<u>Model Course Table for post graduate Course</u>

First year, First Semester

Course Code (Practical)	**Credit/ Max. marks**	**Course name**	**Remark**
MPYC- 101	04/100	Paper -1	Mathematical Physics
MPYC- 102	04/100	Paper -2	Classical Mechanics
MPYC- 103	04/100	Paper -3	Quantum Mechanics- I
MPYC- 104	04/100	Paper -4	Solid state electronics
MPYL- 105	04/100	Paper -5	Practical
MPYM- 106	04/100	Paper -6	Minor Elective (optical fibre communication)
MPYP- 107	04/100	Paper -7	Research Project
Total	28/700		

Subject: PHYSICS

First year, Second Semester

Subject: PHYSICS

Course Code (Practical)	Credit/ Max. marks	Course name	Remark
MPYC- 208	04/100	Paper -1	Statistical Physics
MPYC- 209	04/100	Paper -2	Electromagnetic theory

MPYC- 210	04/100	Paper -3	Quantum mechanics- II
MPYC- 211	04/100	Paper -4	Solid state Physics
MPYL- 212	04/100	Paper -5	Practical
MPYP- 213	04/100	Paper -6	Research Project
Total	24/600		

Model Course Table for post graduate Course

Second year, Third Semester

Course Code (Practical)	Credit/ Max. marks	Course name	Remark
MPYC- 314	04/100	Paper -1	Computational techniques
MPYC- 315	04/100	Paper -2	Atomic and Molecular Physics
MPYE- 316 a	04/100	Paper -3a	Electronics – I
MPYE- 316 b	04/100	Paper -3b	Condensed Matter Physics –I
MPYE- 317 a	04/100	Paper -4a	Bio Physics - I
MPYE- 317 b	04/100	Paper -4b	Molecular Modelling - I
MPYE- 317 c	04/100	Paper-4c	Nanoscience and Nanotechnology
MPYL- 318	04/100	Paper -5	Practical
MPYP- 319	04/100	Paper -6	Research Project
Total	24/600		

Subject: PHYSICS

Second year, Fourth Semester

Course Code (Practical)	**Credit/ Max. marks**	**Course name**	**Remark**
MPYC- 420	04/100	Paper -1	Nuclear Physics
MPYC- 421	04/100	Paper -2	Numerical and Experimental Techniques
MPYE- 422 a	04/100	Paper -3a	Electronics-II
MPYE- 422 b	04/100	Paper -3b	Condensed Matter Physics-II
MPYE- 423 a	04/100	Paper -4a	Bio Physics – II
MPYE- 423 b	04/100	Paper -4b	Molecular Modelling- II
MPYE-423 c	04/100	Paper-4c	Nanoscience and nanotechnology
MPYL- 424	04/100	Paper -5	Practical
MPYP- 425	04/100	Paper -6	Research Project
Total	24/600		

Subject: PHYSICS

Abbreviations:

MPYC : M.Sc. Physics Core paper
MPYM : M.Sc. Physics Minor elective
MPYE : M.Sc. Physics elective paper
MPYL : M.Sc. Physics Lab
MPYP : M.Sc. Physics Research Project

In course code:

Ist letter (M) :	Master degree (M.Sc.)
IInd and IIIrd letter (PY) :	Subject code (Physics)
IV letter (C,M,L,P,E) :	Nature of course

(C: Core paper, M: Minor elective, L: Lab, P: Research Project, E: elective paper)

Syllabus for M.Sc. (Physics)

I^{st}Semester

MPYC 101: Mathematical Physics

Unit I **(10 hours)**

Vector analysis in curved coordinates and Tensors: Review of vector algebra and calculus, Gauss and Stokes theorems, Orthogonal coordinates, differential vector operators, special coordinate systems, circular cylindrical coordinates, spherical polar coordinates, tensor analysis, contraction, direct product, quotient rule, psuedotensors, dual tensors, non-Cartesian tensors, covariant differentiation, and tensors differentiation operators.Elements of Group theory.

Unit II **(10 hours)**

Special Functions: Second order ordinary differential equations, Frobinus method for solving second order linear ODEs, Beta and Gamma functions, Legendre's equation, Legendre polynomials and their properties, Bessel's equation, Bessel function and their properties, Laguerre's equation, its solutions and properties, Hermite equation, Hermite Polynomials and their properties. Partial differential equation (Laplace, wave and heat equations).

Unit III **(10 hours)**

Matrices and Calculus of Residues: Different types of matrices, orthogonal, Hermitian, unitary and normal, eigenvalues and eigen functions of matrices, diagonalisation of matrices, properties of analytic functions,Complex variable,Cauchy's integral theorem, Cauchy integral formula, Laurent expansion, singularities, Cauchy's residue theorem, evaluation of definite integrals, dispersion relations.

Unit IV (10 hours)

Integral Transforms: Laplace Transform (LT), first and second shifting theorems, LT of derivative and integral of a function, Inverse LT by partial fractions, Solution of initial value problems by using LT
Fourier Series and Fourier Transform: Fourier series, Half range expansion, Arbitrary period, Fourier integral and transforms, FT of delta and Gaussian function.

References:

1. *Mathematical method for Physicists,* Arfken & Weber, Elsevier Academic Press
2. *Mathematical Method for Physics and Engineers,* K.F.Reily, M.P.Hobson and S.J.Bence, Cambridge University Press
3. *Advanced Engineering Mathematics,* E. Kreyszig, John Wiley & Sons
4. *Special Functions,* E.D. Rainville, Chelsea Publication Co.
5. *Special Functions for Scientists and Engineers,* W.W. Bell, Dover Publications
6. *Functions of complex variable,* R.V. Churchill, McGraw Hill

MPYC 102: Classical Mechanics

Unit I (10 hours)

Lagrangian Formulations: System of particlesand equation of motion ofa system of particles, conservation of linear momentum, energy and angular momentum.

Constraints, generalized co-ordinates, virtual displacement, D'Alembert's principle, Lagrange's equations of motion and its application, Single free particle, a bead sliding on a uniformly rotating wire in a force-free space, Simple Pendulum, Compound Pendulum.

Unit II (10 hours)

HamiltonFormulations: Generalized momenta, canonical variables, Legendre transformations and the Hamilton's equation of motion, Examples of (a) The Hamiltonian of a particle in a central force field, (b) the simple harmonic oscillator. Cyclic co-ordinates and conservation theorems, derivation of Hamilton's equations from variational principle.

Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of poison brackets (antisymmetry, linearity, and Jacobi identity), Poisson bracket of angular momentum, The Hamilton-Jacobi equation and application to Linear harmonic oscillator.

Unit III **(10 hours)**

Central force problem: Reduction of two body problem into one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion), equations of motion for the orbit, classification of orbits, conditions for closed orbits, The Kepler problem (inverse-square law of force).

Unit IV **(10 hours)**

Small oscillations:Types of equilibrium, Quadratic forms for kinetic and potential energies of a system in equilibrium, Lagrange's equations of motion, Normal modes and normal frequencies, examples of (a)longitudinal vibrations of two coupled harmonic oscillators (b) linear, symmetric, triatomic molecule, (c) oscillations of two linearly coupled plane pendulum.

Reference:

1. *Classical Mechanics,* H. Goldstein, Narosa Publishing House
2. *Classical Mechanics,* N.C. Rana and P.S. Joag, Tata McGraw Hill
3. *Introdution to Dynamics,* I.C. Percival and D. Richards, Cambridge University Press
4. *Classical Mechanics*,Gupta and Kumar, Pragati Prakashan, Meerut.

MPYC 103: Quantum Mechanics - I

Unit I **(10 hours)**

Wave Mechanical Formulation and Energy Eigenvalue Problem: Time-dependent Schrödinger equation, Conservation of probability, Time-independent Schrödinger equation, The potential step: reflection coefficient, The potential barrier: transmission and reflection coefficient, Eigenvalues and eigenfunctions of linear harmonic oscillator, The periodic potential, spherically symmetric potential, The hydrogen atom.

Unit II **(10 hours)**

Matrix Formulation: Dynamical variables and operators, Expectation value, Expansion of eigenfunctions, Completeness property, Commutator algebra – Physical significance in Quantum Mechanics, Commuting observables, Unitary transformations, Matrix representations of wave functions and operators, Equations of motion in Schrödinger, Heisenberg and Interaction pictures.

Unit III **(10 hours)**

Theory of Angular Momentum: Spatial rotations, Orbital angular momentum, Commutation relations – L_x, L_y, L_z and L^2, Eigenfunctions and eigenvalues of L^2 and L_z, Spin angular momentum, Pauli spin matrices, Total angular momentum, the spectrum of J^2 and J_z, Ladder operators, Addition of two angular momenta, Clebsch-Gordan coefficients for $j_1=j_2=1/2$ and $j_1=1/2$, $j_2=1$.

Unit IV **(12 hours)**

Identity of Particles and Scattering: Symmetric and antisymmetric wave functions, Slater's determinantal wave functions, Stern-Gerlach experiments; Scattering, Introduction to classical and quantum scattering theory, Scattering cross section, The Born approximation method, Scattering from screened coulomb potential, Validity of Born approximation, Partial wave analysis, Phase shift, Scattering from square well potential.

References:

1. *Introduction To Quantum Mechanics* by David J. Griffiths, Pearson (2005).
2. *Quantum Mechanics* by G. Aruldas, PHI Learning Private Ltd. (2009)
3. *Quantum Mechanics* by L.I. Schiff, Tata Mcgraw Hill Education Private Limited Tata Mcgraw Hill Education Private Limited (2010).
4. *Modern Quantum Mechanics*by J. J Sakurai, Pearson (1994).
5. *Quantum Mechanics: Theory And Applications* by A. Ghatak, Macmillan India Limited (2004).
6. *Quantum Mechanics: An Introduction* by Walter Greiner, Springer (India) Pvt. Ltd. (2008)
7. *Quantum Physics: Of Atoms Molecules Solids Nuclei And Practicles* by Robert Resnick and Robert Eisberg, Wiley India Pvt Ltd (2006).

MPYC 104: Semiconductor Electronics – I

Unit-1 **(10 hours)**

Transistors- Bipolar junction transistor BJT, Junction field effect transistor JFET, Metal oxide semiconductor field effect transistor MOSFET: Structure, working, derivation of the equation for I-V characteristics under different conditions, high frequency limits.

Unit – II **(10 hours)**

Oscillators: Oscillator principle, Oscillator types- frequency stability response, the phase shift oscillator, wein bridge oscillator, IC tunable oscillator, multivibrators, monostable and astable comparators, square wave and triangular wave generators.

Unit – III **(10 hours)**

Operational Amplifiers: Introduction,block diagram, ideal characteristics, comparison with 741 Operational amplifier as a open loop amplifier, Limitations of open loop configuration, Operational amplifier as a feedback amplifier, Closed loop again, input impedance, output impedance of inverting and non-inverting amplifiers, Voltage follower, Differential amplifier, voltage gain. Applications of op-amp: Linear applications Phase and frequency response of low pass, high pass and band pass filters (first order), inverting and non-inverting configurations, summing amplifier, subtractor, ideal and practical differentiator and integrator.

Unit – IV **(12 hours)**

Digital Circuits: Review of gates (AND, OR, NAND, NOR, NOT, EX-OR), Boolean laws and theorems simplification of SOP equations, Simplification of POS equations, Simplification using Karnaugh Map technique (4 variables), Flip flops: Latch using NAND and NOR gates, RS flip flop, clocked RS flip flop, JK flip flop, JK master slave Flip Flop—racing- Shift Registers, Counters: Ripple counters- truth table, timing diagram, Synchronous counters-truth table, timing diagram, Decade counter

References:

1.*Electronic devices and circuit theory* by Robert Boylested and Louis Nashdsky, PHI, New Delhi
2.*OP amps & linear integrated circuits* by Ramakanth A Gayakwad, PHI second addition, 1991
3. *Microelectronics* by Jacob Millman, Mc-Hill international book co, New Delhi, 1990
4.*Optoelectronics- theory and practice* by Alien Chappal, Mc-Hill international book co, New York.
5. *Schaum's Outline of Electronic Devices and Circuits* by J.J. Cathey.
6.*Digital Electronics: A Practical Approach* by W. Kleitz**.**
7. *Principles of Electronics*byV.K. Mehta**.**
8. *Handbook of Electronics* by Gupta and Kumar.
9.*Basic Electronics* by B.L. Theraja**.**

MPYL 105: Practical

List of Experiments

1. Studyofcharacteristics ofSolarcell
2. ComptonEffect
3. Plank’s constant
4. Polarization: half –wave plate
5. Study of RC coupled amplifier
6. Study of characteristics of SCR
7. Photoelectric effect
8. Study of feedback amplifier
9. Study of Michelson Morley experiment

MPYM - 106
Fiber Optic Communication

Unit I (14 hours)

Basics of fiber communications: Need for fiber Optic Communication, evolution of light wave systems, lightwave system components, Optical fibers - their classification, essentials of electromagnetic theory - total internal reflections, Goos Hanchen shifts, Analysis of Optical fiber waveguides, electromagnetic modes, Characteristic equation of step-index fiber, modes and their cut-off frequencies, single-mode fibers, Dispersion in Single mode fiber, fiber losses, Non liner optical effects and polarization effect. Theory for optical propagation attenuation and single distortion in optical waveguide, weakly guiding fibers, linearly polarized modes, power distribution, Graded-index fibers - WKB and other analysis, propagation constant, leaky modes, power profiles, dispersions - material, modal & waveguide, impulse response.

Unit II(10 hours)

Physics and Technology of Optical Fiber: Passive photonic components: FO cables, Splices, Connectors, Couplers, Optical filter , Isolator, Circulator and Attenuator. , switches, MEMS.
Fabrication of optical fibers; MCVD, OVD, VAD, PCVD. Drawing of optical fibers; measurement of RI, attenuation etc. Fiber devices, fiber Bragg gratings, long period gratings, fiber amplifiers and fiber lasers. Application of optical fibers in science, industry, medicine and defense.

Unit III (10 hours)

Optical fiber systems: modulation schemes, Digital and analog fiber communication system, system design consideration, emitter design, detector design, fiber choice, wavelength conversion, switching and cross connect Semiconductor Optical amplifier (SOA), characteristics, advantages and drawback of SOA , Raman amplifier, erbium doped fiber amplifier, gain and
noise in EDFA, Brillouin fiber amplifier wideband Hybrid amplifier, Noise characteristics, amplifier spontaneous emission, Noise amplifier, Noise figure, Cumulative and effective noise figure, Noise impairments, amplifier applications.

Unit IV(12 hours)

Optical Transmitters: Basic concepts, Light emitting diodes, Semiconductor laser, Laser characteristics, Transmitter design. **Optical Receivers**: Basic concepts, P-n and pin photo detectors, Avalanche photo detector MSM photo detector, Receiver design, Receiver noise, Receiver sensitivity, Sensitivity degradation, Receiver performance. Wavelength division multiplexing (WDM) : Multiplexing Techniques, Topologies and architectures, Wavelength shifting and reverse, Switching WDM demultiplexer, optical Add/drop multiplexers. Dense wavelength division multiplexing (DWDM): System considerations, Multiplexers and demultiplexers, Fiber amplifier for DWDM, SONET/ SDH Transmission, Modulation formats, NRZ and RZ signaling, DPSK system modeling and impairments.

Reference Books

1. *Optical fiber communications: Principles and Practice,* John M. Senior, Prentice Hall of India.
2. *Optical fiber communications,* Gerd Keiser, McGraw Hill, 3rd edition.
3. *Fiber optic communication technology,* D. K. Mynbaev and L. L. Scheiner, Pearson Technology.
4. *Fiber optics and optoelectronics,* R. P. Khare, Oxford University press.

5. *Optical Communication Systems,* John Gowar, Prentice Hall of India.
6. *Light wave Communication Systems: A practical prospective,* R Papannareddy, Penrum International Publishing.
7. *Fiber Optic Communication Systems,* G.P. Agrawal, John Wiley and Sons.

Second Semester

MPYC 208: Statistical Physics

Unit-I (10 hours)

Introduction to statistical physics: phase space and phase space trajectory, concept of a statistical ensemble, distribution function, mean value of a physical quantity, statistical equilibrium, statistical independence and quasi-closed systems. Liouville's theorem (no derivation) and its significance, thermodynamic potential: Helmholtz and Gibb's potentials, first and second order phase transitions

Unit-II (10 hours)

Ensemble Theory: Concept of ensembles: microcanonical, canonical and grand canonical ensembles.Microcanonical distribution in classical statistics. Gibb's canonical distribution. Partition function, grand canonical distribution, free energy and equation of state of an ideal gas, chemical potential of a monoatomic ideal gas. Statistical distribution in quantum statistics.

Unit-III (10 hours)

Quantum statistics: Fermi-Dirac and Bose-Einstein distribution, F-D and B.E gases of elementary particles.

The electron gas in metals, Degenerate electron gas-equation of state, degeneracy temperature, specific heat. Degenerate Bose Gas, Specific heat and pressure, B-E condensation, Ising model, Diffusion equation

Unit-IV (10 hours)

Fluctuations: Fluctuations in ensemble, correlation of space-time dependent fluctuations, fluctuations and transport phenomenon, Brownian motion, Langevin theory, fluctuation dissipation theorem, Fokker-Plank equation.

Reference Books:

1. *Fundamentals of Statistical and Thermal Physics* by F. Rief.
2. *Statistical Mechanics* by K. Huang.
3. *Statistical Mechanics* by R.K. Pathria.
4. *Statistical Mechanics* by D.A. McQuarrie.
5. *Statistical Mechanics* by S.K. Ma.

MPYC 209: Electromagnetic Theory

Unit I **(10 hours)**

Electrostatics: Differential equation for electric field, Poisson and Laplace equations, boundary value problems, examples of image method and Green's function method, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics, polarization of a medium, electrostatic energy.

Magnetostatics: Biot-Savart law, differential equation for static magnetic field, vector potential, magnetic field from localized current distributions, examples of magnetostatic problems, Faraday's law of induction.

Unit II **(10 hours)**

Maxwell's Equations: Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges, electromagnetic energy and momentum, conservation laws.

Electromagnetic Waves: Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity, metallic wave guides, boundary conditions at metallic surfaces.

Unit III **(10 hours)**

Radiation: Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula.

Unit IV **(10 hours)**

Introductory Concepts of Plasma Physics: Formation of plasma, Debye theory of screening, plasma oscillations, motion of charges in electromagnetic fields, magneto-plasma, plasma confinement, hydromagnetic waves.

References:

1. *Classical Electrodynamics* by J.D. Jackson.
2. *Introduction to Electrodynamics* by D.J. Griffiths**.**
3. *Foundations of Electromagnetic Theory* byJ.R. Reitz, F.J. Milford and R.W. Christy**.**
4. *Introduction to Plasma Physics and Controlled Fusion* byF.F. Chen.

M.Sc.SemesterII

MPYC 210: Quantum Mechanics-II

Unit-I (12 hours)

Approximate Methods: WKB approximation method, Time independent perturbation theory for non-degenerate and degenerate cases up to second order energy and eigen function, Application to: Perturbed oscillator, First order Stark effect, Time dependent perturbation theory, Emission and absorption of radiation, Spontaneous emission.

Unit-II (10 hours)

Covariance of Dirac's Equation: Free particle Klein-Gordan equation, Charge and current densities, Minimal electromagnetic coupling, Dirac's relativistic equation, Covariant form of the Dirac's equation, Continuity equation.

Unit-III (10 hours)

Relativistic Quantum Mechanics: Free particle solutions, Dirac and Feynman interpretation of negative energy states, Dirac equation in electromagnetic field and its non-relativistic reduction, Dirac's equation in a central field: spin angular momentum, spin-orbit energy, the hydrogen atom.

Unit-IV (10 hours)

Second Quantization: Single-particle and Many-particle Hilbert space, Fock Space, Basics of second quantization: Occupation number representation, Creation and annihilation operators, Bosons. Representation of operators: Change of basis and the field operator, Representation of one-body and two-body operators.

Reference:

1. *Advanced Quantum Mechanics* by J. J Sakurai, Pearson (2005).
2. *Relativistic Quantum Fields* by James D. Bjorken, Sidney D. Drell, Dover publications
3. *A First Book of Quantum Field Theory* by A Lahiri, Narosa Book Distributors Pvt Ltd
4. *Quantum Field Theory* by F. Mandl and G. Shaw, John Wiley & Sons (20100525).

MPYC 211: Solid State Physics

Unit-I **(12 hours)**

Crystal structure and Reciprocal Lattices: Periodic array of atoms, fundamental types of lattices and Bravais lattice; Miller Indices of a family of planes and interplanar spacing for an orthorhombic crystal, Cubic Zinc Sulphide and closed packed structures. Bragg's law, Scattered wave amplitude, Reciprocal lattice, Construction of reciprocal lattices, Reciprocal lattice of SC, BCC, FCC, Concept of Brillouin zone, Fourier Analysis of the base; Basic of Crystal binding and elastic constants of crystals.

Symmetry element: Proper rotation axis, improper rotation axis, rotoreflection, rotoinversion, glide planes, screw axes, space groups and point groups.

Unit-II **(10 hours)**

Phonon- Lattice Vibration and Thermal Properties: Wave motion of one dimensional atomic lattice, Group velocity and phase velocity, Force constants, Brillouin zones, Normal modes of vibration in one dimensional atomic lattice of finite length, Lattice with two atoms per primitive cell, Optical properties in the infrared, Phonons, Momentum of phonons, Inelastic scattering of photons by long wavelength phonons, Local phonon model; Specific heat, Classical Theory, Einstein's Theory, Debye's Theory, thermal conductivity.

Unit-III **(10 hours)**

Free electron theory of Metals: Drude model of electrical and thermal conductivity, Sommerfeld model of free election gas; Motion of electrons in a one-dimensional periodic potential, Band Theory of Solids: Metals, insulators and intrinsic semiconductors; Kroning-Penney Model. Basic of Hall Effect, band gap of semiconductor, Hall Effect in semiconductors**.**

Fermi surface and Metals: Construction of Fermi Surfaces, Fermi surface and Brillouin zones, Experimental Methods in Fermi Surface Studies, de Hass van Alphen effect, quantum Hall effect, Magnetoresistance.

Unit-IV **(10 hours)**

Superconductivity and Magnetism: Occurrence of superconductivity, Meissner effect, London equation, effect of magnetic field, type I and type II superconductors, High temperature Superconductor, Cooper pairs and elementary discussion of BCS model, Josephson junction, superfluidity; Langevin Theory of diamagnetism and Quantum Theory of diamagnetism and paramagnetism; Ferromagnetism, Antiferro magnetism, Ferrimagnetic Domain.

References:

1. *Introduction to Solid State Physics* by C.Kittel.
2. *Solid State Physics*by A.J. Dekker.
3. *Condensed Matter Physics* by M.P. Marder.
4. *Principles of the Theory of Solids* by J.M. Ziman.
5. *Solid State Physics* by N.W. Achcroft and N.D. Mermin.
6. *Solid State Physics (Part-I): Transport Properties of Solid* by M.S. Dresselhaus.
7. *Solid State Physics-Structure and Properties of Materials*by M.A. Wahab.
8. *Principles of Condensed Matter Physics* by P.M. Chaikin and T.C. Lubensky.

9. *Solid State Physics* by S.O. Pillai.
10. *Solid State Physics* by G. Burns.

MPYL 212: Practical

List of Experiments

1. Measurement of Adiabatic compressibility of:
   a. Distilled water
   b. Piezoelectric crystal
2. Study of Solid-liquid phase diagram for a mixture.
3. Study of Magneto-resistance and its field dependence
4. Hall effect: Determination of
   a. Hall coefficient,
   b. Mobility
5. Determination of Band Gap energy of given thermistor
6. Magneticsusceptibility
7. Hysteresisloop
8. BandGapofSemiconductor
9. FaradayEffect
10. Frank-Hertzexperiment

M.Sc. Semester III
MPYC 314: Computational Techniques

UnitI 12 Periods

Interpolation:methodsofinterpolation,leastsquarecurvefitting,Methodsofequalintervals, unequalintervals,CentralDifferences.Inverseinterpolation:Iterationofsuccessiveapproximation,exchangeof dependent and independent variables and reversion of series. Numerical differentiation: Method based on interpolation, on finite differences. operator and on undetermined coefficients.

Unit II 12 Periods

Numerical integration: Simpson's one-third and one-eighth rule, Euler-Maclaurin formula, Quadrature formulae,NumericalSolutiontoordinarydifferentialequationbyEuler'sandRunge-Kuttamethods,Solutionof algebraic and transcedental equations: Convergence, Newton-Raphson method, Iterative methods.

Unit III 10 Periods

ElementsofProgrammingLanguages-Fortran Flow Charts, Integer and Floating point Arithmetic, Expression, Built in fuctions, Executable and Non- Executable statements, Assignments, Control and Input and Output Statements, Looping, Function and Subroutines, Operation with files.

UnitIV

ApplicationtoNumericalAnalysisrelatedtoUnit II.

References:

1. IntroductoryMethodsofNumericalAnalysisbyS.S.Sastry.
2. NumericalAnalysisbyBalguruswamy.
3. NumericalAnalysisbyHarper.
4. Fortran77andapplicationtoNumericalAnalysisbyC.Xavier
5. NumericalRecipesforFORTRANbyW.Pressetal.

MPYC 315: Atomic and Molecular Physics

Unit I **(12 hours)**

Hydrogen Atom Problem: Application of Schrödinger equation for hydrogen atom, interpretation of the results of Schrodinger equation, atomic energy levels, dependence of wave function on the angle θ and ϕ and radial dependence of wave function, Pauli exclusion principle, maximum number of electrons in a given group or subgroup.

Unit II **(12 hours)**

Atomic Spectra: Different series in alkali spectra, term values in alkali spectra and quantum defect, spin-orbit interaction, doublet structure in alkali spectra coupling schemes. LS coupling, JJ coupling interaction energy in L-S coupling & JJ coupling, fine structure & hyperfine structure (qualitative) Line-broadening mechanisms (general ideas), normal and anomalous Zeeman effect, Paschen-Back effect and Stark effect.

Unit III **(10 hours)**

Rotational and Vibrational Spectra: Rotation of molecules, classification of molecules, interaction of radiation with rotating molecule, rotational spectra of rigid diatomic molecules. Isotope effect in rotational spectra, intensity of rotation lines, non-rigid rotator, linear polyatomic molecules, symmetric top molecules, asymmetric top molecules, Microwave spectrometer, information derived from rotational spectra.

Vibrational energy of a diatomic molecule, infrared spectra (preliminaries) Morse curve and the energy levels of a diatomic molecules. Vibrating diatomic molecule, diatomic vibrating rotator, vibration of polyatomic molecules, normal modes of vibration in crystal, interpretation of vibrational spectra.

Unit IV **(10 hours)**

Spectroscopy Techniques: Raman spectroscopy, Frank Condon principle and selection rules, Photoelectron Spectroscopy, Mössbauer spectroscopy, Nuclear Magnetic Resonance, Chemical Shift, and Electron Spin Resonance (Introduction and their principles only).

References:

1. *Introduction to Atomic Spectra* by H.E. White, McGraw Hill
2. *Molecular Structure & Spectroscopy* by G. Aruldhas, Prentice Hall of India
3. *Elements of Spectroscopy* byGupta, Kumar & Sharma, Pragati Prakashan

4. *Fundamentals of molecular spectroscopy*by C. Banwell & E. McCash, Tata McGraw Hill
5. *Introduction to Molecular Spectroscopy* by G.M. Barrow, McGraw Hill
6. *An Introduction to Molecular Spectroscopy*by Gerhard Herzberg, Nostrand Co.
7. *Atomic & Molecular Physics* by Raj Kumar, Kedar Nath & Sons

MPYE 316a: Electronics – I

Unit – I **(10 hours)**

Photonic Devices - Radiative and non-radiative transitions, Photoconductive devices LDR, diode photo detector, Solar cell, light emitting diode LED, high frequency limit, effect of surface and indirect
recombination light confirmation factor, optical gain and threshold current for lasing.

Unit-II **(10 hours)**

Microwave Devices- Tunnel Diode, Transfer electron devices, Gunn Diode, Avalanche transit time devices, Impact diode and parametric devices.

Unit-III **(10 hours)**

Memory and other electronic Devices - Static and Dynamic random-access memories, SRAM and DRAM, CMOS and NMOS, non-volatile NMOS, magnetic, optical and ferro-electric memories, charge coupled devices CCD, Electro-optic, Magneto-Optic and Acousto-Optic effects, Piezo-electric, Electro-strictive and Magneto-strictive effects, sensors and Actuators devices.

Unit – IV **(10 hours)**

Photodetectors: Photo detectors with external photo effect, Photo detectors with internalphoto effect, photo conductor and photo resistor, junction photo detector, circuits with LED, diode tester, polarity and voltage tester, LED, numeric and alphanumeric display units, semiconductor switches and potential isolation, the phototransistor as a switch in the optocouplers, steady state performance, dynamic performance.

References:

Semiconductor Devices- Physics and Technology by S M Sze, Willey, (1985).
2. *Introduction to Semiconductor Devices*by M S Tyagi, John Willey & Sons.
3. *Measurement, Instrumentation and Experimental Design in Physics and Engineering* byM Sayer and A
Mansingh, PHI
4. *Opticl Enginnering* by Ajoy Ghatak and K Tyagrajan, Cambridge Univ Press.

MPYE 316 b: Condensed Matter Physics –I

UnitI 10 Hours

Symmetry Properties of Crystal Lattice: Mathematical group representation, Proper rotation axis, Improper rotation axis, Rotoreflection, Rotoinversion, Glide planes, Screw axes, Space groups and point groups, Classes, The crystalline structure, Transformation of crystal lattice, Symmetries in Bravis lattice,Transformation and construction.

UnitII 10 Hours

Crystal Physics and Binding: Periodic array of atoms, fundamental types of lattices and Bravis lattice; Miller Indices of a family of planes and interplanar spacing for an orthorhombic crystal, Cubic Zinc Sulphide and closed packed structure, Bragg's law, scattered wave amplitude, Diffraction of electromagnetic waves by crystals, Powder and rotating crystal methods, Neutron and electron diffraction.

UnitIII10 Hours

Free electron theory of Metals: Drude model of electrical and thermal conductivity, Sommerfield model of free election gas; Motion of electrons in a one-dimensional periodic potential, Band Theory of Solids: Metals, insulators and intrinsic semiconductors; Kroning-Penney Model, Basic of Hall Effect, band gap of semiconductor, Hall Effect in semiconductors

Fermi surface and Metals: Construction of Fermi Surfaces, Fermi surface and Brillouin zones, Experimental Methods in Fermi Surface Studies, de Hass van Alphen effect, quantum Hall effect, Magnetoresistance.

Unit IV 10 Hours

Disordered Materials: Structure, Short range order and dangling bond;Random network model; Amorphous semiconductor; Density of states and mobility gap; Electrical transport, Optical and switching properties.

References:

1. *Introduction to Solid State Physics by C. Kittel.*
2. *Solid State Physics by S.O. Pillai.*
3. *Solid State Physicsby A.J. Dekker.*
4. *Condensed Matter Physics by M.P. Marder.*
5. *Principles of the Theory of Solids by J.M. Ziman.*
6. *Solid State Physics by N.W. Ashcroft and N.D. Mermin.*
7. *Solid State Physics (Part-I): Transport Properties of Solid by M.S. Dresselhaus.*
8. *Solid State Physics-Structure and Properties of Materials by M.A. Wahab.*
9. *Principles of Condensed Matter Physics by P.M. Chaikin and T.C. Lubensky.*

MPYE 317a: Bio Physics - I

Unit I (10 Hours)

Nucleic Acids: Nucleosides and nucleotides, primary, secondary and tertiary structure of DNA, Watson - Crick model, backbone conformation,sugar puckering, different forms of DNA, Z-DNA, structure of RNA, differentforms of RNA and their biological functions. The central dogma, DNAreplication, RNA transcription and protein biosynthesis, reverse transcription,mutation and regulation of genes.

UnitII (10 Hours)

Proteins: Aminoacids, peptidebond,disulphidebridge,Primary,secondary,(αhelix and β-sheet),tertiary and quaternary structure ofproteins.Protein conformation, torsion anddihedral angles, Ramachandran map, structure of heamoglobin andmyoglobin.

Unit III (10 Hours)

Membranes: Cell membrane, Micelle. Bilayerand liposome; structure of membrane,conformational propertiesof membranes, passive membrane transport; Donnan equilibrium,Hodgkin-Katz formula, Active membrane transport and transport of charged particlesthroughmembranes. Simple idea of molecular reception - smell reception and taste reception.

Unit IV (10 Hours)

Nerve Impulse: The neuron and Axon and Action potential,recordingof action potential, Chronaxie and rheobase; depolarization andreporalization of axon membrane, mechanism of propagation of nerveimpulse; Ionic channels, Elementary idea of synaptic transmission.

References:

1. *Molecular Biology of the Genes* by J. D. Watson (Benjamin Inc, California).
2. *Principles of Nucleic Acid Structure* by W. Saenger (Springer Verlag, New York).
3. *Biophysics;* Ed. W. Hoppe et. al., (Springer Verlag, New York).
4. *Introduction to Biophysics* by P.S. Narayanan.
5. *Biophysics* by M. V. Volkenstein (MIR publishers).
6. *Biophysics* by V. Pattabhi & N. Gauttam.
7. *Intermolecular Interactions: From Diatomics to Biopolymers*, Ed. B. Pullman (John Wiley, N. Y.).
8. *Physical Biochemistry*by K. E. van Holde, (Prentice Hall, N, J.).

MPYE 317b: Molecular Modelling – I

Unit 1 **(6 Hours)**

Introduction about the computational chemistry and molecular modeling: Coordinate systems, Concept of 2D and 3D structure, molecules, Surfaces,

Unit 2 **(6 Hours)**

Molecular energetic profile: Brief idea about the computational software's for drawing, visualization and simulation of small and large molecules. Basic concept of Chemoinformatics, 3D-Structure file system and Databases.

Unit 3 **(15 Hours)**

Brief introduction about Quantum Mechanics & Molecular Mechanics: Molecular Orbital Theory, The Hartree-Fock method, ab-initio calculation, Semi-empirical methods, Huckel theory, Valence bond theories, Force Field, Geometrical Parameters, Density Functional Theory.

Non-covalent Parameters: understanding of electrostatic interactions, van der Waals interaction, Hydrogen bonding, hydrophobic interactions

Unit 4 **(15 Hours)**

Computer simulation methods: Minimization, Molecular dynamics, Monte Carlo Simulations, Simulated Annealing, Conformational Search and Conformational Analysis, Understanding of iterations, convergence, protocols and algorithm such as steepest descents, conjugate gradient etc.

References

1. Computational Chemistry, Introduction to Theory and Application of Molecular and Quantum Mechanics. By Errol Lewars, Springer

2. Molecular Modelling: Principle and Application, 2nd Ed. By Andrew R. Leach, Addison-Wesley Longman Ltd, (February 2001) ISBN: 0582382106.

MPYE 317c: Nanoscience and Nanotechnology - I

Unit I **(10 hours)**

Background to nanoscience and nanotechnology: nano sized effects, surface to volume ratio, atomic structure, energy at the nanoscale, molecular and atomic size -quantum effects-types of nanotechnology and nano machines

Unit-II **(10 hours)**

Properties of nanomaterials: classification of nanocrystals, dimensionality and size dependent phenomena, Quantum dots, Nanowires and Nanotubes, 2D films, importance of the nanoscale materials and their devices, size dependent variation in mechanical, physical and chemical, magnetic, electronic transport, reactivity.

Unit III **(10 hours)**

Nanoporous materials: Nature of carbon clusters, discovery of C60 structures, Fullerenes, chemical and physical properties, spices of fullerenes, term and nomenclature, geometry of fullerenes-general, 5/6 Fullerenes, introduction to carbon nanotubes, carbon nanotubes and related structures, single walled carbon nanotubes (SWNTs), chirality, multi walled carbon nanotubes (MWNTs).

Unit IV **(10 hours)**

Graphene:structure of Graphene, synthesis and functionalization of Graphene, electronic application of Graphene, Electrochemical deposition, Graphene Oxide.

References

1. *Nanostructures & Nanomaterials: Synthesis, Properties &Applications* by G. Cao, Imperial College Press, 2004.
2. *Nanomaterials, Nanotechnologies and Design*:*An introduction for engineers and Architects* by Micheal F. Ashby, P.J. Ferreria, D.L. Schodek,
3. *Intoduction to Nanotechnology* by Charles P Poole & Frank J. Ownes.
4. *Physical properties of Carbon Nanotube* by R Satio.
5. *Applied Physics Of Carbon Nanotubes: Fundamentals Of Theory, Optics And Transport Devices*by S. Subramony & S.V. Rotkins.
6. *Carbon Nanotubes: Properties and Applications* by Michael J. O'Connell.
7. *Nanotubes and Nanowires* by CNR Rao and A Govindaraj, RCS Publishing.
8. *Nanoscale materials* by Liz Marzan and Kamat.

MPYL 318: Practical

List of Experiments

1. Alpha, Beta and Gamma ray spectrometer.
2. Electron-spin resonance
3. X-ray diffraction
4. G.M. Counter: End point energy and absorption coefficient of the absorber
5. Study of normal Zeeman effect
6. To study the dielectric constant of solid using microwave
7. To study magic Tee, directional coupler, Isolators and Circulators
8. Measurement of piezoelectric coefficient
9. Production of plasma and measurement of its characteristics
10. Magnetic susceptibility
11. Hysteresis loop

M.Sc.SemesterIV

MPYC420:NuclearPhysics

Unit -I **(10 hours)**

Basic properties of nuclei: Fundamental properties of Nucleus - Charge, mass and radius determination methods, Nuclear magnetic dipole moments, Electric quadrupole moment, Binding energy, Nuclearforces-Spindependenceandnon-centralfeatures, Chargesymmetryandchargeindependenceofnuclearforces,Mesontheoryofnuclear forces.

Unit -II **(10 hours)**

Radioactive decays: Alpha decay and Gamow's theory, Beta decay- Concept of neutrino and its detection, Fermi theory, Selection Rules, Allowed and forbidden transitions, Non-conservation of parity and Wu's experiment, Gamma decay: Multiple transitions selection rules, Idea of internal conversion, nuclear isomerism.

Unit -III **(10 hours)**

Nuclear Models:Liquid drop model and Bethe-Weizsäcker mass formula, Magic numbers, Shell model- Evidence of shell structure, Spin-orbit coupling, Extreme single particle model, Predictions of spin, parity and magnetic moments, Collective model-Vibrationalandrotational spectra.

Unit -IV **(10 hours)**

Nuclear reaction: Nuclear reaction and their types, Q-equation, Solution of Q-equation, Threshold energy, Nuclear reaction cross section and its measurement, cross section in terms of partial wave amplitudes, effective range analysis, Compound reaction mechanism, Level width, Nuclear resonances and single level Breit Winger formula.

Unit -V **(10 hours)**

Elementaryparticles: Classificationofelementaryparticles,Typesofinteractionsbetweenelementaryparticles,Exactconservationlaws,Approximateconservationlaws-Isospin,parity,strangeness,chargeconjugation,time reversal, CP violation, CPT theorem, SU(3) classification of particlesandresonances, Quark flavor and color, Quark model of hadrons, Basicidea about thestandard model.

Books:

1. *NuclearPhysics*byIrvingKaplan,Narosa(2002).
2. *NuclearPhysics*byS.N. Ghoshal, S.ChandPublisher(1994).

3. *ConceptsofNuclearPhysics* byB.L.Cohen,Tata McgrawHillEducationPrivateLimited(2005).
4. *ElementaryNuclearTheory*byH.A. Bethe,John Wiley(1947)
5. *IntroductoryNuclearPhysics* bySamuelS. M.Wong, Wiley-VCH;2ndedition (1999)
6. *TheoreticalNuclearPhysics* byJohn M.BlattandV. F.Weisskopf,Dover (10/2010).
7. *BasicIdeasandConcepts inNuclearPhysics,An IntroductoryApproach* by KrisL.G.Heyde, Taylor& Francis Group(2004).
8. *QuarksandLeptons*byF.Halzenand A.D.Martin,JohnWiley(1983).
9. *IntroductiontoElementaryParticles*byDavidJ.Griffiths,Wiley-vchVerlag(2008).
10. *Theoryof NuclearStructure* byM. K. Pal,EWP (1982).

MPYC 421: Numerical & Experimental Techniques

Unit I **(8 hours)**

Curve fitting and error analysis: Linear and nonlinear curve fitting, Chi-square test, Sources of systematic error, reduction of systematic errors, quantification of systematic errors, random errors.

Unit II **(10 hours)**

Measuring systems and Transducers: Instruments types and performance characteristics. Transducers (temperature, pressure/ vacuum, magnetic fields, vibration, optical and particle detectors). Measurement and control, Signal conditioning and recovery. Fourier Transforms.

Unit III **(8 hours)**

Electronics applications: Amplifications (Op-Amp based, instrumentation amp), Filtering and noise reduction, shielding and grounding, Impedance matching. Modulation Techniques

Unit IV **(12 hours)**

Data acquisition system: Digital-to-analog and analog-to-digital converters, multiplexers and demultiplexers, Basics of Microprocessors and microcontroller.

References:

1. *Transducers& Instrumentation* by D.V.S. Murthy.
2. *Instrumentation-Devices &system* by C.S.Rangan,G.R.Sharma,V.S.V.Mani.
3. *Principles of measurement and Instrumentation*: Alan S.Morris.
4. *Electronic Instrumentation*: Kalsi
5. *Electrical & electronic measurement Instrumentation*: A.K.Sawhney.
6. *Modern electronic instrumentation & measurement Technique*: Helfrick Cooper.

MPYE 422a: Electronics – II

Unit – I **(10 hours)**

Modulation techniques: Amplitude modulation- generation of AM wave, demodulation of AM waves DSBSC modulation, generation of DSBSC waves, coherent detection of DSBSC waves, SSB modulation, generation and detection of SSB waves, Principle of super-hetrodyne receiver, frequency modulation & spectrum, FM using varactor diode, Armstrong method of FM, frequency stabilization, Pulse amplitude modulation, Sampling theorem-pass and band-pass signals, channel BW for a PAM signal, delta modulation.

Unit – II **(10 hours)**

Noise: Mathematical representation of noise, sources of noise, frequency domain representation of noise, effect of filtering on the probability, density of Gaussian noise, spectral component of noise, effect of a filter on the power spectral density of noise, superposition of noise, mixing involving noise, linear filtering, noise bandwidth.

Unit – III **(10 hours)**

Microwave Devices: Klystrons, magnetrons and traveling wave tubes, velocity modulation, basic principles two cavity klystrons and reflex klystrons, principles of operation of magnetrons, Helix traveling wave tubes, wave modes, transferred electron devices, gunn effect, principle of operations,
read diode, IMPATT and TRAPATT diode, Advantage and disadvantage of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation.

Unit – IV **(10 hours)**

Radar Systems & Satellite Communications: Radar block diagram of an operation, radar frequencies, pulse considerations, radar range equation, derivation of radar range equation, minimum detectable signal, receiver noise, signal to noise ratio, integration of radar pulses, radar cross section, pulse repetition frequency, antenna parameters, system losses and propagation losses, radar transmitters,
receivers, antenna displays, Satellite communication, orbital satellites, geostationary satellites, orbital patterns, look angles, orbital spacing, satellite systems, link modules.

References:
1. *Communication System* by Symen Haykins.
2. *Digital principles and applications* by A P Malvino and Donald P Leach Tata McGraw Hill comp, New Delhi, (1993).
3. *Communication System* by B P Lathi.
4. *Principles of Electronics* by V.K. Mehta**.**
5. *Handbook of Electronics* by Gupta and Kumar.
6. *Basic Electronics* by B.L. Theraja**.**

MPYE 422b

Condensed Matter Physics –II

Unit I **(10 Hours)**

Transport Properties: Linearized Boltzmann transport equation, Electrical conductivity, Relaxation time, Impurity scattering, Ideal resistance, Carrier mobility, General transport coefficient; Thermal conductivity, Thermoelectric effects, Lattice conduction, Phonon drag, Hall effect and magnetoresistance.

Unit II(10 Hours)

Superconductivity: Basic features (Zero resistance, Meissner effect, Penetration depth, Critical field, Heat capacity and isotopic shift) of superconductors, Soft and hard superconductors; Thermodynamics of superconducting transitions, Electron-electron interaction and screening, electron-phonon-electron interaction and Cooper pairs, Salient features of BCS theory, Superconducting ground state, Quasi particle and energy gap, High temperature superconductor

Unit III **(8 Hours)**

Mossbauer Effect: Difficulties in observing resonance fluorescence of nuclear system, Recoil energy, Natural and dipole broadenings, Classical and quantum theories of Mossbauer effect, experimental method and principal uses of Mossbauer effect.

Unit IV(12 Hours)

Materials Characterization Techniques: Techniques: X-Ray Diffraction (XRD),Scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), scanning tunneling microscopy (STM), XPS, Fourier Transform Infrared Spectroscopy (FTIR), Ultraviolet-VISIBLE Infrared Spectroscopy (UV-IR), Raman Spectroscopy, Low Energy Electron Diffraction (LEED) and Auger Electron Spectroscopy (AES), Thermal Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential scanning calorimetry (DSC).

References:

1. *Introduction to Solid State Physics* by C. Kittel.
2. *Solid State Physics* by S.O. Pillai**.**
3. *Solid State Physics*by A.J. Dekker.
4. *Condensed Matter Physics* by M.P. Marder.
5. *Principles of the Theory of Solids* by J.M. Ziman.
6. *Solid State Physics* by N.W. Ashcroft and N.D. Mermin.
7. *Solid State Physics (Part-I): Transport Properties of Solid* by M.S. Dresselhaus.
8. *Solid State Physics-Structure and Properties of Materials* by M.A. Wahab.
9. *Principles of Condensed Matter Physics* by P.M. Chaikin and T.C. Lubensky.

MPYE 423a

Bio Physics - II

Unit I **(10 Hours)**

Radiation Biophysics: Types of ionic radiations, interaction between radiation and matter. Radiation dose and doserate, radiation effect on living cell, protein, nucleic acid and membrane. Radiation hazards and radiation protection.

Photo biophysics:chemical structure and properties of chlorophyll, mechanism of photosynthesis, photochemical systems: PS-I and PS-II, Importance of photosynthesis.

Unit II **(12 Hours)**

Intermolecular Interactions:Intermolecular potential functions, Rayleigh-Schrodinger perturbation theory of long-range intermolecular interactions, classification of intermolecular forces, concept of short – range forces and inadequacy of Rayleigh-Schrodinger treatment at short range. Representation of short-range forces by classical and semi-empirical methods. Equivalence of classical and quantum-mechanical forces, Multicentred-multipole representation of intermolecular interactions.

Unit III

X-ray methods: Basic principle of X- raydiffraction, structure factor, Analysis of Laue, Rotation and Powder photographs.

NMR:Basic theory of Nuclear Magnetic Resonance, Chemicalshift and spin-spincoupling, relaxationeffect, NMRspectrometers and FT spectroscopy, Applications.

Unit IV

ORD and CD: Basic concept of circular dichoism and optical rotation, Drude equation, Molecular basis of rotator power, Rotatory behavior of macromolecules, Moffit plots for helical and random coil structure.

Sedimentation: Sedimentationvelocity, apparatus and procedures forsedimentation studies, sedimentation equilibrium, Archibald method; Density ingredient sedimentation.

Electrophoresis: Transport in an electric field, isoelectric focusing, orientation of molecules in electric fields.

Chromatography: Basic idea of Molecular-Sievechromatography, Gelfiltration, analysis of the shape of elutingbands;Determination of shape and size of macromolecules.

References:

1. *Molecular Biology of the Genes* by J. D. Watson (Benjamin Inc, California).
2. *Principles of Nucleic Acid Structure* by W. Saenger (Springer Verlag, New York).
3. *Biophysics;* Ed. W. Hoppe et. al., (Springer Verlag, New York).
4. *Introduction to Biophysics* by P.S. Narayanan.
5. *Biophysics* by M. V. Volkenstein (MIR publishers).
6. *Biophysics* by V. Pattabhi & N. Gauttam.
7. *Intermolecular Interactions: From Diatomics to Biopolymers*, Ed. B. Pullman (John Wiley, N. Y.).
8. *Physical Biochemistry*by K. E. van Holde, (Prentice Hall, N, J.).

MPYE 423b: Molecular Modelling - II

Unit 1 **(10 Hours)**

Perturbation Theory:

First-Order Correction to a Nondegenerate Reference System, Second-Order Correction—Nondegenerate Case, The Morse Potential, The Degenerate Case, Perturbation Theory in Approximate MO Theory, MP2 as Perturbation Theory, Time-Dependent Perturbation Theory, Time-Dependent Perturbation Theory for Charged Particles in the Electromagnetic Field.

Unit 2 **(10 Hours)**

Density Functional Theory: The Size Consistency Issue in CC and CI, Beyond CCSD, Performance of CCSD(T), Thermochemical Standards by Quantum Chemistry, Aspiration to Exact Description: Quantum Monte Carlo Calculations

Unit 3 **(12 Hours)**

Highly Accurate Methods: Coupled Cluster Calculations, Extrapolation to Chemical Accuracy,and Quantum Monte Carlo Methods: John Perdew's Ladder, Early Forms of Density Functional Theory: Gill's History, Thomas–Fermi–Dirac Theory, The Hohenberg–Kohn Existence Theorem, Kohn–Sham Procedure for Finding the Density.

Unit 4 **(10 Hours)**

The Representation of Electronically Excited States: CI-Singles, Practical Use of the CIS Equations, Singlet and Triplet State Energies for the 1G Model, Structural Relaxation in the Excited State, Correlation Corrections, Time-Dependent Hartree–Fock Treatments of Excitations.

References:

1. Computational Chemistry, Introduction to Theory and Application of Molecular and Quantum Mechanics. By Errol Lewars, Springer

2. Molecular Modelling : Principle and Application, 2nd Ed. By Andrew R. Leach, Addison-Wesley Longman Ltd, (February 2001) ISBN: 0582382106.

3. Electronic Structure, Modeling: Connections Between Theory and Software by Carl Trindle and Donald Shillady

MPYE 423c:Nanoscience and Nanotechnology – II

Unit I **(12 hours)**

Methods of synthesis of nanoparticle: Critical issues for nanostructure synthesis and assembly, nanomaterial synthesis strategies.

Physical Methods: Ball milling, sonication, low temperature combustion synthesis (LCS) method: principle, typical process, process control

Physical vapor deposition: introduction to deposition and growth, langmuire-knudsen relation, mass evaporation rate, thickness deposition rate, kundsen cell, directional distribution of evaporating species, evaporation of elements, compounds, alloys, Raoult's law, e beam, pulsed laser and ion beam evaporation, glow discharge and plasma, sputtering mechanism and yield, dc and rf sputtering, hybrid and modified PVD-ion plating,reactive evaporation.

Unit II (10 hours)

Chemical Methods Sol-gel technique, solvothermal methods, control of grain size, co-precipitation hydrolysis, sonochemical method combustion technique, colloidal precipitation template process, growth of nanorods, solid-state sintering, Electrodeposition, Arc method

Unit III (10 hours)

Characterization of nanomaterials: Introduction to spectroscopy, Basic principles and applications of UV-Vis-NIR, FTIR, FT-Raman, Photoluminescence, NMR, X-ray powder diffraction, Ellipsometry- thickness measurements, transmission electron spectroscopy, scanning Electron Spectroscopy, X-Ray Photoelectron Spectroscopy, Auger Electron Spectroscopy, EDAX and WDA analysis

Unit IV (10 hours)

Applications of nanostructured materials: Humiditysensors, gas sensor-LPG, Hydrogen, Nitrogen and CO2, Organic photovoltaic cell cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Organic- Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells,biomedical applications in drug delivery system

Ballistic electron transport and coherence, coulomb blockade and quantum transport, single electron transport (SET)

References:

1. *Introduction to Nanoscience and Nanotechnology* by Gabor.L et al.
2. *Elements of X-ray Diffraction* by B. D. Cullity, Addison Wesley, 1977.
3. *Transmission Electron Microscopy: A Textbook for Materials Science* by David B Williams, C Barry Carter, (1996) Plenum Press, New York.
4. *Impedance Spectroscopy: Theory, Experiment, and Applications* by E. Barsoukov and J. Ross Macdonald (Editors) (2000) John Wiley & Sons (P)Ltd.
5. *Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers* by Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, Elsevier, 2009.
6. *Nanostructures & Nanomaterials: Synthesis, Properties & Applications* by G. Cao, Imperial College Press, 2004.
7. *Nanomaterials: An introduction to synthesis, properties and application* by Dieter Vollath, WILE-VCH, 2008.

MPYL-424

List of Practical

1. Absorptionbandsofchlorophyllusingspectrophotometer
2. EmissionspectraofCuusingFeasstandard
3. RotationalspectraofCNmolecule
4. Dissosiationenergyofiodinemolecule
5. Vibrationalspectraofbenzene
6. LinearcharacteristicsofOperationalamplifier
7. Non-linearcharacteristicsofOperationalamplifier