kinetic energy correction

	GOVERNMENT COLLEGE (AUTONOMOUS) **RAJAMAHENDRAVARAM** ***(Re-Accredited by NAAC with grade "A⁺")*** **DEPARTMENT OF PHYSICS**	**Program & Semester** **I M.Sc., PHYSICS** **SEMESTER II**
Course Code **PHY 203**	**TITLE OF THE COURSE** **ATOMIC AND MOLECULAR PHYSICS**	

		L	T	P	C
Teaching	Hours Allocated: 60 (**Theory**)	L	T	P	C
Pre-requisites:		4	1		4

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 line of hydrogen (I = ½).

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 **10 Hrs**

MANY ELECTRON ATOMS: Indistinguishable particles, bosons, fermions, Pauli's principle, Ground states. LS coupling and Hund's rules based on Residual coloumbic 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 **8 Hrs**

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 line of hydrogen, weak field and strong field Stark effects in Hydrogen, Quadratic stark pattern of D1 and D2 lines of Sodium.

UNIT-IV **20 Hrs**

DIATOMIC MOLECULES: Molecular quantum numbers, bonding and anti-bonding orbitals from LCÅ's Explanation of bond order for N2 and O2 and their ions, Rotational spectra and the effect of isotopic substitution. Effect of nuclear spin functions on Raman rotation spectra of

H2 (Fermion) and D2 (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.

BOOKS:

1. Atomic and Molecular Spectra- Raj Kumar
2. Fundamentals of Molecular Spectroscopy- C.N.Banwell.
3. Group Theory- K. V. Raman.
4. Introduction to Atomic Spectra- H. E. White.

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 equationin the solutions of electrostatic problems.

Ampere's circuital law, Biot-savart's law, magnetic vector potential, displacement current, Electric Polarization, Gauss theorem in di-electric medium, Magnetic field intensity (H), Faraday's laws of electromagnetic Induction, Lenz's law.

	GOVERNMENT COLLEGE (AUTONOMOUS) RAJAMAHENDRAVARAM *(Re-Accredited by NAAC with grade "A+")* DEPARTMENT OF PHYSICS	**Program & Semester**			
Course Code **PHY 105**	**TITLE OF THE COURSE** **ELECTRONICS & MODERN PHYSICS LAB – I**	**I M.Sc., PHYSICS SEMESTER I**			
Teaching		L	T	P	C
Pre-requisites:		0	0	12	8

UNIT-II:

Maxwell's equations, differential and integral forms, physical significance of Maxwell's equations, boundary conditions on the fields at interface.

Electromagnetic energy, Poynting theorem, Poynting vector (S), Wave equation, plane electromagnetic waves in free space, wave impedance (Z), in non-conducting isotropic medium, in conducting medium, Skin depth, electromagnetic vector and scalar potentials, uniqueness theorems of electromagnetic potentials, 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:

Vector and Scalar potentials; Lienard-Wiechart potentials, electromagnetic fields from Lienard-wiechart 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, Brehmsstrahlung, cyclotron and synchrotron 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 electromagentic 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, Transmission lines , Types of wave guides and its applications.

Text books:

1. *Electromagnetic Theory and Electrodynamics* – Satyaprakash
2. *Introduction to Electrodynamics*, by David J. Griffiths, Prentice-Hall, Inc.(1999)
3. J.D.Jackson, *"Classical Electrodynamics"*, 3rd Ed., Wiley (2007).
4. *Classical Theory of Electromagnetism*, by Baldassare, Di Bartolo, Prentice-
5. Hall (1991).
6. *Electromagnetic Fields and Waves*, by Corson and Lorrain, W. H. Freeman and Co.(1970).
7. *Foundations of Electromagnetic Theory*, by Reitz and Milford, Addison-Weseley (1967

UNIT – I: LINEAR EQUATIONS AND INTERPOLATION

Error analysis: Source of errors, Significant digits, Round-off error,

Solution of algebraic and transcendental equations: Bisection method, Method of false position and

	GOVERNMENT COLLEGE (AUTONOMOUS) RAJAMAHENDRAVARAM *(Re-Accredited by NAAC with grade "A+")* DEPARTMENT OF PHYSICS	**Program & Semester**			
Course Code **PHY 301**	**TITLE OF THE COURSE** **NUMERICAL METHODS AND FORTRAN**	**II M.Sc., PHYSICS SEMESTER III**			
Teaching	Hours Allocated: 60 (**Theory**)	L	T	P	C
Pre-requisites:		4	1		4

Newton-Raphson method, Gauss-Jordan Method, Gauss Seidel method.
Interpolation: Finite differences (forward, backward and central difference), Newton's formula for Interpolation, Cubic-spline interpolation. **(Sastry) 15Hrs**

UNIT – II: NUMERICAL DIFFERENTIATION & INTEGRATION

Differentiation: Based on interpolation, Finite differences method, Method of undetermined coefficients.
Numerical Integration: Trapezoidal Rule, Simpson's 1/3 Rule and 3/8 Rule, modified Simpson's 1/3 rule.
Numerical solutions of ordinary differential equations: Euler's method and Range-Kutta method,
. (Das & Sastry) **15Hrs**

UNIT- III: FORTRAN BASICS AND CONTROL STATEMENTS

1. Introduction to Computing : Introduction to Digital Computers, Operating Systems, Linux, Windowsand other Operating Systems, Open Source Foundation Free and Open Source Software (FOSS) and GNU, Programming and Problem Solving. **5Hrs**

2. Basic Fortran : Introduction to Fortran, Data Types, Constants, and Variables, Operation and IntrinsicFunctions, Expressions and Assignment Statements, Simple Input/Output, Program Structure, Example: Simple Unit Conversion **5Hrs**
3. Control Constructs: Logical Operators and Logical Expression, If Constructs, The Case Construct, Do Loops. **5Hrs**

UNIT-IV: FORTRAN FUNCTIONS SUBROUTINES ARRAYS FILES

4. Programming Units: Types of Programming Units, Main Program, Subroutines, Functions, Arguments of Procedures, Scope of Variables, Recursion. Call by name and call by reference.
5Hrs
5. Arrays and Array Operations: Arrays in Fortran, Array Processing, Array Constructors, Mask Array, Allocatable Arrays, Arrays Passed as Argument to Procedures, Functions Return Arrays, Other Data Types: Parameterized Data Types, The Complex Data Type.
Fortran I/O and External Files: Formatted Output, Formatted Input, File Processing'**10 Hrs**

Additional inputs:

Additional inputs: Graphics (Gnuplot), The Gnuplot Scientific Graphic Library, Linking Fortran Programs to GnuPlot Graphic Library. The Fortran Scientific Libraries: The Slatec library of scientificsubroutines, The Linpack and Lapack Numerical Libraries.

References:

1. Numerical methods, E. Balagurusamy, 1st Ed., TMH (1999).
2. Numerical methods for scientists and Engineers, Antia HM, TMH (1991).

3. Computer oriented Numerical Methods, V. Rajaraman, PHI (2006).
4. FORTRAN 77 Reference manual, Sun microsystems

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. **8 Hrs**

	GOVERNMENT COLLEGE (AUTONOMOUS) RAJAMAHENDRAVARAM *(Re-Accredited by NAAC with grade “A+”)* DEPARTMENT OF PHYSICS	**Program & Semester** **II M.Sc., PHYSICS** **SEMESTER III**			
Course Code **PHY 302**	**TITLE OF THE COURSE** **SOLID STATE PHYSICS**				
Teaching	Hours Allocated: 60 (**Theory**)	L	T	P	C
Pre-requisites:		4	1		4

CRYSTAL DIFFRACTION AND RECIPROCAL LATTICE:

Bragg’s law, Experimental diffraction methods-- Laue method and powder method, Derivationof scattered wave amplitude, indexing pattern of cubic crystals and non-cubic crystals (analytical methods). Geometrical Structure Factor, Determination of number of atoms in a celland position of atoms. Reciprocal lattice, Brillouin Zone, Reciprocal lattice to bcc and fcc Lattices. **7 Hrs**

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. **7 Hrs**

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- Halleffect, Ratio of thermal to electrical conductivity. **8 Hrs**

UNIT-III

THE BAND THEORY OF SOLIDS:

Nearly free electron model, Origin of the energy gap, The Block 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 distinctionbetween metals, insulators and semiconductors. **15 Hrs**

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 TC superconductors, Preparation, Properties. **15 Hrs**

UNIT-I: IDENTICAL PARTICLES AND MOLECULES:

In distinguishability of identical particles, Symmetric and anti-symmetric wave functions and **their construction**, Pauli's exclusion principle. Hydrogen molecule ion, Hydrogen molecule -Hitler London treatment. Oscillations and Rotations of H2.Concept of Ortho and Para Hydrogen. (15 Hrs)

(Gupta Kumar and Sharma; Pauling and Bright Wilson)

	GOVERNMENT COLLEGE (AUTONOMOUS) RAJAMAHENDRAVARAM *(Re-Accredited by NAAC with grade "A+")* DEPARTMENT OF PHYSICS	Program & Semester II M.Sc., PHYSICS SEMESTER III			
Course Code **PHY 303**	**TITLE OF THE COURSE** **ADVANCED QUANTUM MECHANICS**				
Teaching	Hours Allocated: 60 (**Theory**)	L	T	P	C
Pre-requisites:		4	1		4

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 method and its application to the ground state energy of helium atom, exchange energy and low lying excited states of helium atom. WKB method, barrier penetration of alpha-particle decay, Sudden and Adiabatic perturbations. (15 Hrs)

(Gupta Kumar and Sharma)

UNIT-III: THEORY OF SCATTERING:

Basic Cpncepts of Scattering, the scattering experiment - Quantum Mechanical Description of Scattering, 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. (15 Hrs)

(Gupta Kumar and Sharma; Aruldhas)

UNIT-IV: RELATIVISTIC QUANTUM MECHANICS:

Klein-Gordan equation for free particle and Probability and current density, **Klein-Gordan equation in presence of electromagnetic field,** Inadequacies of Klein-Gordan equation.
Dirac matrices, Dirac relativistic equation for free particle and its solution and concept of negative energy states. (15 Hrs)

(Gupta Kumar and Sharma)

TEXT BOOKS

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

REFERENCE BOOKS

1. Quantum Mechanics by B.K.Agarval and Hariprakash, Prentice-Hall of India Ltd., New Delhi, (1997).
2. Quantum Mechanics. L.I.Schiff, Mc Graw Hill Book Co.,Tokyo, (1968)
3. Modern Quantum Mechanics. J.J.Sakurai, Addison- Wesley, Tokyo, (1968).
4. A Text Book of Quantum Mechanics. P.M.Mathews and K.Venkateswaran, Tata McGraw Hill, New Delhi, (1976).
5. Introduction to Quantum Mechanics, R.H.Dicke and J.P.Witke, Addison-Wisley Pub. Co. Inc.,London, (1960).
6. Quantum Mechanics, V.K.Tankappan, Wiley-Eastern Ltd.,New Delhi, (1985).

UNIT-I **(10 Hrs)**

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

<table>
<tr><td></td><td colspan="1">GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade “A^+”)
DEPARTMENT OF PHYSICS</td><td colspan="4" rowspan="2">**Program & Semester**
II M.Sc., PHYSICS
SEMESTER III</td></tr>
<tr><td>Course Code
PHY 304</td><td>**TITLE OF THE COURSE**
DIGITAL, COMMUNICATION ELECTRONICS & MICROPROCESSOR</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (**Theory**)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td></td><td>4</td></tr>
</table>

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 **(15 Hrs)**

Sequential Logic Circuits: (i) Flip-Flops and Related Devices: NAND latch, NOR latch, Clockedflip-flops, Clocked S-C flip-flop, J-K flip-flop, D flip-flop, D latch, Asynchronous inputs, and Timingproblem in flip-flops.

(ii) Counters: Asynchronous counters (Ripple), Counters with MOD number < 2N, 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 **(15 Hrs)**

Amplitude Modulation:

Need for 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, Single Side Band Modulation (SSB)

Frequency 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. Sampling theorem

Additional inputs

Filters: Active filters and crystal filters. Oscillators: Crystal oscillator, Voltage controlled oscillator, phase locked loop (PLL).

UNIT –IV **(20 Hrs)**

Intel 8085 Microprocessor:

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

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.

Prescribed books:

1. "Digital Systems – Principles and applications" –Ronald.J.Tocci,
2. "Fundamentals of Microprocessors & Microcomputers" - B. RAM.
3. " Introduction to Microprocessors for Engineers and Scientists" - P.K.Ghosh and P.R.Sridhar
4. "Microprocessor Architecture, Programming and Applications with the 8085 /8080A" Ramesh. S. GÅnkar.
5. Electronic Communications D. Roody and John Coolin
6. Electronic Communications Systems G. Kenned
7. Modern Analog & Digital Communications B.P. Lathi.

Digital Electronics Lab:

Simulations:
1. Synchronous, Asynchronous counters
2. Modulus counter
3. Digital clock design.

Hands on:
1. Encoder and Decoder, Multiplexer and De multiplexer
2. Adders: Half adder, Full Adder, Paraller Adder
3. Flip Flops (7400, 7402, 7408, and 7446)
4. Decade Counter (IC 7490) and Seven segment Decoder/ Driver (7490,7447)
5. UP/DOWN Counter IC 74193
6. Digital Comparator (7485)

Solid State Physics Lab:

1. Particle size analysis using laser and Airy rings
2. Study of dielectric constant as a function of temperature.
3. Determination of refractive index of rectangular glass slab using laser.
4. Quinck's tube method for the measurement of paramagnetic susceptibility of liquid
5. Powder XRD snalysis of NaCl and KCl
6. B-H Curve

7. Lattice dynamics
8. Resistivity measurement of a thin film using four probe
9. Hall coefficient of given semiconductor material

<table>
<tr><td>(logo)</td><td colspan="1">GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade “A+”)
DEPARTMENT OF PHYSICS</td><td rowspan="2" colspan="4">Program & Semester
II M.Sc., PHYSICS
SEMESTER III</td></tr>
<tr><td>Course Code
PHY 305</td><td>TITLE OF THE COURSE
DIGITAL ELECTRONICS & SOLID STATE PHYSICS LAB</td></tr>
<tr><td>Teaching</td><td></td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>0</td><td>0</td><td>12</td><td>8</td></tr>
</table>

Digital Electronics Lab:

Simulations:

1. Synchronous, Asynchronous counters
2. Modulus counter
3. Digital clock design.

Hands on:

1. Encoder and Decoder, Multiplexer and De multiplexer
2. Adders: Half adder, Full Adder, Paraller Adder
3. Flip Flops (7400, 7402, 7408, and 7446)
4. Decade Counter (IC 7490) and Seven segment Decoder/ Driver (7490,7447)
5. UP/DOWN Counter IC 74193
6. Digital Comparator (7485)

Solid State Physics Lab:

1. Particle size analysis using laser and Airy rings
2. Study of dielectric constant as a function of temperature.
3. Determination of refractive index of rectangular glass slab using laser.
4. Quinck’s tube method for the measurement of paramagnetic susceptibility of liquid
5. Powder XRD snalysis of NaCl and KCl
6. B-H Curve
7. Lattice dynamics
8. Resistivity measurement of a thin film using four probe
9. Hall coefficient of given semiconductor material

<table>
<tr><td></td><td>GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade “A+”)
DEPARTMENT OF PHYSICS</td><td colspan="4" rowspan="2">Program & Semester
II M.Sc., PHYSICS
SEMESTER IV</td></tr>
<tr><td>Course Code
PHY 401</td><td>TITLE OF THE COURSE
LASERS & NON – LINEAR OPTICS</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td></td><td>4</td></tr>
</table>

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,CO2 Laser, Dye laser, Excimer laser, Semiconductor laser. **(15 Hrs)**

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 Intensityfor modes oscillating at random and modes locked in phase. Methods of Q-Switching and Mode locking. **(15 Hrs)**

UNIT-III

OPTICAL FIBER WAVE GUIDES: 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.
Chirped Pulse Amplification concept**.** **(8 Hrs)**

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 andintermodal 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.

(7 Hrs)

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) **(15 Hrs)**

Prescribed Books:

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

Reference Books:

1. Laser fundamentals – William T. Silfvast (Cambridge)
2. Introduction to fiber optics – Ajoy Ghatak and K. Thyagarajan (Cambridge)
3. Optical Electronics – Ajoy Ghatak and K.Thyagarajan (Cambridge)
4. Opto- electronics – J. Wilson and J.F.B. Hawkes (Printice Hall

<table>
<tr><td rowspan="1"></td><td colspan="1">GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade “A⁺”)
DEPARTMENT OF PHYSICS</td><td colspan="4" rowspan="2">Program & Semester
II M.Sc., PHYSICS
SEMESTER IV</td></tr>
<tr><td>Course Code
PHY 402</td><td>TITLE OF THE COURSE
PROPERTIES AND CHARACTERIZATION OF MATERIALS</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td></td><td>4</td></tr>
</table>

UNIT – I

THERMAL PROPERTIES:

Basic Material properties-Anharmonic crystal interactions-thermal expansion, thermal conductivity, lattice thermal resistivity, umklapp processes, and imperfections. (7 Hrs)

OPTICAL PROPERTIES:

Lattice Vacancies, Diffusion, Color Centers—F Centers, other centers in alkali halides, Alloys, Order- disorder transformations, Elementary theory of Order. (8 Hrs)

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.(15 Hrs)

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. (15 Hrs)

UNIT - IV

MATERIAL CHARACTERIZATION TECHNIQUES:

XRD data analysis, Microscopic techniques: SEM, TEM, AFM, Spectroscopic techniques: UV, FTIR, RAMAN, Macroscopic techniques: DTA, DSC, TGA, Cole-Coleplots, Hysteresis, DLS.

DC & AC Conductivity, Curie temperature, Saturation Magnetization and

Susceptibility.(15 Hrs)

TEXT BOOKS:

1. Solid State Physics, 5th edition, C.Kittel
2. Fundamentals of Molecular Spectroscopy CN BanwellMossbauer Effect and its applications VG Bhide
3. Solid State Physics. M. A. Wahab

<table>
<tr><td></td><td colspan="1">GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade "A+")
DEPARTMENT OF PHYSICS</td><td colspan="4" rowspan="2">Program & Semester
II M.Sc., PHYSICS
SEMESTER IV</td></tr>
<tr><td>Course Code
PHY 403</td><td>TITLE OF THE COURSE
THEORY AND PHYSICS OF NANO MATERIALS</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td></td><td>4</td></tr>
</table>

Unit - I

Concepts of Nano-Science

Nano size, top- down and bottom - up approaches, size matters reduction of dimensionality and surface to volume ratio, changes to the system total energy, changes to the system structure, structural properties, thermal properties, chemical properties, mechanical properties, magnetic properties, optical properties and electronic properties of nano - scale systems. (15 Hrs)

Unit - II

Nano materials

Introduction, materials used in nano technology, Fullerenes - discovery , variations of Bucky balls, Bucky tubees, Properties of Fullerenes - aromaticity, chemistry of Fullerenes, solubility of fullerenes and quantum mechanics of fullerenes, synthesis of nano mateirals - ball milling and sol gel methods. (15 Hrs)

Unit - III

Carbon nanotubes

Discovery, structure of nano tubes, Types of nano tubes- single walled nano tubes (SWNT) and multi walled nanotubes (MWNT), types of SWNT - chiral, armchair and zig zag, properties of nano tubes - strength, electrical conductivity, thermal conductivity, transport, optical activity and chemical activity. (7 Hrs)

Theory of Nano tubes

The continuum shell theories of mechanics of carbon nano tubes, parameterization of continuum theories for single wall carbon nano tube repeat space theory applied to carbon nano tubes, modelling and analysis of carbon nano tube bucking using thick shell theory - Effective medium theory of optica properties of CNTs. Theory of electric charge - enhancements in carbon nano tubes. (8 Hrs)

Unit - IV

Synthesis of Nano tubes

Growth mechanisms of CNT - tip growth and root growth , Arc discharge method - synthesis of SWNT and MWNNT, Laser Ablation method, Plasma Enhanced CVD, Laser Assisted Thermal CVD, and Flame synthesis, purification of CNTs - Oxidation, Annealing, Magnetic purification. (15 Hrs)

References

1. Nano technology by William Illsey Alkinson, Jaico Books
2. Apppliacablity of the continnum shell theories, VM Harik, TS Gate & MPNemeth, NASA
3. Wondrous world of carbon nano tubes by M. Daenen and R.D de Fouw

<table>
<tr><td rowspan="1"></td><td>GOVERNMENT COLLEGE (AUTONOMOUS)
RAJAMAHENDRAVARAM
(Re-Accredited by NAAC with grade "A+")
DEPARTMENT OF PHYSICS</td><td colspan="4" rowspan="2">Program & Semester
II M.Sc., PHYSICS
SEMESTER IV</td></tr>
<tr><td>Course Code
PHY 404</td><td>TITLE OF THE COURSE
RESEARCH APTITUDE & DATA ANALYSIS</td></tr>
<tr><td>Teaching</td><td>Hours Allocated: 60 (Theory)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Pre-requisites:</td><td></td><td>4</td><td>1</td><td></td><td>4</td></tr>
</table>

UNIT – I
15Hrs

Research: Meaning, Types, and Characteristics, Positivism and Post-positivistic approach to research. ***Methods of Research***: Experimental, Descriptive, Historical, Qualitative and Quantitative methods. (7 Hrs)
Steps of Research. Thesis and Article writing: Format and styles of referencing. Applicationof ICT in research. Research ethics and Plagiarism policies. (8 Hrs)

UNIT – II
15Hrs

Statistical Methods: Random number generation, Visual representation of statistical data, mean-mode-median, Binomial-Poisson-Gaussian distributions, Variance, Standard deviation, Uncertainty and other errors in statistical data, Confidence interval, Testing of hypothesis.

UNIT – III
15Hrs

Error analysis and curve fitting: Types of errors, random and systematic errors, error flow, accuracy and precision, least square fit, chi-square test, Linear and nonlinear curve fitting.

UNIT – IV
15Hrs

Software tools: Data analysis and curve fitting, plotting tools in MS-Excel, ORIGIN, MATLAB/OCTAVE, Fundamentals of programming in MATLAB/OCTAVE

Prescribed books:

1. A. Bevan, "Statistical Data Analysis for the Physical Sciences", Cambridge UniversityPress.
2. Materials characterization: introduction to microscopic and spectroscopictechniques, Yang Leng, John Wiley 2009.
3. Getting started with MATLAB, Rudra Pratap, Oxford University press,

2010.

Reference Books:

1. F. James, “Statistical Methods in Experimental Physics”, World Scientific Publishing Comp Company
2. D. Placko, “Fundamentals of Instrumentation and Measurement”, ISTE Ltd.
3. A. S. Morris, “Measurement and Instrumentation Principles”, Butterworth-Heinemann.

Solid State Physics Lab:

	GOVERNMENT COLLEGE (AUTONOMOUS) **RAJAMAHENDRAVARAM** ***(Re-Accredited by NAAC with grade "A⁺")*** **DEPARTMENT OF PHYSICS**	**Program &** **Semester** **II M.Sc., PHYS** **SEMESTER IV**
Course Code **PHY 405**	**TITLE OF THE COURSE** **SOLID STATE PHYSICS and MICROPROCESSOR LAB**	
Teaching		L | T | P
Pre-requisites:		0 | 0 | 12

1. Green Synthesis of metal oxide (ZnO or MgO) nanoparticles by Precipitation method
2. Synthesis of metal oxide(ZnO or MgO) nanoparticles by Sol-gel method
3. Synthesis of nanoparticles in Polyol method
4. Determination of absorbance peak and band gap using UV photo spectrometer for a given sample
5. Identification of functional groups in a given sample (powder form) using FTIR characterization technique
6. Identification of functional groups in a given sample (Liquid form) using FTIR characterization technique
7. Identification of diffraction peak positions (2 theta) from given XRD data using Origin /Scidavis software.
8. Identification of Miller Indices and lattice parameters for given XRD data using X'pert High Score software
9. Electron Spin Resonance DPPH - Determination of 'g' value of an electron.

Microprocessor Lab:

1. Addition/ subtraction of 8-bit numbers
2. Sum of series of 8 – bit numbers
3. Largest / Smallest number in an array of 8 – bit numbers
4. Addition of two 16 – bit numbers
5. Ascending / Descending order of 8 – bit numbers
6. Multiplication of two 8 – bit numbers
7. Separate even numbers from given numbers
8. Find the square of given number