NEHRU MEMORIAL COLLEGE [AUTONOMOUS]

PUTHANAMPATTI – 621 007.

M.Sc., PHYSICS

SYLLABUS

UNDER CHOICE BASED CREDIT SYSTEM [CBCS]

[FOR THE CANDIDATES ADMITTED FROM THE YEAR 2015-2016 ONWARDS)

2015

Sem.	Course Code	Title of Course	Inst. Hours/ Week	Credits	Marks		
					Int.	Ext.	Total
I	15PP101	CC-I Mathematical Physics - I	6	5	40	60	100
	15PP102	CC-II Classical Dynamics and Special Relativity	6	5	40	60	100
	15PP103	CC-III Analog and Digital Electronics	6	5	40	60	100
	15PP104	CC-IV Instrumentation Techniques	6	5	40	60	100
	15PP205L	CC-V Practical –I General Physics and Computer Programming	3	--	--	--	--
	15PP206L	CC-VI Practical –II Electronics and Instrumentation	3	--	--	--	--
II	15PP205L	CC-V Practical –I General Physics and Computer Programming	3	4	40	60	100
	15PP206L	CC-VI Practical –II Electronics and Instrumentation	3	4	40	60	100
	15PP207	CC- VII Mathematical Physics - II	6	5	40	60	100
	15PP208	CC-VIII Electromagnetic Theory	6	5	40	60	100
	15PP209	CC-IX Quantum Mechanics	6	5	40	60	100
	15PP210	EC-I Microcontroller and Its Applications	6	4	--	100	100
III	15PP311	CC-X Statistical Mechanics	6	5	40	60	100
	15PP312	CC-XI Nuclear and Particle Physics	6	5	40	60	100
	15PP313L	CC-XII Practical – III Advanced General Physics	3	--	--	--	--
	15PP314L	CC-XIII Practical – IV Digital Electronics and Microcontroller Programming	3	--	--	--	--
	15PP315	EC-II Atomic and Molecular Physics	6	4	40	60	100
	15PP316	EC-III Crystal Growth and Thin films	6	4	40	60	100
IV	15PP313L	CC-XII Practical – III Advanced General Physics	3	4	40	60	100
	15PP314L	CC-XIII Practical – IV Digital Electronics and Microcontroller Programming	3	4	40	60	100
	15PP416	CC- XIV Solid State Physics	6	4	40	60	100
	15PP417	EC-IV Electronic Communication Systems	6	4	40	60	100
	15PP418	EC- V Nano Science	6	4	40	60	100
	15PP419P	CC-XV Project*	6	5	40	60	100
			120	90	Total Marks		2000

Semester	I	CC-I MATHEMATICAL PHYSICS-I	Hours	6
Course Code	15PP101		Credit	5

Objectives:

- To introduce the concepts of Vector Analysis and Vector Space.
- To learn the concepts of Fourier Serious and Laplace Transform.
- To learn the concepts of first and second order Differential Equations.
- To learn the concepts of Special Function and Green Function.

UNIT – I VECTOR ANALYSIS

Scalar and Vector Fields – Gradient, Divergence and Curl – Rectangular, Cylindrical and Spherical Polar Co-ordinates Systems – Line, Surface and Volume Integrals – Stokes Theorem – Gauss Divergence Theorem – Green's Theorem.

UNIT – II FOURIER SERIES AND LAPLACE TRANSFORM

Fourier series of periodic functions in different possible periods – Fourier Cosine and Sine Series. Laplace Transform: Properties – Convolution Theorem – Inverse Laplace Transform – Evaluation of Second Order Linear Ordinary Differential Equation.

UNIT – III LINEAR ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS:

Linear first & second order differential equations with constants coefficients: Elementary Methods – Linear second order differential equations with variable coefficients: Frobenius method, Method of Variation of Parameters and Stum Liouville's problems. Linear Partial Differential Equations **-** Wave, Laplace and Diffusion Equations (2D & 3D) by the method of separation of variables.

UNIT IV SPECIAL FUNCTIONS

Gamma and Beta functions – Legendre, Laguerre, Bessel and Hermite differential equations: Series Solutions, Generating function, Rodrigue formula, Recurrence Relations and Orthogonality Relations.

UNIT V GREEN FUNCTION AND PROBABILITY

Delta functions - Symmetry property of Green function – Methods of Evaluations.

Probability- Addition-Multiplication theorems- Baye's theorem-Normal distribution-Poison distribution and Binomial distribution-Properties.

Books for Study

1. *Satya Prakash, "Mathematical Physics", Sultan Chand and Sons, New Delhi (2008), (Unit I,III, IV and V)*
2. *P.K.Chattopadhyay, Mathematical Physics, New Age International Pvt., Ltd., New Delhi, (2004) (Unit II, V)*

Books for Reference

1. *E. Kreyszig, "Advanced Engineering Mathematics" Wiley (8th Ed), New York (1999)*
2. *M. D. Greenbreg, "Advanced Engineering Mathematics" Pearson Education P. Ltd, (2nd Ed), Singapore, (1999).*
3. *B. D. Guptha, "Mathematical Physics", Vikas Publishing House, New Delhi* **(2004).**

Semester	I	CC- II CLASSICAL DYNAMICS AND SPECIAL RELATIVITY	Hours	6
Course Code	15PP102		Credit	5

Objectives:

- To understand the Newton's, Lagrangian and Hamilton's Formulations.
- To learn the concepts of Rigid Body Dynamics and Small Oscillations.
- To study the Special theory of Relativity.

UNIT-I NEWTON'S AND LAGRANGIAN FORMULATIONS

Mechanics of a Particle and System of Particles - Conservation Laws - Constraints - Generalized Coordinates - D'Alemberts Principle and Lagrangian Equations - Hamilton's Principle - Lagrange's Equations of Motion – Examples - Conservation Theorems and Symmetry Properties.

UNIT-II CENTRAL FORCE AND SCATTERING PROBLEMS

Reduction to Equivalent one Body Problem - Equations of Motion and First Integrals - Equivalent *1D* Problem and Classification of Orbits - Equation of the Orbit and Integral Power law Potentials - Kepler Problem - Inverse Square law of Force - Scattering in Central Force Problem - Virial Theorem.

UNIT – III RIGID BODY DYNAMICS AND SMALL OSCILLATIONS

Rigid Body Dynamics: Euler Angles - Moments and Products of Inertia – Euler's Equations - Symmetrical Top. *Small Oscillations*: Theory of Small Oscillations - Frequencies of Vibration and Normal Coordinates - Linear Triatomic Molecule.

UNIT-IV HAMILTON'S FORMULATION

Hamilton's Equation from Variational Principle - Principle of Least Action – Applications - Canonical Transformations - Lagrange and Poisson Brackets - Equation of Motion and Conservation Theorems in Poisson Brackets - Hamilton Jacobi Method – Action Angle Variables - Kepler Problem in Action Angle Variables.

UNIT – IV SPECIAL THEORY OF RELATIVITY

Postulates of Relativity - Lorentz Transformation- Addition of Velocities - Mass-energy Relation - Lorentz Transformation in four Dimensional Space - Invariance of Maxwell's Equations under Lorentz Transformation.

Books for Study

1. *J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, New Delhi, 2007.*
2. *G. Aruldhas, Classical Mechanics, PHI Learning Private Ltd., New Delhi, 2009.*

Reference

1. *H. Goldstein, Classical Mechanics, Narosa Publication House, New Delhi, 2007.*
2. *N. C. Rana, and P. S. Joag, Classical Mechanics, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008.*
3. *R. G. Takwale, P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2007.*

Semester	I	CC- III ANALOG AND DIGITAL ELECTRONICS	Hours	6
Course Code	15PP103		Credit	5

Objectives:

- To know the principle of various types of diodes, FET, SCR, UJT and applications
- To know the concept of linear integrated circuits and its applications
- To study the digital systems
- To study the applications of sequential logical circuits

Unit –I SEMICONDUCTOR DEVICES

Theory of PN junction diode –Diode resistance - Effect of Temperature on PN junction diodes – Junction diode switching characteristics – Breakdown in PN junction diodes – PN diode applications – Clippers –Clampers – Zener diode – Bipolar Junction transistor – construction – h-parameters.

Unit –II FIELD-EFFECT TRANSISTOR (FET)

Construction and operation of N-Channel FET – Characteristic parameters of the JFET- Comparison of JFET and BJT – Applications of JFET –FET as voltage variable resistor Solar cell – MOSFET, SCR, UJT.

UNIT – III OPERATIONAL AMPLIFIERS

Operational amplifier – Characteristics – Applications of op-amps – Inverting amplifier –Non inverting amplifier – voltage follower – Summing amplifiers – Subtractor - Integrator – Differentiator –Comparators and circuits – Active Filters (first order only) - Instrumentation amplifier – D/A converter – Binary weighted method – R- 2R ladder method - Schmitt trigger- Logarithmic and antilogarithmic amplifier- Solving Differential Equations with an Analog Computer.

UNIT –IV BOOLEAN FUNCTIONS AND COMBINATIONAL LOGIC

Boolean functions – Demorgan's theorem – K-Map method – Two and Three variable maps – Four variable map – Product of sums simplification – Don't care conditions Introduction - Design procedure –Half and Full adders – Half and Full Subtractors – Code conversion – Universal gates – Exclusive OR functions – Binary parallel adder – BCD adder – Magnitude comparator – Decoders – Demultiplexers –Encoders – Multiplexers.

UNIT –V SEQUENTIAL LOGIC AND A/D CONVERTER

Flip flops- RS flip flops – Edge triggered RS, D, Master-slave flip flop and JK flip flop – Types of registers – serial in serial out – Serial in parallel out – Parallel in serial out – Parallel in parallel out – Ring counters.

– Asynchronous counter – Synchronous counter – Changing the counter modules – A/D converter – counter method – successive approximation – Dual slope A/D conversion.

BOOKS FOR STUDY

1. *S.Salivahanan, N. Suresh Kumar, A.Vallavaraj, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.(Unit-I,II)*
2. *L D.Roy Choudhury, Shail Jain, Linear Integrated Circuits, New Age International Pvt., Ltd., New Delhi, 1999 (Unit-III)*
3. *M.Morris Mano, Digital Logic and Computer Design, Prentice Hall of India Private Limited, New Delhi, 1996.(Unit-IV)*
4. *Leach and Malvino, Digital Principles and Applications, Tata McGraw Hill Publishing Company Limited, New Delhi, Second reprint, 2002. (Unit-V)*

BOOKS FOR REFERENCE

1. *Ramkant A.Gayakward, Op-amps and Linear Integrated Circuits,Prentice Hall of India, New Delhi, Third Edition.*
2. *R.P.Jain, Digital Electronics and Systems, Tata Mc Graw Hill, New Delhi, 2004*
3. *Rajeev Ratan, Deepak Batra, Digital Electronics, Acme Learning Pvt., Ltd., New Delhi, First Edition, (2009)*
4. *Milman and Halkias, Integrated Electronics, Tata Mc Graw Hill, New Delhi.*

Semester	I	CC-IV **INSTRUMENTATION TECHNIQUES**	Hours	6
Course Code	15PP104		Credit	5

Objectives:

- To understand the Instrumentation of physical system, errors measurements and statistical analysis.
- To understand the principles and applications of transducers.

UNIT – I STATIC CHARACTERISTICS OF INSTRUMENTS

Measurement system performance – static characteristics – Errors in measurement – static error – scale range and span – reproducibility and drift – repeatability - noise– accuracy and precision – significant figures – static sensitivity – linearity – Hysteresis – threshold – resolution – Loading effects – Dynamic characteristics.

UNIT- II ERRORS IN MEASUREMENTS AND STATISTICAL ANALYSIS

Limiting errors – Relative error – Types of errors – Gross errors – systematic errors – instrumental errors – environmental errors – observational errors – random errors – Basic statistical concepts – mode – median- arithmetic mean – measures of dispersion – Chi – square test for goodness of fit – curve fitting of data – Equations of approximating curves – Determination of parameters in linear relationships – linear least square curve fitting.

UNIT – III TRANSDUCERS-I

Introduction-Primary and Secondary transducers-Electrical Transducers-Active and Passive transducers-Resistive transducers-Potentiometers-Strain Gauges-Resistance thermometers- Thermocouples - Thermistor - variable Inductive transducers-LVDT-Capacitive Transducers - Piezoelectric Transducers- Photo conductive cells – photo voltaic cell – Hall effect transducers.

UNIT – IV TRANSDUCERS-II

Vacuum gauges – Mcleod gauge – Kundsen gauge – Thermocouple gauge – Pirani gauge – Ionization type vacuum gauge – Measurement of vibrations – Seismic transducers – Types of accelerometers.

UNIT –V BIO SENSORS

Bio sensors – definition – Components of Bio sensors – Types of Bio sensors – Enzyme electrode – Bacterial Electrode – Enzyme immunosensors – Biosensors to detect cancer and health abnormalities – biosensors to monitor the status of Diabetes without using blood samples – Environmental Bio sensors.

BOOKS FOR STUDY

1. *A.K. Sawhney and Puneet Sawhney, A Course in Mechanical Measurement and Instrumentation, Dhanpat Rai &Sons, New Delhi (2000). (Units I, II, III,IV)*
2. *B.C. Nakra and KK Chaudhry, Instrumentation, Measurement and Analysis, Tata McGraw Hill Publishing Company Ltd, New Delhi (2006). (Unit-I.II).*
3. *L.Veerakumari, Bio Instrumentation, MJP Publishers, Chennai. (2007).(Unit-V)*

BOOKS FOR REFERENCE

1. *Michael sayer and Abhai mansingh, Measurement, Instrumentation and Experiment Design in Physics and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi (2005).*
2. *D.V.S. Murty, Transducers and Instrumentation, Prentice Hall of India Pvt. Ltd., New Delhi (1995).*
3. *D.Patranabis, Sensors and Transducers, Prentice Hall of India Pvt. Ltd., New Delhi (2003).*

Semester	II	CC-V PRACTICAL-I GENERAL PHYSICS AND COMPUTER PROGRAMMING	Hours	3
Course Code	15PP205		Credit	4

General experiments (Any 10 experiments)

1. Determination of q, η,L by elliptical fringes method.
2. Determination of q, η,L by Hyperbolic fringes method.
3. Determination of Stefan's Constant.
4. Determination of e/m of an electron by Thomson's method.
5. Determination of e/m of an electron by Magnetron method.
6. Identification of prominent lines by spectrum photography-copper spectrum
7. Identification of prominent lines by spectrum photography-Iron spectrum.
8. Four Probe method-Determination of resistivity.
9. Charge of electron by spectrometer.
10. Laser Grating – Determination of wave length.
11. Bangap in a semiconductor using P.N Junction diode.
12. Polarizability of liquids using Hollow prism.
13. Measurement of Refractive index in liquids- Abbe's Refractometer.

Computer Programming (Any 5 experiments)

1. Solving algebric equation by Newton's raphson Method.
2. Gauss Elimination Method.
3. Gauss-Seidal Method.
4. Trapezoidal Rule.
5. Simpson Rule.
6. Euler's Method.
7. Runge-Kutta II and IV th order Method.
8. Least square Curve fitting.

Semester	II	CC-VI PRACTICAL-II **ELECTRONICS AND INSTRUMENTATION LAB**	Hours	3
Course Code	15PP206		Credit	4

(Any 15 experiments)

1. Study Characteristics of FET
2. Study the Characteristics UJT.
3. Construct UJT relaxation Oscillator.
4. Design of Integrator and Differentiator Using op-Amp.
5. Design built and test Wiens Bridge Oscillator using op-amp.
6. Design built and test Phase Oscillator using op-amp.
7. Design and study of low pass, high pass circuits using op-amp.
8. Design and study of Band pass, Band reject circuits using op-amp.
9. Design and study Instrumentation amplifier using op-amp.
10. Voltage to frequency/frequency to voltage converter using op-amp.
11. V/I and I/V converter circuits using op-amp
12. Solving simultaneous equation using op-amp.
13. Design Astable and Monostable multivibrator using IC 555/741.
14. Construct and study the performance of Half wave and full wave precision rectifier.
15. Construction of Dual regulated power supply.
16. Design of FET common source amplifier.
17. Characteristics of LED's
18. Characteristics of Photo Transistor/Photodiode.
19. Study of AM modulation and demodulation.
20. Study of FM modulation and demodulation.
21. Characteristics of LVDT.
22. Calibration of Pressure gauge.
23. Calibration of thermistor.
24. Calibration of thermocouple.
25. Study the characteristics of strain gauge.
26. Study the characteristics of load cell.
27. Study the characteristics of torque Transducer.
28. Study the characteristics of Piezo electric transducer.
29. Study the characteristics of Hall effect Transducer.

Semester	II	CC-VII **MATHEMATICAL PHYSICS-II**	Hours	6
Course Code	15PP207		Credit	5

Objectives:

- To learn the concepts of Complex variables.
- To learn the concepts of Group theory and Matrix theory.
- To study the concepts of Tensor Analysis and Numerical Methods.

UNIT – I COMPLEX ANALYSIS

Functions of complex variables – Cauchy Riemann Conditions – Cauchy integral Theorem – Taylor's and Laurent's Series – Residues and Singularities – Evaluation of Residues – Cauchy Residue theorem – Residue at Infinity – Evaluation of Definite Integrals.

UNIT – II MATRIX THEORY

Matrix Theory - Review of basic concepts – Rank of matrix – Eigen value and Eigenvectors – Trace of a matrix – Cayley Hamilton Theorem – Inverse of a matrix – Reduction of a matrix to diagonal form - Jacobi method (2X2 matrices).

UNIT – III GROUP THEORY

Basic definitions – Sub groups – Cosets – Factor groups – Permutation groups – Cyclic groups – Homomorphism and Isomorphism – Classes of a group – Reducible and Irreducible representations - Symmetry elements and Symmetry operations – Schur's Lemmas - Great Orthogonality Theorem – Character representation – Construction of Character Table for C2v and C3v groups – SU(2) and O(3) groups.

UNIT IV TENSOR ANALYSIS

Transformation of Co-ordinate – Summation Convention – Covariant and Contravariant, and Mixed Tensors – Rank of a Tensor – Symmetric and Antisymmetric Tensors – Contraction of a Tensor – Raising and Lowering of Suffixes – Metric Tensor.

UNIT V NUMERICAL METHODS

Newton-Raphson Method – Convergence and Rate of Convergence – Gauss Elimination Method for simultaneous algebraic equations - Newtons Methods for Interpolations - Trapezoidal and Simpson's Rule for Numerical Integrations – Solution for ODE by Euler and Runge Kutta-IV methods.

Books for Study

1. *Satya Prakash, "Mathematical Physics", Sultan Chand and Sons, New Delhi (2008), (Unit II, IV and V)*
2. *P.K.Chattopadhyay, Mathematical Physics, New Age International Pvt., Ltd., New Delhi, (2004) (Unit I,III)*

Books for Reference

1. *E. Kreyszig, "Advanced Engineering Mathematics" Wiley (8^{th} Ed), New York (1999)*
2. *M. D. Greenbreg, "Advanced Engineering Mathematics" Pearson Education P. Ltd,(2^{nd} Ed), Singapore (1999)*
3. *W. Joshi, "Elements of Group Theory for Physicists" New Age International P. Ltd., (3^{rd} Ed) New Delhi (1995).*
4. *W. Joshi, "Matrice and Tensors in Phyiscs" New Age International P. Ltd., (3^{rd} Ed) New Delhi (1995).*
5. *S. S. Sastry, "Introductory Numerical Methods" Prentice Hall of India, New Delhi (1998).*

Semester	II	CC-VIII ELECTROMAGNETIC THEORY	Hours	6
Course Code	15PP208		Credit	5

Objectives:

- To understand the Electrostatics, Magnetostatics and Electromagnetism.
- To study the concept of Electromagnetic Waves.
- To understand the concept of Radiating systems and Wave Guides.

Unit – I ELECTROSTATICS

Coulombs law - The electric field - Continuous charge distributions - Field lines – flux - Gauss's law - The divegence of E - Application of Gauss's law - The curl of E - Electric potential - Poisson and Laplace equations - The potential of a localized charge distribution - Electrostatic boundary conditions – Laplace equation in one dimension - The classic image problem - The induce surface charge - Force and energy - Multipole expansion - Approximate potentials at large distances.

Unit – II MAGNETOSTATICS

Lorentz force law – Magetic fields - Magnetic forces - Currents – Continuity equation - Biot-Savart law – Steady current - Magnetic field of a steady current - Straight line current - Ampere's law - Application of Ampere's law - Comparison of magnetostatics and electrostatics - Magnetic vector potential - Magetostatic boundary conditions - Multipole expansion of vector potential - Ampere's law in magnetised material - Magnetic susceptilibity and permeability.

Unit – III ELECTROMAGNETISM

Electromagnetic induction - Faraday's law of induction - Integral and differential forms - Displace current - Formulation of Maxwell's equations - Maxwell's equations in free space and in linear isotropic media - Boundary conditions on the fields at interfaces - Poynting's Theorem - Poynting vector - Conservation of energy - Scalar and vector potentials - Gauge transformations - Coulomb Gauge and Lorentz Gauge.

Unit – IV ELECTROMAGNETIC WAVES

Electromagnetic waves in vacuum – The wave equation for E and B - Monochromatic plane waves - Energy and momentum in electromagnetic waves - Electromagnteic waves in matter – Propagation in linear media - Reflection and transmission at normal incidence - Reflection and transmission at oblique incidence - Fresnel's equation - Electromagnetic waves in conductors - Reflecting at a conducting surface - The frequency dependence of permittivity.

Unit – V RADIATING SYSTEMS AND WAVE GUIDES

Retarded potential - Jefimneko's equations - Lienard-Wiechert potentials - The fields of moving point charge electric dipole radiation - Magnetic dipole radiation - Radiation from an arbiary source - Guided waves: wave guides - TE waves in rectagular wave guide - The coaxial transimission line.

Book for study

1. *David J. Griffiths, Introduction to Electrodynamics Third edition, Prentice-Hall of India Private Limited, New Delhi (2014).*

Book for Reference

1. *J. D. Jackson, Classical Electrodynamics, Willey India (P) Ltd., New Delhi (2010)*
2. *Edward C.Jordan, Keith G.Balmin, Electromagnetic Waves and Radiating Systems, Prentice –Hall of India Ltd, New Delhi (2003)*
3. *J.R. Reitz, F.J.Milford, R.W.Christy, Foundations of Electromagnetic theory, Norosa Publishing House,New Delhi ,(1998).*
4. *Walter Greiner, Classical ElectrodynamicsSpringer-Verlag, Newyork,(1998).*

Semester	II	CC-IX QUANTUM MECHANICS	Hours	6
Course Code	11PP209		Credit	5

Objectives:

- To study the Schrodinger Wave Equation, Linear Operators and Heisenberg Picture.
- To learn the concepts of perturbation theory.
- To study the Matrix Representation and Relativistic Wave Equation.

UNIT – I THE SCHRÖDINGER EQUATION AND STATIONARY STATES

The wave function: Statistical interpretation – Normalization of the wave function – probability current density – Expectation values and Ehrenfest's theorem – Time independent Schrödinger equation – stationary states and Boundary conditions.

UNIT- II GENERAL FORMULATION

Linear operators – Dynamical variables – eigenfunction and eigen values scalar product – orthogonality – Expansion and completeness of eigen functions – Hermitian operators – Commutators of operators – Commutation rules and Uncertainity principle – Postulates of Quantum Mechanics – Dirac notations – Bra and Ket notations – Relationship between Kets and wave functions – Matrix representation of an operator – Unitary transformation – The Schrödinger picture – Heisenberg Picture – Interaction picture – Parity operator.

UNIT – III APPROXIMATION METHODS

Time independent perturbations: Non-degenerate case: First and second order perturbations – Degenerate case: Zeeman effect – Stark effect – Variational method – WKB Quantization rule.

Time dependent perturbation theory – First order perturbation – Constant perturbation - Harmonic perturbation – Transition probability – Fermi's Golden rule – Adiabatic approximation – Sudden approximation.

UNIT – IV ANGULAR MOMENTUM AND MATRIX REPRESENTATION

Orbital angular momentum – Commutation relations – Eigen values - Matrix representation of angular momentum Matrices corresponding to j=2 and Pauli spin matrices – Addition of angular momenta

Scattering theory: The scattering cross section – Methods of partial waves Green function - Born approximation.

Unit – V Relativistic Wave Equation

Klein-Gordon equation for a free particle and in an electromagnetic field –Dirac Hamiltonian – Dirac matrices properties – spin of the Dirac particle – Negative energy states.

Books for Study

1. *V.K.Jain, Introduction to Quantum Mechanics, Narosa Publishing House, New Delhi, 2010 (Unit I,II,III and IV)*
2. *P. M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics, Tata McGraw Hill, New Delhi (2004) (Unit V)*

Books for Reference

1. *L.I. Schiff, Quantum Mechanics, McGraw Hill, New Delhi (1968).*
2. *S.Devanarayanan, Quantum Mechanics, Narosa Publishing House, New Delhi, 2006)*

Semester	II	EC- I MICROCONTROLLER AND ITS APPLICATIONS	Hours	6
Course Code	11PP210		Credit	4

Objectives:

- To learn the architecture, instructions, programming and applications of 8051 Microcontroller.
- To know the applications of 8051 microcontroller.

UNIT – I 8051 MICROCONTROLLER

Microcontroller and embedded processors – Overview of the 8051 - Introduction to 8051 assembly programming – Program counter and ROM space in the 8051 – 8051 data types and derivatives – 8051 flag bits and the PSW register – 8051 register banks and stack.

UNIT – II INSTRUCTIONS

Loop and jump instructions – Call instructions – 8051 I/O programming - I/O bit manipulation programming – 8051 addressing modes – Bit addresses for I/O and RAM – Arithmetic instruction – Logical instruction – Compare instruction – Rotate instruction.

UNIT – III HARDWARE CONNECTIONS

Pin description of the 8051 – Programming 8051 timers – Counter programming – Basics of serial communication – 8051 serial port – Programming in assembly.

UNIT – IV INTERRUPTS PROGRAMMING

8051 interrupts – Programming timer interrupts – programming external hardware interrupts – programming the serial communication interrupt – interrupt priority of the 8051.

UNIT – V INTERFACING DEVICES

LCD interfacing – Keyboard interfacing – ADC interfacing (0804) – DAC interfacing (MC1408/DAC 0808) – Sensor interfacing and signal conditioning – Memory address decoding– Stepper motor interfacing.

BOOKS FOR STUDY

1. *Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Prentice Hall of India Private Limited, New Delhi, 2007.*

BOOKS FOR REFERENCE

1. *Kenneth J.Ayala, The 8051 microcontroller, architecture, programming and applications, Thomson, Delmar Learning (ISE). (2004).*
2. *Myko Predko, Programming and Customizing the 8051 microcontroller, Tata McGraw Hill Publishing Company Ltd, New Delhi,1999.*
3. *Lecture notes on Microcontroller applications, Department of Physics, Nehru Memorial College, Puthanampatti.*

Semester	III	CC- X STATISTICAL MECHANICS	Hours	6
Course Code	11PP311		Credit	5

Objectives:

- To understand the nature of thermodynamics and Boltzmann Transport Equation.
- To study the Classical, Quantum Statistical Mechanics and its applications.

UNIT – I REVIEW OF THERMODYNAMICS

Laws of thermodynamics- consequences-Entropy- changes in entropy in reversible processes –Principle of increase of entropy- Thermodynamic functions - Phase transitions- The Clausius Clayperon equation.

UNIT – II KINETIC THEORY

Boltzmann transport equation - Boltzmann's H theorem- Relation between H- function and entropy - Maxwell –Boltzmann distribution- Mean free path- Transport properties.

UNIT – III CLASSICAL STATISTICAL MECHANICS

Macroscopic and microscopic states- Phase space- statistical ensembles- Fluctuation - Liouville's theorem- Statistical density matrix – The phase space and Quantum states – Micro canonical distribution – canonical distribution – Equipartition theorem - Grand canonical distribution.

UNIT – IV QUANTUM STATISTICAL MECHANICS

Introduction – Ideal quantum gases- Maxwell – Boltzmann statistics – Bose Einstein statistics – Photon statistics – Fermi –Dirac statistics – validity of Maxwell – Boltzmann statistics- Sackur- Tetrode equation.

UNIT – V APPLICATIONS OF QUANTUM STATISTICAL MECHANICS

Ideal Bose gas – Bose Einstein Condensation – Black body radiation – The photon gas – liquid Helium – Ideal Fermi gas – Weakly degenerate – Strong degenerate – electron gas.

Books for Study

1. *S.K.Sinha, Introduction to Statistical Mechanics, Narosa Publishing House, New Delhi (2007).*

Books for Reference:

1. *F. Mandl, Statistical Physics, John Wiley Eastern Ltd., New Delhi. (1983).*
2. *Singhal, Agarwal, Prakash, Thermodynamics and Statistical Physics,Prakashan, Meerut, (2003).*
3. *Donald, A.Mc Quarrie, Statistical Mechanics, Vikas Books Private Ltd, New Delhi, (2003).*
4. *B.K. Agarwal and M.Eisner, Statistical Mechanics, Wiley Eastern Ltd, New Delhi,(1994).*

Semester	III	CC- XI NUCLEAR AND PARTICLE PHYSICS	Hours	6
Course Code	11PP312		Credit	5

Objectives:

- To study the properties of nucleus, radioactivity and Detectors.
- To understand the nuclear reactions and elementary particles.
- To study the Accelerators, Nuclear Fission and Fusion Processes.

UNIT – I BASIC NUCLEAR FORCES

Basic nuclear properties – size by Masonic X- ray method – shape, charge distribution – spin and parity – determination of nuclear Mass by mass synchrometer method. Binding Energy – Semi – empirical mass formula - Nuclear Stability Nuclear, Shell model, its validity & limitation – Liquid drop Model.

Nuclear Forces : Nature of Nuclear forces – Elements of two body problem – Ground state of deuteron – Phass shift analysis – Scattering length – Scattering amplitude-low energy n-p Scattering – Non – central forces (Tensor forces)- Yukawa's meson theory.

UNIT – II RADIOACTIVE DECAYS, DETECTORS

Gamow's theory of decay – Fermi theory of decay – Selection rules – Non conservation of parity in beta decay – Gamma decay – Selection – rules – international conversion – Nuclear isomerism.

Nuclear radiation Detectors : interaction of charged particles & energy with matter – Basic principles of Particle detectors – ionization chamber – gas proportional counter and GM counter – scintillation counter – Semiconductor detector.

UNIT – III ACCELERATORS, FUSION, FISSION

Cyclotron – Synchrocyclotron – Betatron – Synchrotron – Linear accelerators.

Nuclear Fission : Characteristics of fission – Mass & energy distribution to nuclear fragments –

Energy in fission – nuclear chain reaction. Four – factor formula – Bohr wheelers theory of nuclear fission – Fission reactors – Power & Breeder type reactor.

Nuclear Fusion: Basic fusion processes – Solar fusion – Cold fusion – Controlled thermonuclear reactions – Pinch effect.

UNIT IV NUCLEAR REACTIONS

Energetic of reactions –Q equation – Level widths in unclear reaction – Nuclear reaction cross – section – Partial wave analysis – Compound nucleus model – Resonance scattering – Breit –

Wigner one level formula – Direct reactions – stripping and Pick up reactions.

UNIT V ELEMENTARY PARTICLES

Four types of interactions and classifications of elementary particles – Isospin – quantum numbers – Strangeness- & hyper charge – Hadrons – Baryons – Leptons – Invariance principles and symmetries – Invariance under charge – parity (CP). Time (T) and CPT – CP violation in neutral K meson decay – Quark model- SU (3) symmetry – Gell Mann Nishijma formula –Charm, bottom and top Quarks.

Books for Study

1. *M. L. Pandya and R. P. S. Yadav, Elements of Nuclear Physics, Kedar Nath Ram Nath, Meerut, (2004) . (Unit I,II)*
2. *D.C Dayal, Nuclear Physics, Himalayan Publishing House, Mumbai,(2002) (Unit III,IV,V)*

Books for Reference

1. *B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill, New Delhi, (1983).*
2. *D. Griffiths, Introduction to Elementary Particles, Wiley International Edition, New York, (1987).*
3. *D. C. Cheng and G. K. O'Neill, Elementary Particle Physics: An Introduction, Addison – Wesley, New York, (1979).*
4. *K. S. Krane, Introductory Nuclear Physics, John-Wiley, New York, (1987).*

Semester	IV	CC- XIII PRACTICAL – III ADVANCED GENERAL PHYSICS	Hours	3
Course Code	11PP313		Credit	4

(Any 15 experiments)

1. B.H.Loop- Energy loss of a magnetic material –Anchor ring.
2. Determination of wavelength and thickness of a film by using Michelson Interferometer using laser /Sodium lamp.
3. Determination of wavelength of monochromatic source using Biprism.
4. Determination of refractive index of liquids using Biprism.
5. Determination of specific rotatory power of a liquid using polarimeter.
6. Forbe's method of determining thermal conductivity.
7. Determination of Magnetic susceptibility using Quinke's method.
8. Magnetic Susceptibility of salts –Guoy's Balance.
9. Mass and Molecular susceptibility by Quinke's method
10. Construction of RF oscillator, determination of dielectric constants of a liquid.
11. Diamagnetic susceptibility of liquids- Guoy's method.
12. Ultrasonic velocity of liquids- ultrasonic Interferometer.
13. Determination of lande 'g' factor – ESR spectrum.
14. Energy band gap of a semiconductor by Four Probe method.
15. Determination of Planks Constant using LED's.
16. Determination of carrier concentration and Hall coefficients in semiconductors.
17. Dipole moment of a liquid by RF oscillator.
18. Voltage standing wave ration using microwave bench
19. Impedance measurement using microwave bench
20. Dielectric constant measurement using microwave bench
21. Absorbtion/ Transmission using UV spectrophotometer.

Semester	IV	CC- XIII PRACTICAL – IV ADVANCED DIGITAL ELECTRONICS AND MICROCONTROLLER	Hours	3
Course Code	11PP314		Credit	4

(Any 15 experiments)

1. Half adder and full adder.
2. Half subtractor and Full subtractor.
3. Study of Flip flops. (D, JK, RS)
4. Multiplexer using ICs
5. Demultiplexer using ICs.
6. Shift register.
7. BCD to seven segment Display.
8. Decade counter –MOD 3.5,7,9. (Using IC 7490)
9. K-maps
10. Reduction of Boolean expression.
11. D/A converter Binary weighted and R-2R method.
12. A/D converter using IC 0804.
13. Decoder using ICs.
14. Encoder using ICs.

Micro Controller 8051

1. Simple Programs addition, subtraction, multiplication, division.
2. Find the Biggest and smallest number in a given array.
3. Stepper motor interface.
4. D/A converter (Generate sine and square wave forms).
5. Interface BCD to seven segment display.
6. A/D converter.
7. Relay control.
8. Logic Controller.
9. Study of PSoC micro controller

Semester	III	EC-II ATOMIC AND MOLECULAR PHYSICS	Hours	6
Course Code	11PP315		Credit	4

Objectives:

- To learn structure of atom, atomic spectra and other phenomena.
- To study the Microwave, IR and Raman Spectroscopy.
- To study the concept of LASER and MASER.

UNIT – I ATOMIC SPECTRA

Quantum states of Electron in atoms- Hydrogen atom spectrum- Electron spin- Stern Gerlach Experiment- Spin Orbit interaction- Lande interval rule- Two electron systems- LS –JJ coupling Schemes-Fine structure- Spectroscopic terms and selection rules- Hyperfine structure - Exchange symmetry of wave function- Pauli's exclusion principle- periodic table- Alkali type spectra-Equivalent electrons.

UNIT – II ATOMS IN EXTERNAL FIELDS AND RESONANCE SPECTROSCOPY

Zeeman and Paschen Back Effect of one and two electron systems- Selection Rules- Stark effect-Inner Shell vacancy- X-ray- Auger transitions- Compton Effect. NMR – Basic principles – Classical and Quantum mechanical description – Spin-spin and Spin-lattice relaxation times – Magnetic dipole coupling – Chemical shift – Knight shift.

ESR – Basic principles – Nuclear interaction and Hyperfine Structure – g-factor – Zero field splitting

UNIT – III MICROWAVE SPECTROSCOPY AND IR SPECTROSCOPY

Rotational spectra of diatomic molecules – Rigid rotator – Effect of isotropic substitution – Non rigid rotator – Rotation spectra of polyatomic molecules – Linear, symmetric top and asymmetric top molecules – Experimental Techniques. Diatomic vibrating rotator – Linear, Symmetric top molecule –Analysis by infrared techniques - Characteristic and group frequencies

UNIT – IV RAMAN AND ELECTRONIC SPECTROSCOPY

Raman effect – Quantum theory of Raman effect – Rotational Raman spectra – Vibrational Raman Spectra - Raman spectra of polyatomic molecules. Electronic spectra of diatomic molecules – Frank-Condon principle – Dissociation energy and dissociation products – Rotational fine structure of electronic vibration transitions – Fortrat Diagram – Predissociation.

UNIT – V LASERS AND MASERS

Spontaneous and stimulated emission – Interaction of radiation with atomic systems - Einstein Coefficients - Population inversion - Laser threshold condition- Rate equation for 3 and 4 level lasers- Laser resonators- Ruby laser- He-Ne Laser- CO 2 Laser- Semiconductor Lasers – Laser Applications - Ammonia Maser.

Books for Study

1. *J.B.Rajam, Atomic Physics, S.Chand & Company Ltd., New Delhi, 1950. (Unit I,II)*
2. *C.N. Banwell, Fundamentals of Molecular Spectroscopy, Fourth edition, Mc Graw Hill, New York (2004).(Unit-III, IV)*
3. *Sathya Prakash, Laser Systems and Applications, Pragati Prakasan Publishers, First edition, (2010), (Unit V)*

Books for Reference

1. *Suresh Chandra, Physics of atoms and Molecules, Narosa Publishing House, New Delhi, (2010).*
2. *G.M Barrow, Introduction to Molecular Spectroscopy, McGraw Hill Ltd., Singapore (1986).*
3. *Manas chanda, Atomic Structure and Chemical Bond, Tata McGraw Hill, New Delhi (2003).*
4. *Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill, New Delhi (2003).*

Semester	III	EC-III CRYSTAL GROWTH AND THIN FILMS	Hours	6
Course Code	11PP316		Credit	4

Objectives:

- To study the Solution Growth, Gel Growth and Melt Growth Techniques.
- To learn the concept of Thin Film techniques.
- To study the Characterization techniques XRD, UV, FTIR and SEM.

UNIT – I SOLUTION GROWTH TECHNIQUE

Low temperature solution growth: Solution – Solubility and super solubility – Expression of super saturation –Miers T-C diagram – Constant temperature bath and crystallizer – Seed preparation and mounting – Slow cooling and solvent evaporation methods.

UNIT – II GEL GROWTH TECHNIQUES

Principle – various types – Structure of gel – Importance of gel – Experimental procedure – Chemical reaction method – single and double diffusion method – Chemical reduction method – Complex and de-complexion method – Advantages of gel method.

UNIT – III OTHER GROWTH TECHNIQUES

Melt technique: Bridgman technique – Basic process – Various crucible design – Thermal consideration – Vertical Bridgman technique – Czochralski technique– Experimental arrangement – Growth process. **Vapour technique:** Physical vapour deposition – Chemical vapour deposition – Chemical Vapour Transport

UNIT – IV THIN FILM DEPOSITION TECHNIQUES

Thin films – Introduction to Vacuum Technology – Deposition Techniques – Physical Mehtods – Resistive Heating, Electron beam Gun, Laser Gun Evaporation and Flash Evaporations – Sputtering – Reactive Sputtering, Radio Frequency Sputtering – Chemical methods – Spray Pyrolysis – Preparation of Transparent conduction oxides.

UNIT – V CHARACTERIZATION TECHNIQUE

X- ray Diffraction (XRD) – Powder and single crystal – Fourier transform infrared analysis – Elemental analysis – Atomic absorption spectroscopy – Scanning Electron Microscopy (SEM) – UV-VIS Spectrometer – Etching and surface morphology – Vickers Micro hardness tester.

Books for Study

1. *P.Shanthana Ragavan and P.Ramasamy, Crystal Growth Processes and Methods, KRU Publications, Kumbakonam (2001).*
2. *A. Goswami, Thin Film Fundamentals, New Age International (P) Limited, New Delhi (1996).*

Books for Reference

1. *J.C. Brice, Crystal Growth Processes, John Wiley and Sons, New York (1986).*

Semester	IV	CC-XIV SOLID STATE PHYSICS	Hours	6
Course Code	11PP417		Credit	4

Objectives:

- To study the concept of Crystal classes, Crystal structure, Crystal vibration and Diffraction Methods.
- To understand the free electron theory and Dielectrics & Ferroelectrics.
- To study the concept of Super conductivity.

UNIT –I CRYSTALLOGRAPHY

Crystal classes and systems: 2D & 3D lattices - Bravais lattice - Point groups - Space groups -Bonding in crystals – Crystal structure of NaCl, CsCl, ZnS and Diamond - Miller indices - Diffraction methods: Laue, rotating crystal and powder crystal method - Reciprocal lattice of BCC and FCC crystals - Structure factor for BCC and FCC - Systematic absences.

UNIT II CRYSTAL VIBRATION

Crystal vibration: Crystal with monoatomic basis – Crystal with diatomic basis – Quantization of elastic waves – Phonon momentum. Phonon heat capacity: Density of states in 1D – Density of states in 3D – Debye model – Einstein model. Thermal conductivity: Thermal resistivity of Phonon gas – Umklapp processes.

UNIT – III THEORY OF SOLIDS

Free electron theory: Energy levels in 1D and 3D - Density of orbitals – Effect of temperature on the Femi Dirac distribution – Heat capacity of electron gas - Electrical conductivity and Ohm's law –Motion in magnetic fields – Hall effect. Nearly free electron model: Origin and magnitude of energy gap - Bloch Theorem and function – Kronig-Penny model – Wave equation of electron in periodic potential - Crystal momentum of an election – Number of orbitals in a band - Band structure ins metals and Insulators - Effective mass of the free electron.

UNIT-IV DIELECTRICS AND FERRO ELECTRICS

Macroscopic electric field – Local electric field in an atom - Dielectric constant and polarizability - Clausius–Mossotti equation – Dielectric loss - Ferroelectric crystals – polarization catastrophe - ferroelectric domains – Antiferro electricity – Quantum Theory of Dia and Para magnetisms – Rare earth ions - Crystal field splitting - Quenching of the orbital angular momentum – Cooling by isentropic demagnetization – Paramagnetic susceptibility of conduction electrons. Ferromagnetic order – Spin waves - Magnons - Thermal excitations - Antiferromagnetic order.

UNIT V SUPER CONDUCTIVITY

Super Conductivity: Occurrence of Super conductivity – Meissner effect -- Thermodynamics of super conducting Transition – London equation – BCS theory of superconductivity - Type I and II superconductors – Flux quantization – Coherence length – Josephson Tunneling – High temperature super conducting materials – Application – SQUID - Cryo electronics.

Books for study

1. *C. Kittel, Introduction to Solid State Physics, 7th Ed, Wiley Eastern., New Delhi (1996).*
2. *R. L. Singhal, Solid State Physics, 3rd Ed. , Kedarnath and Ramnath & Co. Meerut, New Delhi (1987)*
3. *S. O. Pillai, Solid State Physics, 3rd Ed., New Age International Publishers, New Delhi (1999).*

Book for Reference

1. *N. W. Ashcroft and N. D. Mermin ,Solid State Physics, Harcourt Asia Pvt Ltd, Singapore, (2001).*
2. *M. M. Woolf man, An Introduction to X-ray Crystallography, Cambridge University Press, Cambridge (1991).*
3. *J. S. Blakemore, Solid State Physics, 2nd Ed., Cambridge University Press Cambridge, London (1974).*

Semester	IV	EC-IV ELECTRONIC COMMUNICATION SYSTEMS	Hours	6
Course Code	11PP418		Credit	4

Objectives:

- To study the concept of Modulation, Demodulation.
- To understand the Digital and Optical Fiber Communication.
- To study the Satellite and Mobile Communication.

UNIT-I INTRODUCTION TO COMMUNICATION SYSTEM

Modulation and Demodulation: Theory Amplitude modulation-Frequency modulation-Phase modulation-modulator and demodulator circuits. Noise: Internal Noise-External Noise-noise calculation-noise figure-noise temperature-noise in communication systems.

UNIT –II DIGITAL COMMUNICATION

Pulse modulation: Pulse amplitude modulation-Pulse frequency modulation-Pulse time modulation-Pulse position modulation-Pulse width modulation. Digital data Carrier systems: Amplitude shift keying (ASK)-Frequency shift keying (FSK) –Phase shift Keying (PSK)-Differential PSK-Quatrapolar Phase shift Keying (QPSK)-Pulse code modulation-Delta modulation-error control coding.-Multiplex transmission-frequency and time division multiplexing.

UNIT –III OPTIC FIBER COMMUNICATION

Fiber optics-Different types of fiber-step index and graded index fibers-signal degradation fibers-Absorption, attenuation, Scattering losses and dispersion-Optical sources and detectors (qualitative only)-Power launching and coupling-Sources to power launching –fiber joints-Splicing techniques-general optical communication systems.

UNIT –IV SATELLITE COMMUNICATION

Satellite links-Orbits and inclination-satellite construction-satellite communication frequencies-Different domestic satellites –Intelsat system-MARISAT satellites-telemetry.

UNIT –V MOBILE COMMUNICATION

Cellular concept-Multiple Access Cellular systems-Cellular system Operation and planning-General Principles-analog cellular systems-Digital cellular mobile systems-GSM-cellular standards.

Books for study

1. *Alok Singh and A.K.Chhabra, Principles of Communication Engineering S.Chand group,New Delhi,(2007).(Unit I and II)*
2. *K.Sam Shanmugam, Digital and Analog Communication system, John.wiley &sons, Singapore (2009).(Unit II)*
3. *R.Allen Shotwell, An Introduction to fiber optics, PHI Learning Pvt.Ltd,(2010).(Unit –III)*
4. *N.D.Deshpande, P.K.Rangole, Communication Electronics, Tata McGraw Hill Pvt.Ltd.(Unit –IV)*
5. *Raj Pandya, Mobile and Personal Communication Services and systems Prentice Hall of India Private ltd., New Delhi,(2003).(Unit V)*

Books for Reference

1. *Dennis Reddy and john Coolen, Electronic Communication, fourth edition PHI Private Ltd,(1999).*
2. *G.Kennady and Davis, Electronic Communication systems, TMH, New Delhi,(1999).*
3. *Gerd Keiser, Optical Fiber Communication, Third Edition, McGraw-Hill, Singapore,(2000)*
4. *Sanjeev Gupta ,electronic Communication systems, Khanna publications, New Delhi(1995).*

Semester	IV	EC-V NANO SCIENCE	Hours	6
Course Code	11PP419		Credit	4

Objectives:

- To study the basic concept of Nanoscience and its application.
- To understand the Nanomaterials, Nanopowders and its applications.
- To study the Nanoelectronics, AFM and STM.

UNIT - I INTRODUCTION OF NANO SCIENCE

Nanoscience and Technology – Basics and basis – meaning of nanotechnology dimensions of Nanoscience and Technology – applications of nanotechnology in nanoscience – information & Communication- heavy industry

UNIT – II NANOPOWDERS AND NANOMATERIALS

Nanomaterials – Preparation - Topdown – bottom up approaches. – Plasma arcing – Chemical vapour deposition – Sol-gels – Eletro deposition – Ball milling – Using natural Nano particles – Application of Nano materials.

UNIT – III CARBON AGE AND QUANTUM DOTS

Carbon age – New form of Carbon – Types of Nano tubes – Formation of Nano tubes-assembiles – Purification of carbon tubes – Properties – uses. Q-dot – description – QCE in semi Conductors – fabrication – applications

UNIT – IV NANO ELECTRONICS

Nano electronics – Birth of electronics – Micro and Nano fabrication – Quantum electronic devices – Quantum information and Quantum computers – Experimental implementation of quantum computers – MEMS, NEMS.

UNIT – V INSTRUMENTS AND METHODOLOGY

Atomic Force microscope – description Imaging modes – advantages – disadvantages – Scanning tunneling microscope – components of STM – disadvantages – FESEM – NMR.

Books for Study

1. *M. Wilson, K.K.G. Smith, M. Simmons, B.Ragase, Nanotechnology, Overseas press India Pvt., Ltd., New Delhi, First Edition, 2005. (Unit II, III)*
2. *S. Shanmugam, Nano Technology, MJP publishers, 2010. (Unit I,III,IV,V)*

Books for reference

1. *Mark Ratner, Daniel Ratner, Nanotechnology, Pearson Education, 2003.*
2. *Charles P.Poole Jr. Frank J.Owens, Introduction to Nanotechnology, John Wiley & Sons Inc, Publications, 2006.*
3. *T.Pradeep, Nano: The essentials, McGraw Hill Education, 2007.*