विज्ञानं ब्रह्म

Master of Physics

(Two Year Full Time Degree Program)

SYLLABUS

(M.Sc. Physics)

School of Physics

Shri Mata Vaishno Devi University Katra

(May 2018)

	ABBREVIATIONS / CODES / NOMENCLATURE
Course Code Convention	
SCT – LSAY Example PHL 7091 PHP 6121	Course Code for various Courses / Subjects SC: School Code T: Course Type Code (Lecture/Studio/Practical/Project etc.) L: Course Level (1, 2, 3, 4 & 5 for First, Second years …)
PH	School Code (SoP)
L	Lecture
P	Practical
D	Project Based
Teaching Scheme Convention	
L	Lecture
T	Tutorial
P	Practical
C	Course Credit
Evaluation Scheme Convention	
Minor	(Mid Term Exams / Tests) I & II
Major	End Semester Examination (ESE)

Teaching & Examination Scheme

M. Sc. Semester-I (Fall), First Year

			Teaching & Credit Scheme					Evaluation & Examination Scheme					
S. No.	Subject Code	Title of the Subject	L	T	P	Total Periods/ week	C	Minor E Duration (hours)	Major E Duration (hour)	Internal Marks	Minor (I +II) Marks	Major ESE Marks	Total Marks
1.	PHL 6021	Classical Mechanics	4	0	0	4	4	1.5	3	10	40	50	100
2.	PHL 6031	Mathematical Physics-I	4	0	0	4	4	1.5	3	10	40	50	100
3.	PHL 6041	Quantum Mechanics-1	4	0	0	4	4	1.5	3	10	40	50	100
4.	PHL 6051	Electronics-I	4	0	0	4	4	1.5	3	10	40	50	100
5.	PHP 6121	General Laboratory-I	0	0	12	12	6	3	3	10	30	60	100
		SUB TOTAL	16	0	12	28	22			50	190	260	500

M. Sc. Semester-II (Winter), First Year

			Teaching & Credit Scheme					Evaluation & Examination Scheme					
S. No.	Subject Code	Title of the Subject	L	T	P	Total Periods/ week	C	Minor E Duration (hours)	Major E Duration (hour)	Internal Marks	Minor (I +II) Marks	Major ESE Marks	Total Marks
1.	PHL 6061	Electromagnetic Theory	4	0	0	4	4	1.5	3	10	40	50	100
2.	PHL 6032	Mathematical Physics-II	4	0	0	4	4	1.5	3	10	40	50	100
3.	PHL 6042	Quantum Mechanics-II	4	0	0	4	4	1.5	3	10	40	50	100
4.	PHL 6052	Electronics-II	4	0	0	4	4	1.5	3	10	40	50	100
5.	PHP 6122	General Laboratory-II	0	0	12	12	6	3	3	10	30	60	100
		SUB TOTAL	16	0	12	28	22			50	190	260	500

Teaching & Examination Scheme (Contd..)

M. Sc. Semester-III (Fall), Second Year

			Teaching & Credit Scheme					Evaluation & Examination Scheme					
S. No.	Subject Code	Title of the Subject	L	T	P	Total Periods/ week	C	Minor E Duration (hours)	Major E Duration (hour)	Internal Marks	Minor (I +II) Marks	Major ESE Marks	Total Marks
1.	PHL 7071	Atomic and Molecular Physics	4	0	0	4	4	1.5	3	10	40	50	100
2.	PHL 7081	Condensed Matter Physics	4	0	0	4	4	1.5	3	10	40	50	100
3.	PHL 7082/ 7053/ 7072	Special Paper I	4	0	0	4	4	1.5	3	10	40	50	100
4.	PHL 7083/ 7054/ 7073	Special Paper II	4	0	0	4	4	1.5	3	10	40	50	100
5.	PHP 7056/ 7106	Special Paper Lab	0	0	12	12	6	3	3	10	30	60	100
		SUB TOTAL	16	0	12	28	22			50	190	260	500

M. Sc. Semester-IV (Winter), Second Year

			Teaching & Credit Scheme					Evaluation & Examination Scheme					
S. No.	Subject Code	Title of the Subject	L	T	P	Total Periods/ week	C	Minor E Duration (hours)	Major E Duration (hour)	Internal Marks	Minor (I +II) Marks	Major ESE Marks	Total Marks
1.	PHL 7091	Nuclear & Particle Physics	4	0	0	4	4	1.5	3	10	40	50	100
2.	PHL 7022	Thermodynamics & Statistical Physics	4	0	0	4	4	1.5	3	10	40	50	100
3.	PHL 7084/ 7055/ 7074	Special Paper III	4	0	0	4	4	1.5	3	10	40	50	100
4.	PHL 7085/ 7056/ 7075	Special Paper IV	4	0	0	4	4	1.5	3	10	40	50	100
5.	PHD 7131	Minor Project	0	0	12	12	6	3	3	10	30	60	100
		SUB TOTAL	16	0	12	28	22			50	190	260	500

PHL 6021				Classical Mechanics			Pre Requisites			
~~Version R-01~~							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. understand the fundamental concept of dynamics of a system of particles.
2. develop the skills to understand and use the Lagrangian and the Hamiltonian formalism for solving the equations of motion for any reasonable mechanical system.
3. gain the familiarity with basic ideas of motion in central potential, small oscillations, kinematics and dynamics of rigid bodies.
4. to acquire the knowledege of basic theory of special relativity and relativistic kinematics.

COURSE CONTENTS

Unit I: [8]

Newton's laws, Mechanics of systems of particles, conservation laws, dynamical systems: conservative versus dissipative systems, Phase space dynamics, stability analysis, degrees of freedom, constraints, and generalized coordinates, velocities, momenta and forces.

Unit-II [12]

Hamilton's variational principle, the Lagrangian and the Euler-Lagrange equations, the Hamiltonian, Cyclic Coordinates and Canonical Momenta, Applications of the Lagrangian and Hamiltonian formalisms to systems with one and two degrees of freedom, Principle of least action, Canonical transformations, Poisson brackets, the Hamilton-Jacobi theory, symmetry, invariance and Noether's theorem.

Unit-III [7]

Central force problem, Kepler problem, bound and scattering motions, Scattering in a central potential, Rutherford formula, and the Scattering cross section. Two body Collisions–scattering in laboratory and Centre of mass frames.

Unit-IV [10]

Non-inertial frames of reference and pseudoforces: Centrifugal, Coriolis and Euler forces, Elements of rigid-body dynamics: moment of inertia tensor, Euler angles and the symmetric top, Periodic motion; Small Oscillations: Normal modes analysis, and Normal modes of a harmonic chain

Unit-V [8]

Inertial frames, Postulates of special relativity. Lorentz transformations relativistic velocity addition formula, Relativistic kinematics–Four- vector notation. Velocity-energy-momentum-force four-vectors for a particle. Relativistic invariance of physical laws, relativistic mass-energy equivalence

SUGGESTED BOOKS

1. Classical Mechanics: H Goldstein.
2. Mechanics: L. D. Landau and E. M. Lifshitz
3. Introduction to the principle of Mechanics: W. Hauser
4. Principle of Mechanics: Synge and Griffith
5. Theoretical Mechanics: M. R. Spiegel
6. Concepts and Methods of Theoretical Physics: Lindsay
7. Classical Mechanics: N C Rana and P S Joag

PHL 6031			**Mathematical Physics-I**				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Understand the basics skills of using vector calculus, linear algebra, and probability and distribution theory to solve and interpret physical problems;
2. Solve ordinary and partial differential equations arising in physical sciences;
3. Understand and to apply methods of functions of complex variables to evaluate the integrals;
4. Familiar with the most important special functions to solve mathematical problems of physics;
5. Understand the basics of Fourier and Laplace Transformations and applications in physics.

COURSE CONTENTS

Unit-I. **[10]**

Dimensional analysis, Linear algebra, matrices, Cayley-Hamilton Theorem, Eigenvalues and eigenvectors, Vector algebra and vector calculus, Vector differential operators: gradient, curl, Divergence and Laplacian, Vector operators in curvilinear coordinates, Gauss's theorem. Green's theorem and Stoke's theorem.

Unit-II. **[10]**

Linear ordinary differential equations of first & second order, elementary probability theory, random variables, binomial, Poisson and normal distributions, central limit theorem.

Unit-III. **[10]**

Elements of complex analysis, analytic functions, Analyticity and Cauchy-Reimann Conditions, Cauchy's integral theorem and formula,Taylor, Laurent and Maclaurine series expansion, zeros and singular points, poles, residues and residue theorem, Cauchy's residue theorem, contour integration, Jordan's Lemma, evaluation of definite integrals.

Unit-IV. **[10]**

Special functions: (Bessel, Hermite, Legendre, Laugerre functions) properties and solutions, generating functions, recurrence relations, orthogonality and orthonormality.

Unit-V. **[5]**

Fourier series, Fourier and Laplace Transforms and applications in Physics.

SUGGESTED BOOKS

1. Mathematical Methods for Physicists: George B. Arfken and Hans-Jurgen Weber.
2. Mathematics for Physicists and Engineers: Louis A. Pipes.
3. Mathematical Method of Physics: A.K. Ghatak.
4. Analytical Mathematics in Physics: C. Harper, 1st Edition Prentice Hall
5. Mathematical Method- Potter and Goldberg (Prentice hall of India)
6. Vector Analysis (Schaum Series) (McGraw Hill)
7. Advanced Engineering Mathematics: Erwin Kreyszig (John Willey & Sons, Inc.)

PHL 6041				Quantum Mechanics-I			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Understand the inadequacy of Classical Mechanics
2. Understand the development of Schrodinger equation and its application to one dimensional and three dimensional problems.
3. Understand operator method and bra ket notations and applications of this method.
4. Understand the concept angular momenta in Quantum Mechnics.
5. Understand the matrix representation of angular momenta, eigen values of total angular momentum and its addition

COURSE CONTENTS

Unit-I **[10]**

Inadequacy of classical mechanics (Black body radiations, photoelectric effect, Compton effect, hydrogen spectrum), Wave-particle duality, Wave-function in coordinate and momentum representations, Schrödinger equation (time-dependent and time-independent), current density, equation of continuity, Ehrenfest's theorem.

Unit-II **[5]**

Eigenvalue problems: (Particle in one and three dimensional box, one dimensional harmonic oscillator).Tunneling through a barrier, Rigid rotator and Hydrogen atom.

Unit-III **[10]**

Fundamental postulates of wave mechanics, Commutators and Heisenberg uncertainty principle. Hermitian operators, properties of eigen functions and eigen values of Hermitian operators. Dirac notation for state vectors (Bra and ket notations), matrix representationof wave function and operator, energy spectrum of one dimensional harmonic oscillator using matrix mechanics.

Unit-IV **[10]**

Definition of generalized orbital angular momentum, Angular momentum algebra: operators for J_+, J_and J_Z, Commutation relation of angular momentum operator. Spectrum of eigen values of J^2 and J_Z, operators for angular momentum L in spherical polar co-ordinates, Eigen values and eigen functions of L^2 and L_Z. Spin angular momentum, Eigen values and eigen functions of S^2 and S_Z. Spin orbit coupling, fine structure.

Unit-V **[10]**

Matrix representation of J^2, J_Z, J_+, J, J_x, J_y for j=1/2 and 1. Pauli's spin matrices and their properties, Addition of two angular momenta; coupled and uncoupled representation, Clebsch Gordon coefficients, Spectrum of eigen values of total angular momentum. Calculations of C. G. coefficients when (i) $j_1 = ½$, $j_2 = ½$ (ii) $j_1 = ½$, $j_2 = 1$.

SUGGESTED BOOKS

1. Quantum Mechanics, L. I. Schiff, 3rd Edition, McGraw-Hill (1968).
2. Quantum Mechanics, Ghatak &Loknathan, 1st Edition, MacMillan India
3. Quantum Mechanics, Thankapan, 2nd Edition, New Age Int. Ltd (2004).
4. Introductory Quantum Mechamics, Richard L. Liboff.
5. Introduction to Quantum Mechanics: C.J. Joachain and B.H. Bransden.
6. Introduction of Quantum Mechanics: D.J. Griffiths.

PHL6051			**Electronics-I**				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Assignment(s)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to:

1. Understand working of semiconductors, their application potential in device fabrication
2. differentiate between various types of semiconductors
3. understand the need, role and types of doping and its impact on characteristic of devices
4. understand the working principles of ideal and practical devices
5. understand the working principles of various devices and their application
6. understand the application potential of devices
7. pick up the need for amplifiers and operational amplifiers including their applications
8. the concept of energy conservation and conversion from one form to another using various transducers

COURSE CONTENTS

Unit-I: (09 Contact Periods)

Semiconductor diodes, physical operation of junction diode, depletion and diffusion capacitances, Zener diode, light emitting diode, photodiode, schottky diode. Rectifiers, filters, clipper and clamper, Zener regulator.

Unit-II: (09 Contact Periods)

BJT construction, dc biasing of BJT, characteristics of BJT, load line, FET, JFET, MOSFET (Depletion and enhancement), FET biasing, device structure, device characteristics, frequency dependence and applications. Introduction to homo- and hetero- junction devices.

Unit-III: (09 Contact Periods)

Operational amplifiers, inverting and non-inverting, differential amplifiers, characteristics, offset parameters, differential gain, CMRR, slew rate, input output impedance.

Unit-IV: (09 Contact Periods)

Applications of operational amplifiers: Comparator, adder, subtractor, voltage follower, differentiator, integrator, multivibrators, instrumentation amplifier and filters.

Unit-V: (09 Contact Periods)

Transducers (temperature, pressure/ vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, noise reduction, shielding and grounding, lock-in detector, box-car integrator, modulation techniques. High frequency devices: generators and detectors.

SUGGESTED READINGS

1. Electronic Devices and circuit theory, (Eighth Edition) Robert Boylested and Louis Nashelsky PHI, 2002.
2. Electronics Principles, (Seventh Edition), A.P. Malvino, TMH, 2007
3. Electronic Devices & Circuits, Milman & Halkias, (Fourth Edition), TMH, 2015.
4. Solid State Electronic Devices (Fourth Edition), Ben G. Streetman, Prentice Hall, 1995.
5. OP Amps & Linear integrated circuits, by Ramakant A.Gayakwad PHI, Fourth Edition, 2010
6. Modem Electric Instrumentation and Measurement Techniques (Second Edition), Albert, D. Cooper, PHI, 2008.
7. Measurement and Instrumentation Principles (Third Edition), Alan S. Morris, Elsevier, 2001.

PHL 6061			**Electromagnetic Theory**				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Evaluate the electrostatic fields and potential in free space and in a dielectric meadia.
2. Evaluate configuration energy of an electrostatic system.
3. Understand the production of magnetic field due to steady current and calculate magnetic fields using Boit Savart and Ampers law.
4. Understand the Maxwell's equation of electrodynamics and its applications to propagation of electromagnetic waves.
5. Understand the concept of wave guide and basic concept of plasma and confinement.

COURSE CONTENTS

Unit-I: **[10]**

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. electric potentials, Work done in assembling a charge distribution Electrostatic field in Matter-Polarization, bound charges, Dielectrics and conductors.

Unit-II: **[10]**

Magnetostatics: Biot-Savart law, Ampere's theorem.Magnetic field in matter.Electromagnetic induction.Boundary conditions on the fields at interfaces, Maxwell's equations in free space and linear isotropic media, Electromagnetic waves in free space.Scalar and Vector Potentials, gauge invariance.

Unit-III: **[10]**

Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Radiation from moving charge and Retarded Potential, Lienard-Weichert potentials, Radiated power and angular frequency.

Unit-IV: **[5]**

Transmission lines and wave guides- TE, TM and TEM modes, rectangular and cylindrical wave guides, resonant cavities, Energy dissipation, Q of a cavity.

Unit V: **[10]**

Dispersion relations in plasma, Lorentz invariance of Maxwell's equation. Dynamics of charged particles in electromagnetic fields: uniform and non-uniform fields, time varying fields; Elementary concepts: Boltzmann equation, Plasma oscillations, Debye shielding, Plasma parameters, magneto plasma, Plasma confinement.

SUGGESTED BOOKS

1. D.J. Griffiths- Introduction to Electrodynamics
2. J.D. Jackson- Classical Electrodynamics
3. F.F. Chen- Plasma Physics
4. Bittencourt- Plasma Physics

PHL 6032				**Mathematical Physics-II**			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to:

1. Apply mathematical methods to solve problems in classical physics, statistical physics and quantum mechanics as well as electrodynamics;
2. Numerically, solve ordinary differential equations with boundary value problems;
3. Learn numerical methods for interpolation, finding roots of equations;
4. Integrate a function within limits of given interval and hence to estimate the area under the curves;
5. Iteratively finds the roots of smoothly varying functions with nonzero derivatives.

COURSE CONTENTS

Unit I: [10]

Non-homogeneous boundary value problems and Green's function, Fourier Transform Method of Constructing the Green's Function, Applications of Green's Functions – Green's function for Poisson's equation, The quantum mechanical scattering problem.

Unit II: [10]

Separation of variable methods,partial differential equations (Laplace, wave and heat equations in two and three dimensions), Poisson equations (with particular emphasis on solving boundary value problems in Electrostatics and Magnetostatics).

Unit III: [15]

Root of functions–Bisectional method, false position method, Newton-Raphson method, Interpolation–Linear interpolation, Newton's divided difference interpolation, Lagrange's interpolation, extrapolation, Integration–Newton-cotes expression**,** trapezoidal and Simpson's rule, Solution of first order differential equations using Runge-Kutta method, Finite difference methods, Data interpretation and analysis, Precision and accuracy, Error analysis, propagation of errors, Linear and non-linear curve fitting–least squares fitting, chi-square test.

Unit IV: [5]

Introductory group theory –Groups, subgroups, classes, Matrix representation of a group, Group representation–Reducible and irreducible representations, Three dimensional rotation group **SO(3**), Special unitary groups **SU(2)**.

Unit V: [5]

Tensor and their ranks, contravariant and covariant tensors, symmetric and asymmetric tensors, Scalars or invariants, The Kronecker delta, Algebraic operations of tensors – sum and difference of tensors, direct product of tensors, Contraction, Extension of the rank, quotient law.

SUGGESTED BOOKS

1. G.B. Arfken, Mathematical Methods for Physicists, Elsevier
2. P. Dennery and A. Krzywicki, Mathematics for Physicists, Dover
3. S.D. Joglekar, Mathematical Physics: Basics (Vol. I) and Advanced (Vol. II), Universities Press
4. P.K. Chattopadhyay, Mathematical Physics, New Age International Publishers
5. M.K. Jain, S.R.K.Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 2nd Edition (1985), Wiley Eastern Limited, New Delhi
6. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, fifth edition(2006), McGraw-Hill Education (Asia).
7. A.W. Joshi, Matrices and Tensors in Physics, New Age Publishers

PHL 6042			**Quantum Mechanics-II**				Pre Requisites		**Yes**	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Apply perturbation theory (tine independent & time dependent) for non-degenerate and degenerate cases
2. Apply Variation method to obtain the ground state energy of various systems and WKB method for one dimensional problems
3. Learn the application of operator method to find the energy levels and wavefunctions.
4. Understand the concept of Scattering theory and its applications
5. Understand the basic concept of Relativistic Quantum Mechanics

COURSE CONTENTS

Unit-I: [10]

Time independent non-degenerate perturbation theory upto second order. Applications to normal He atom, perturbed harmonic oscillator. Time independent degenerate perturbation theory upto first order.Application of degenerate perturbation theory to stark effect.Time dependent perturbation theory, calculation of 1st order transition amplitude, transition probability, and derivation of Fermi Golden rule.

Unit-II: [5]

Variational method, its application to ground state of He atom, W.K.B-approximation, classical turning points, connection formulae, Application to WKB to bound state problem.

Unit-III: [10]

Semi Classical theory of radiations, Expression for transition probability for absorption and induced emission using electric dipole approximation. Selection rules, Identical particles, Pauli's exclusion principle, spin-statistics connection.Elementary theory of scattering: phase shifts, partial waves, Born approximation.

Unit-IV: [10]

Relativistic quantum mechanics: Klein-Gordon Equation, Klein-Gordon equation in electromagnetic field, solution of Klein-Gordon equation for a particle with coulomb potential V_0 (hydrogen atom problem), Derivation of Dirac equation, γ-, β-matrices.

Unit-V: [10]

Dirac equation with central potential and hydrogen atom problem, existence of electron spin for a Dirac particle. Covariant form of Dirac Equation, γ-matrices and their properties, γ_5-matrix and properties, Covariance of Dirac Equation, Zitterbewegung and negative energy solutions

SUGGESTED BOOKS

1. Quantum Mechanics, L. I. Schiff, 3rd Edition, McGraw-Hill (1968).
2. Quantum Mechanics, Ghatak&Loknathan, 1st Edition, MacMillan India
3. 4. Introductory Quantum Mechamics, Richard L. Liboff.
4. Introduction to Quantum Mechanics: C.J. Joachain and B.H. Bransden.
5. Introduction of Quantum Mechanics: D.J. Griffiths.

PHL 6052			**Electronics-II**				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. have a thorough understanding of the fundamental concepts and techniques used in Digital Electronics.
2. understand and examine the structure of various number systems, its conversion and its application in digital logic design.
3. build the ability to understand, analyze and design various standard combinational and sequential circuit building blocks.
4. get gamiliar to the Architecture and programming of the microprocessor 8085.
5. write assembly programs to run on 8085 microprocessor based systems.
6. learn about interfacing and various applications of microprocessor.

COURSE CONTENTS

Unit-I **[09]**

Number systems and their conversions: Decimal, binary and hexadecimal, binary arithmetic, binary coded decimal, introduction to logic gates, Boolean algebra. Combinational logic: Basic combinational logic circuits, binary adder/subtractor, decoders, encoders, multiplexers, de-multiplexers, parity generators and checker.

Unit-II **[09]**

Sequential logic: Flip-Flops, Counters, Shift registers and applications, Comparators. D/A and A/D convertors, weighted resistance DAC, R-2R ladder network, flash ADC, single and dual slope ADC, successive approximation ADC.

Unit-III **[09]**

RAM, SRAM, cache memory, DRAM, ROM, PROM, EPROM, Magnetic and optical storage, charge couple devices (CCDs). 8085 Microprocessor, Programming model, I/O and memory mapping, 8085 addressing modes.

Unit-IV **[07]**

8085 instruction set, assembly language programs, looping, counting, delay, indexing, stack, and subroutines, Interrupts.

Unit-V **[11]**

Interfacing of 8255 (PPI), 8253 (PIT), 8279 (PK/DI) with 8085. Direct memory access (DMA) using 8237, Programmable interrupt controller (PIC) intel 8259. Basic idea about microcontrollers.

SUGGESTED BOOKS

1. Digital Fundamentals by Thomas L. Floyd, 10e (2011), Pearson Ed.
2. Digital Systems - Principles and Applications” by Tocci, R. J., Moss and Widmer, 12e (2016) Pearson
3. Modern Digital Electronics: R.P. Jain, 4e (2009), TMH.
4. Digital Principles and Applications, A. P. Malvino, Leach and Saha, 7e (2011), TMH.
5. Microprocessor Architecture, programming and Applications with 8085 by Ramesh S. Gaonkar, 6e (2013), Penram International Publisher.
6. Fundamentals of Microprocessors and Microcontrollers, B. Ram, 2010, Dhanpat Rai Publishing.

PHL 7071				**Atomic and Molecular Physics**			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Apply principles of quantum mechanics to the study of atoms and its behavior;
2. Understand spectroscopy of the hydrogen and multi-electron atoms;
3. Understand of quantum behavior of atoms in external electric and magnetic fields;
4. Familiar with the working principle of laser for its application purposes;
5. Recognize the general features of atomic and molecular spectroscopic methods in order to apply them in explaining the structure and dynamics of atoms and molecules.

COURSE CONTENTS

Unit-I: [8]

Introduction to Spectroscopy and types of Spectra, Spectrum of Hydrogen Atom, Bohr Model for hydrogen atom, Bohr-Sommerfeld model of Hydrogen Atom, Sommerfeld's Relativistic Correction for energy levels of hydrogen atom, Fine Structure of Hydrogen Atom.

Unit-II: [12]

Magnetic Dipole Moments, Electron Spin and Vector Atom Model and Sterrn-Gerlach Experiment, , Zeeman Effect, Paschen-Back effect, Stark Effect, Spin-orbit interaction for two valance electron system (LS and JJ Coupling), Pauli's exclusion Principle, Singlet and Triplet States, Selection Rules, Hyperfine Structure of Spectral Lines and isotopic shift, Spectrum of helium and alkali atom

Unit-III: [5]

Breadth of Spectral Lines, Effect of Nuclear Properties on Spectral Lines, X-ray Spectra, Moseley's Law, Regular and Irregular Doublet Law, Photoelectron Spectra.

Unit-IV: [10]

Frank-Condon principle Born-Oppenheimer approximation Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules

Unit-V: [10]

Nuclear Magnetic Resonance (NMR), and Electron Spin Resonance (ESR). Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

SUGGESTED BOOKS

1. G. Aruldhas, Molecular Structure and Spectroscopy, Second Edition 2007, Prentice Hall Of India, New Delhi
2. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, Third Edition 1972, McGraw-Hill book company, London
3. W. Demtroder, Molecular Physics, 2005, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim
4. J. M. Hollas, Modern Spectroscopy, 1987, Third Edition, John Wiley & Sons, New York
5. V.K. Jain, Introduction to Atomic and Molecular Spectroscopy, 2007, Narosa Publishing House, New Delhi
6. Sune Svanberg, Atomic and Molecular Spectroscopy, 1992, Second Edition, Springer Verlag, Berlin
7. H.E. White, Introduction to Atomic Spectra, 1934, McGraw-Hill Kogakusha Ltd., Tokyo

PHL 7081			Condensed Matter Physics				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. comprehend the scope of Condensed Matter Physics.
2. understand the essential elements of crystallography and the building blocks of common crystalline structures.
3. learn the phenomena of electrical and thermal conductivities in metals.
4. understand the underlying mechanism responsible for the difference in the behavior of metals, insulators and semiconductors.
5. learn about different type of defects in crystals and their consequences.
6. learn the underlying physics of superconductivity.

COURSE CONTENTS

Unit I:
[10]
Bravais lattices, crystal systems, crystal planes and Miller indices, closed packed structures, symmetry elements in crystals, point groups and space groups, common crystal structures, reciprocal lattice, Ewald sphere, Brillouin zone, X-ray diffraction, Bragg's law, Diffraction and the structure factor.

Unit II:
[12]
Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power, Free electron gas (theory), density of states, and Fermi Energy, Electron motion in a periodic potential Bloch theorem, Kronnig –Penny model, band theory of solids: metals, insulators and semiconductors,

Unit III: [10]
Bonding of solids. Elastic properties, Lattice waves, Vibrations of one–dimensional monatomic lattice, Linear diatomic lattice, Three-dimensional lattice, Lattice optical properties in ionic crystal, Quantization of Lattice vibrations,phonons, Lattice specific heat, electronic specific heat.

Unit 1V: [8]
Defects and dislocations – Point defects (Frenkel and Schottky), line defects (slip, plastic deformation, edge and screw dislocation, Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

Unit V: [5]
Superconductivity: Phenomenology, review of basic properties, London's equation and Meissner effect, Type-I and Type-I superconductors, Josephson junctions, Superfluidity.

SUGGESTED BOOKS

1. Solid State Physics by Neil W. Ashcroft and N. David Mermin
2. Introduction to Solids by Azaroff
3. Crystallography Applied to Solid State Physics by A.R. Verma and O.N. Srivastava
4. Introduction to Solid State Physics by C. Kittle
5. Principles of Condensed Mater Physics by P.M. Chaikin and .C. Lubensky.
6. Solid State physics: A.J. Dekker

PHL 7082			**Special paper I (Condensed Matter physics)**				Pre Requisites		**CMP (core)**	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Students shall demonstrate an understanding of knowledge material of practical importance.
2. Students shall design and conduct an experiment (or series of experiments) demonstrating their understanding of the scientific method and process.
3. Students shall demonstrate an understanding of the analytical methods required to interpret and analyze results and draw conclusions as supported by their data.
4. Students shall demonstrate proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.

UNIT I: Atomic diffusion; Fick's 1st and 2nd law of diffusion; diffusion mechanism; measurement of diffusion constant and its application; kirkendall effect; ionic conductivity [12]

UNIT II: Imperfection in solids; classification of imperfactions; extrinsic vacancies; vacancies and diffusion through solid; colour center; and coloration of crystal; F-center; V-center; generation of colour center. [12]

UNIT III: Exciton; weakly bound electron; tightly bound electron; photoconductivity; theory and model of a photoconductor; influence of traps; Space charge effects; Luminescence-excitation and emission; efficiency and decay of phosphors; Thallium activated alkali-halides and other phosphors. [12]

UNIT IV: Magnetic resonance; nuclear magnetic resonance; paramagnetic resonance- analysis with relaxation; application of NMR; electron spin resonance-phenomenon and applications;ferromagnetic resonance-phenomenon and application. [12]

UNIT V: Mossbauer effect, resonant absorption; mechanism of Mossbauer effect; recoil energy; natural line width;thermal line width; doppler's broadening; classical theory; importance of Mossbauer effect. [12]

Suggested Readings

1 Introduction to Solid State Physics, C. Kittel, J. Wiley and Sons, Edition 8th , (2012).
2 Solid State Physics, N. W. Ashcroft and D. M. Mermin, Brooks and Cole, (1978).
3 Elementary Solid State Physics, M. A. Omar, Pearson Education; 1st Edition (2002).
4 Solid State Physics, A.J. Dekker, Publisher: Macmillan India 1st Edition (2000).
5 Solid State Physics: An Introduction, Philip Hofmann 2nd Edition, 2015

PHL 7083			Special paper II (Condensed Matter physics)				Pre Requisites		CMP (core)	
							Co-requisites		Sp. Paper I	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. To understand and learn the concept of different classes of materials in Materials science.
2. To be able to understand the classification and synthesis mechanism of various materials.
3. To understand impact of materials in everyday world and life.
4. To understand the process of degradation of materials
5. To be able to use this knowledge for future higher studies

COURSE CONTENTS

UNIT I : Polymer structures, classification; Characteristics, applications, and processing of polymers; mechanical behavior of polymers, deformation, mechanisms of deformation and strengthening of polymers, crystallization, melting, and glass transition phenomena in polymers, Polymer types, Polymer synthesis and processing. Polymeric fibers, applications of polymers as coatings, adhesives, films and foams. [12]

UNIT II: Composites – particle-reinforced composites, fiber-reinforced composites, and structural composites; polymer-matrix, metal-matrix, and ceramic-matrix composites. [12]

UNIT III: Ceramic structures and mechanical properties of ceramics; types and applications of ceramics; fabrication and processing of ceramics; Electrical conduction in ionic ceramics. [12]

UNIT IV: Corrosion and degradation of materials, – metals, ceramics and polymers. Forms of corrosion – uniform attack, galvanic and crevice corrosion, pitting, stress corrosion and hydrogen embrittlement. [12]

UNIT V: Materials for biomedical applications; Property requirements of biomaterials; Concept of biocompatibility; cell-material interactions; Important biomaterials; Design concept of developing new materials for bio-implant applications, bio-MEMS and bio-NEMS. [12]

Suggested Readings

1 Material Science and Engineering: An introduction, by William D. Jr., Callister Wiley Text Books
2 Material Science and Engineering- A first course by V. Raghavan, Prentice Hall India.
3 Material Science by S.L.Kakani and Amit Kakani, New Age International Publishers.
4 Applied Physics of Solids by Rajnikant, Wiley International
5 Material Science by M.S.Vijaya and G. Rangaranjan, Tata Mc Graw Hill Publishing Company limited.
6 Material and Process in manufacturing by Garmo J.T., Nold A.Kohsor

PHL7053				**Special Paper – I (Electronics)**			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Assignment(s)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to:

1. Get introduced to the concept of microcomputers.
2. differentiate between various types of microprocessors
3. understand the need, role and types of microprocessors and microcontrollers
4. understand the working principles of these devices particularly 8086 and 8051
5. understand the architecture and programing model of 8086 and 8051
6. introduce the students to machine and assembly level programming of these two devices
7. understand their hardware description to be able to use them for electronic circuit/ system design automation

COURSE CONTENTS

Unit-I: (09 Contact Periods)

Register organization of 8086, architecture, signal description of 8086, physical memory organization, general bus operation, I/O addressing capability, special processor activities, maximum mode 8086, system and timings.

Unit-II: (09 Contact Periods)

Machine language instruction formats, Addressing modes of 8086, instruction set of 8086, machine level programs, directives and operators, A few machine level programs, machine coding of the programs.

Unit-III: (09 Contact Periods)

Assembly level sample programs. Review introduction to Microcontrollers and Microprocessors, Review introduction to Microcontrollers and Microprocessors, Embedded vs external memory, Devices, 8-bit and 16 bit Microcontrollers, CISC and RISC processors.

Unit-IV: (09 Contact Periods)

Harvard and Van Neumann Architectures, Commercial Microcontroller Devices, The architecture of the 8051 microcontroller- The plan of 8051 microcontroller, the registers in 8051 microcontroller, the data memory in 8051, the multiplexed port system, the internal and the external memory use, The interrupt and the interrupt flags, the interrupt system- what is interrupt.

Unit-V: (09 Contact Periods)

Why do we use interrupts? The interrupt system of the 8051, setting up an interrupt jump table, Servicing the interrupt, enabling and disabling the interrupts, interrupt from within the microcontroller, external hardware interrupt, how are the interrupts handled, Addressing Modes. Instruction Set, Instructions and simple programs. Using stack pointer, Assembly language programming, Development systems and tools, software simulations of 8051, microcontroller based applications.

SUGGESTED READINGS

1. 8086 microprocessor, programming and interfacing, (Second Edition) K J Ayla, Penram Int.
2. Microprocessor Architecture, Programming, and Applications with 8085, (Fifth Edition) R S Goankar,Penram International.
3. Advanced microprocessors and peripherals, architecture, programming and interfacing, (Third Edition) AK Ray and K M Bhurchandi, TMH.
4. Microcontrollers theory & Applications, (First Edition) Ajay V Deshmukh, TMH.
5. Microprocessors and Interfacing, programming and hardware, (Third Edition) D V Hall,TMH.

6. The 8051 microcontroller and Embedded systems, Rajiv Kapadia, JPH.
7. The 8051 Microcontroller, (Third Edition) K J ayla, Penram International.

PHL 7054			**Special Paper-II (Electronics)**				Pre Requisites			
~~Version R-01~~							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. know about the architectural and other useful features of PIC 16CXX and PIC 16F8XX class of microcontrollers.
2. understand PIC instructions and write simple programs for the general and specific applications.
3. learn the serial communation using various modules of PIC microcontroller.
4. acquire the knowledge of various elements PC parallel port and write programs for their applications.
5. learn the interfacing of PIC microcontrollers with external units like keyboard, displays, memory, ADC/DAC etc. for designing commercial products.

COURSE CONTENTS

Unit-I

Design with Atmel Microcontrollers (89 CXX and 89C20XX): Architecture overview and pin Description, Using flash memory devices AT89CXX and AT89C20XX, Power saving options.

Unit-II

PIC Microcontrollers: Overview and features, PIC 16C6X/7X, FSR (File Selection Register), PIC reset actions. PIC Oscillator connections.PIC memory organization, PIC 16C6X/7X instructions.Addressing modes. I/O ports, Interrupts in PIC 16C61/71. PIC 16C61/71 timers.PIC 16C71 analog to digital converter (ADC).

Unit-III

PIC 16F8XX flash Microcontrollers:- Introduction, Pin diagram, STATUS register, power control register (PCON) and OPTION REG register, program memory, data memory, Capture/ Compare/ PWM (CCP) Modules in PIC 16F877, Master synchronous serial port (MSSP) module. Universal synchronous asynchronous receiver transmitter (USART).Analog-to-digital converter (ADC).

Unit-IV

Interfacing and Microcontroller Applications- Light emitting diodes (LED's); push buttons, relays and latch connections, keyboard interfacing, interfacing 7-segment displays; LCD interfacing, ADC and DAC interfacing with 89C51 Microcontrollers. Industrial applications of Microcontrollers—Introduction to measurement applications.

Unit-V

PC parallel ports for interfacing- Study of PC parallel port: Essentials. Accessing ports (Data, status and control registers, bidirectional ports). Programming issues, Programming tools, Experiments, Interfacing.

SUGGESTED BOOKS

1. PIC microcontroller and Embedded Systems, M. Ali Mazidi, Pearson International Edition.
2. Microcontrollers, Ajay V. Deshmukh (TMH, 2005).
3. Design with PIC microcontrollers John B Peatman, Pearson Education.
4. The Microcontroller Idea Book, Jan Axelson (Penram International Publications, India).

5. Parallel Port Complete: Programming & Interfacing Port, Jan Axelson.

PHL 7072			**Atomic and Molecular Structure**				Pre Requisites		Basic course on thermodynamics	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Understand and explain the hydrogen and helium atomic spectrum
2. Recognize the spectroscopy of many electron atomic systems and hyperfine splitting of spectral lines
3. Familiar with the light sources and spectroscopic techniques to explain the structure of materials
4. Understand Resonance Spectroscopy (ESR and NMR)

COURSE CONTENTS

1. Hydrogen Atom and Helium Atom Spectrum: 15 Periods

Lamb-shift in Hydrogen Spectrum, Rydberg Atoms and Rydberg States, Transition Probability, Helium Atom and Its Spectrum, Alkali Spectrum, Quantum Virial Theorem, Thomas-Fermi Method, Ionization Potential, Electron Affinity.

2. Many-Electron Atoms: 15 Periods

Interpretation of the Spectra of Two Electron Systems, Representation of States for Coupling Schemes, L-S and j-j coupling, Hunds rule, Selection Rules, Complex Spectra and Their Interpretation, Nitrogen, Oxygen and Manganese as examples, Alteration of Multiplicity, Inversion of States, The Atom in magnetic field, Zeeman and Paschen-Back Effect for Two Valance Electron System, Normal and anomalous Zeman Effect, Stark Effect.

3. Magnetic Moment and Resonance Spectroscopy: **10 Periods**

Electron Spin Resonance (ESR), Nuclear Magnetic Moment, Resonance Phenomenon, Magnetic Resonance, Quantum Mechanical Treatment of ESR, NMR Magnetic Structure, Fine Structure in ESR, g-value and Effect of Anisotropy, Chemical Shift and ENDOR.

4. Light Sources, Detectors and Spectroscopic Techniques: 10 Periods

Lasers, Grating Spectrographs and Spectrometers based on Czerny-Turner, Thermal Detector, Photodiode, Photomultiplier Tube, Charge Coupled Detector, Infrared and Raman Spectrometer, Saturation Spectroscopy,

SUGGESTED BOOKS

1. G. Aruldhas, Molecular Structure and Spectroscopy.
2. Laser Spectroscopy: W. Demtroder.
3. High Resolution Spectroscopy: J. M. Hollas.
4. Spectrophysics: A. Thorpe.
5. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy.
6. V.K. Jain, Introduction to Atomic and Molecular Spectroscopy.
7. Sune Svanberg, Atomic and Molecular Spectroscopy.
8. H.E. White, Introduction to Atomic Spectra.
9. M. Karplus and R.N. Porter, Atoms and Molecules: An Introduction for Students of Physical Chemistry.
10. P.W. Atkins and R.S. Friedman, Molecular Quantum Mechanics.
11. L. Fetter and J. D. Walecka, Quantum Theory of Many-Particle Systems.

12. W.A. Harrison, Applied Quantum Mechanics.

PHL 7073			**Molecular Spectra and Structure of Diatomic Molecules**				Pre Requisites		Basic course on thermodynamics	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. apply knowledge to detailed understanding of vibrational-rotational spectroscopy of diatomic molecules, isotope shifts;
2. apply knowledge to detailed understanding of electronic states of atoms, molecules, Franck-Condon Factors;
3. apply knowledge to detailed understanding of electronic states of liquids and solids;
4. understand the continuous and diffuse spectra of diatomic molecule.

COURSE CONTENTS

1. Molecular Structure: **15 Periods**

Quantum Mechanical Interpretation of Near and Far Infrared Spectra of Diatomic Molecules, Rotation, Vibration and Rotation-Vibration Spectra of Diatomic Molecules, Vibrational Isotope Effect, Effect of Nuclear Spin on Intensities of Rotational Spectrum, Raman Spectra.

2. Electronic Spectra of Diatomic Molecule: **10 Periods**

Quantum Mechanical Interpretation of Vibrational and Rotational Structure of Electronic Bands, Frank-Condon Principle, Isotope Effect on Electronic Spectra, Fluorescence and Phosphorescence.

3. Molecular Electronic States: **10 Periods**

Classification of Molecular States, Multiplet Structure, Selection Rules for Electronic Transitions, Building-up Principle, Coupling of Rotational and Electronic Motions.

4. Molecular Orbital Theory and Chemical Bonds: **10 Periods**

Heitler-London Treatment of Hydrogen Molecule, Bonding and Anti Bonding Electrons, Molecular-Orbital Treatment of the Stability of Molecular States.

5. Continuous and Diffuse Molecular Spectra: **05 Periods**

Continuous and Diffused spectra, Pre-dissociation, Determination of Dissociation Energy of O_2, I_2, and N_2 Molecules.

SUGGESTED BOOKS

1. G. Aruldhas, Molecular Structure and Spectroscopy.
2. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy.
3. W. Demtroder, Molecular Physics.
4. S.L. Gupta, V. Kumar and R.C. Sharma, Elements of Spectroscopy.
5. J. M. Hollas, Modern Spectroscopy.
6. Sune Svanberg, Atomic and Molecular Spectroscopy.
7. H.E. White, Introduction to Atomic Spectra.

PHL 7091				**Nuclear & Particle Physics**			Pre Requisites		**Not required**	
Version R-01							Co-requisites		**Not required**	
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. understand the scope of the Nuclear and Particle Physics
2. gain the basic properties of a nucleus such as binding energy and nuclear forces.
3. understand mechanism of decay process of alpha beta and gama particles
4. familiar the process of nuclear Fission and fusion and concept of particle detector and accelerators
5. Understand the basic properties of elementary particles.

COURSE CONTENTS

Unit-I [10]

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model.Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces.

Unit-II [10]

Deuteron problem: Simple theory of ground and excited states of deuteron, spin dependence of nuclear forces, nucleon-nucleon scattering, Evidence of shell structure, single-particle shell model, its validity and limitations, collective model, Rotational spectra.

Unit-III [10]

Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion, Bohr-Wheeler theory of nuclear fission, Nuclear reactions, reaction mechanism, endothermic and exothermic reactions, Compound nucleus model, Resonance scattering: Breit-Wigner formula, optical model, direct reactions.

Unit-IV **[**6]

Sensitivity of detector, response of detector, energy resolution of detector, efficiency of detector, dead time detector, ionization chamber, proportional counter, Geiger-Muller counter, scintillation detector, Synchro-cyclotron, betatron, linear accelerator, nuclear chain reaction, general aspects of reactor design, classification of reactors.

Unit-V [9]

Classification of fundamental forces, Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Fundamental interactions among particles Gellmann-Nishijima formula.Quark model, baryons and mesons.C, P, and T invariance.Application of symmetry arguments to particle reactions.Parity non-conservation in weak interaction.Relativistic kinematics.

SUGGESTED BOOKS

1. Cohen, B.L., Concepts of Nuclear Physics, 2005, Tata McGraw-Hill, New
2. Griffiths, D., Introduction to Elementary Particles, 1987, John Wiley & Sons,
3. Heyde, K., Basic Ideas and Concepts in Nuclear Physics, 2005, Overseas Press, India
4. Kaplan, I., Nuclear Physics, 1998, Narosa Publishing House, New Delhi
5. Wong, S.S.M., Introductory Nuclear Physics, 2005, Prentice-Hall, India

PHL 7022			Thermodynamics and Statistical Physics				Pre Requisites		Basic course on thermodynamics	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Understand the concept of Microscopic and macroscopic states and relationship between thermodynamics and statistics.
2. To know about different types of ensembles.
3. To become familiar with Bose and Fermi Dirac statistics.
4. To gain knowledge on the concepts of phase transitions.
5. To understand no equilibrium processes.

COURSE CONTENTS

Unit-I: [12]

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibrium. The macroscopic and microscopic states – contact between statistics and thermodynamics – the classical ideal gas.

Unit-II: [12]

Phase space, density of distribution in phase space, ergodic hypothesis, Classical distribution law: micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Postulate of equal a priori probability.

Unit-III: [12]

Ideal Bose and Fermi gases. Energy and pressure of gas, Bose Einstein condensation, thermal properties of BE gas, liquid helium, London theory, Ideal Fermi Dirac gas, energy and pressure of gas, slight and strong degeneracy, thermodynamic function of FD gas. Principle of detailed balance. Blackbody radiation andderivation of Planck’s distribution law.

Unit-IV: [12]

Classification of phase transitions, First- and second-order phase transitions. Critical exponents, Ising model, Bragg William Approximation, Diamagnetism, paramagnetism, and ferromagnetism. Fluctuations in thermodynamic quantities: energy, pressure, volume, enthalpy.

Unit-V: [12]

Diffusion equation. Random walk and Brownian motion, Fokker Planck equation, Wiener and Khintchine theorem, electrical noise. Introduction to non-equilibrium processes. Boltzmann transport equation-drift variation and collisions or scattering variations, chamber’s equation.

SUGGESTED BOOKS

1. Walter Greiner, Ludwig Neise, Horst Stocker “Thermodynamics and Statistical Mechanics” Springer
2. Kerson Huang “Introduction to Statistical Physics” Taylor and Francis, 2001
3. P K Pathria “Statistical Mechanics” 2nd Ed.
4. J K Battacharjee, Statistical Physics; Allied Publishers (India)
5. F Reif, Statistical and Thermal Physics, McGraw Hill
6. C Kittel, Thermal Physics, CBS Indian Ed.

PHL 7084	Special Paper III (Condensed Matter Physics)						Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Familiar the concept crystal growth methods.
2. Understand the basic requirement of vacuum and nature of gas flow at low pressure and concept of mean free path along with pressure units and mechanism of production and measurement of low pressure.
3. Familiar with the process of thin film growth and experimental method of thin film growth such as Thermal evaporation, chemical vapour depositions (CVD), Pulsed laser deposition (PLD) etc.
4. Understand the basic method of thickness measurement of thin films.

COURSE CONTENTS

UNIT I: [08]

Crystal Growth techniques: Theories of crystal growth, Homogeneous and heterogeneous nucleation.

UNIT II: [15]

Vacuum Techniques: pressure and mean free path, pressure units, classification of vacuum, gas flow at low pressure: Production of low pressures; vacuum pumps: mechanical pumps, diffusion pump, ion pump. Measurement of pressure, vacuum gauges: thermal conductivity gauge (pirani gauge, ionization gauge (hot and cold cathode gauge).

UNIT III: [05]

Mechanism of thin film formation: Condensation and nucleation, growth and coalescence of islands, factors affecting structure and properties of thin films.

UNIT IV: [12]

Preparation of Thin Films: Thermal evaporation (resistive and e- beam), Cathode Sputtering, magnetron sputtering, Chemical vapour Depositions, Molecular beam epitaxy (MBE), atomic layer deposition (ALD), Laser Ablation: Pulsed laser deposition (PLD).

UNIT V: [05]

Thickness Measurements of thin films: Stylus Method, Electrical Method, Quartz Crystal Method, Optical Methods, mass measurements (microbalance).

SUGGESTED BOOKS

1 K.L. Chopra “ Thin Film Phenomenan” McGraw Hill Inc (1969)
2 A. Roth “Vacuum Technology” North Holland Amsterdam
3 Ludmila Eckertova “ Physics of Thin Films” Plenum Press NY (1986)

PHL 7085			Special paper IV(Condensed Matter physics)				Pre Requisites		CMP (core)	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. Understand the concept of nanomaterials.
2. Acquire knowledge on preparation and characterization techniques.
3. Acquire knowledge on different types of nanomaterials.
4. Apply the knowledge to prepare and characterize novel nanomaterials.
5. Understand practical applications of nanomaterials

COURSE CONTENTS

UNIT I: [12]

Introduction to nanomaterials; Quantum confinement of electrons in semiconductor nanostructures- 3D, 2D, 1D and zero dimensional structures ; Size effect and properties of nanostructures; Excitons and excitonic Bohr radius – difference between nanoparticles and quantum dots.

UNIT II: [12]

Synthesis Methods: Top down and Bottom up approach; chemical methods-colloids and colloidal solutions; growth of nanoparticles; sol-gel methods; combustion methods; ball milling; template synthesis; X-ray and e- beam nano-lithography. Langmuir-Blodget growt

UNIT III: **[12]**

Characterization of Nanomaterials: X-ray diffraction-peak broadening; Scherer formula; Transmission and scanning electron microscopy, Atomic force microscopy; UV-VIS spectroscopy- blue shift and band gap calculation; fluorescence spectroscopy; photoconductivity.

UNIT IV: [12]

Properties of Nanomaterials: mechanical (elastic and hardness); structural; electrical; optical properties of metallic nanoparticles; semiconductor nanoparticles; magnetic properties of nanoparticles;

UNIT V: **[12]**

Nanotechnology Applications: Applications of nanoparticles, quantum dots, quantum well laser; cosmetics; self cleaning glasses; Scratch free lenses; nanoparticles based solar cells and quantum dots based white LEDs ; CNT based batteries; ferrofluids.

SUGGESTED BOOKS

1. Introduction to Nanotechnology, C.P. Poole Jr., F.J. Owens, Wiley (2003).
2. Nanotechnology: Principles and Pratices, S. K. Kulkarni, Capital Publishing Company, (2007)
3. The Physics of Low-Dimensional Semiconductors, John H. Davies, Cambridge University Press, 1998.
4. Nanostructured Materials, Jackie Ying, Academic Press, (2001).
5. Nanoparticles and Nanostructured Films, J.H. Fendler , Springer, (2000).

PHL 7055			Special Paper-III (Electronics)				Pre Requisites			
~~Version R-01~~							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to

1. understand the difference between object oriented programming and procedural oriented language and data types in C++.
2. develop the skills to use C++ features such as composition of objects, operator overloading, inheritance, Polymorphism etc.
3. enable the students to put their assembly programming skills in developing simple embedded programs using C/C++.
4. introduce the embedded systems, their classification and applications for real world.
5. gain the familiarity with basic ideas of embedded hardware and interfacing in product designing.
6. make the students familiar with software development & tools for embedded systems.

COURSE CONTENTS

Unit-I

Introduction to Computers and Programming, Introduction to C++, Expressions and Interactivity, Making Decisions, Looping, Functions, Arrays, Sorting arrays, Pointers

Unit-II

Defining Classes: Data Members and Member Functions, Accessing the Class Members, Class Access Modifiers, Constructors and Destructors, Copy Constructor, Friend Functions, Inline Functions, *this* Pointer, Pointers to Classes, Static Members, Inheritance, Polymorphism, Virtual functions.

Unit-III

Introduction to Embedded Systems, Embedded System v/s General Computing System, Classification of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems, Smart Running Shoes. A Typical Embedded system: Core of the embedded system

Unit-IV

Characteristics of an Embedded System, Quality Attributes of Embedded Systems; Embedded Systems-Application and Domain–Specific:Washing Machine, Automatic-Domain Specific examples of Embedded System; Design Process and design Examples: Automatic Chocolate Vending machine (ACVM), Smart Card, Digital Camera, Mobile Phone, A Set of Robots.

Unit-V

Embedded Development systems and tools- Kiel µVision IDE & Simulator, CodeWarrior tools – Project IDE, Assembler and Debugger, Code Optimization, Software Simulations of 8051,

SUGGESTED BOOKS

1. Starting out with C++, Tony Gladdis (3^{rd}ed.) Dreamtech press
2. Schaum's Outline of Programming with C++, John R. Hubbard, TMH, 2^{nd} Ed.
3. The 8051 Microcontroller and Embedded Systems, 3^{rd} Ed., Mazidi, Pearson.
4. Embedded Systems, Architecture, programming and design, TMH, 2005
5. Embedded Microcomputer Systems: real time interfacing, Jonathan W Valvano, Thomson Learning
6. Embedded Systems Handbook, 2nd Edition By Richard Zurawski, CRC Press/ Taylor & Francis

PHL7056			**Special Paper – IV (Electronics)**				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Assignment(s)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to:

1. Get introduced to the field of communications.
2. Pick up basics of how communications happens over long distances.
3. Understand the difference between various modulation techniques.
4. Learn analog and digital principles involved in this field.
5. Learn network reference models and topologies.
6. Get introduced to the field of computer networks and data communications and some of the associated technologies.

COURSE CONTENTS

Unit-I: **(09 Contact Periods)**

Communications, communications systems, information, transmitter, channel-noise, receiver, Introduction to modulation, need for modulation, Amplitude modulation (AM), Frequency spectrum of AM wave, double side band full carrier, double side band suppressed carrier, single side band suppressed carrier. Advantages, disadvantages and applications of SSB modulation, vestigial side band modulation and its advantages, disadvantages and applications, representation of AM wave,

Unit-II: **(09 Contact Periods)**

Power relations, current calculations, modulation by several sine waves, implementation of AM Modulators and De-Modulators, Representation of FM and PM signals, spectral Characteristic of Analog Modulated Signals. Overview of data communication and networking: Introduction, data communication, Layered tasks, Networks, the internet, protocols and standards.

Unit-III: **(09 Contact Periods)**

network models,OSI reference model, Description of various layers, Internet model Analog and digital signals, Composite signals, r detection and correction, Introduction to LAN's, Wireless LAN's, IEEE 802.11, Bluetooth, information capacity, bits, bit rate, Baud rate, data rate limits, Digital transmission (line and block coding).

Unit-IV: **(09 Contact Periods)**

M-Ary encoding, Transmission media, guided (including description of various types) and unguided media, wireless, transmission impairment, Amplitude Shift Keying, frequency Shift Keying, Phase Shift Keying, Introduction to Pulse modulation, PCM sampling, Signal to quantization noise ratio, Compandling, PCM line speed.

Unit-V: **(09 Contact Periods)**

Delta modulation PCM, Adaptive delta modulation, Multiplexing and de-multiplexing, Frequency division Multiplexing (FDM), high speed digital access, DSL technology, ADSL, DMT, DSLAM, SDSL, HDSL, cable modem, HFC network, CM and CMTS, SONET, Error detection and correction, Introduction to LAN's, Wireless LAN's, IEEE 802.11, Bluetooth

SUGGESTED BOOKS

1. Communication Systems, Simon Haykin, John Willey & Sons, 4th Ed.
2. Communication Systems Engineering, Proakis & Salehi, Pearson Education, 2nd Ed.
3. Electronic Communication, Roody & Coolen, Pearson Education, 4th Ed.
4. Electronic Communication, Kennedy & Davis, TMH, 4th Ed.
5. Data communications and networking by B. A. Forouzan, TMH, 3rd Ed.

6. Advanced Electronic communications systems, Wayne Tomasi, PHI, 6th Ed.

PHL 7074			**Advanced Laser Spectroscopy**				Pre Requisites		Basic course on thermodynamics	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to:

1. Able to describe fundamental operations of modern and advanced lasers;
2. Understand and explain the phenomenon of Non-linear process and Laser-Raman Scattering;
3. Able to describe the novel applications of lasers and to show familiarity with current research issues in laser spectroscopy;
4. Understand the laser-induced phenomenon for its application in isotopic effect, monitoring of atmospheres etc.

COURSE CONTENTS

Unit-I. Basic Principle and Different Lasers: **15 Periods**

Principle and Working of Lasers (solid, liquid and gas), Nd: YAG Laser, Dye Laser, CO_2 Laser, and Excimer Laser, Longitudinal and TE Laser Systems, Threshold condition for Oscillation in Semiconductor Laser.

Unit-II. Non Linear Processes **15 Periods**

Propagation of EM Waves in Nonlinear Medium, Frequency Generation, Phase Matching, Self Focusing, Optical Parametric Oscillator, Stimulated Raman Scattering, Coherent Antistoke Raman Spectroscopy (CARS), Hyper-Raman Effect, Saturation and Two photon Absorptions.

Unit-III. Applications of Laser and Laser-induced Phenomenon: **20 Periods**

Cooling and Trapping of Atoms, Doppler and Polarization Gradient Cooling, Optical Traps and Magneto-Optical Traps, Evaporative Cooling and Bose Condensation, Two-photon spectroscopy, Multi-photon Spectroscopy, Laser Photochemistry, Laser Isotope Separation, Laser-Induced Fluorescence, Hanle effect.

SUGGESTED BOOKS

1. Laser Spectroscopy and Instrumentation: W. Demtroder.
2. Principles of Lasers: O. Svelto.
3. Laser Cooling and Trapping: P.N. Ghosh.
4. Frontiers in Atomic, Molecular and Optical Physics: S.P. Sengupta.
5. G. Aruldhas, Molecular Structure and Spectroscopy.
6. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy.
7. W. Demtroder, Molecular Physics.
8. B.B. Laud, Lasers and Non-Linear Optics.
9. Corney, A., Atomic and Laser Spectroscopy.
10. Bloembergen, N., Nonlinear Optics.

PHL 7075			**Infra-red and Raman Spectra of Polyatomic Molecules**				Pre Requisites		Basic course on thermodynamics	
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 hour	3 hour	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to:

1. Able to describe group theory to classify the molecules and to recognize the symmetry of molecules;
2. Describe the detailed concept of Infrared and Raman spectra of Polyatomic molecules;
3. Understand selection rules to explain transitions;
4. Describe vibrational and rotational spectra of polyatomic molecules.

COURSE CONTENTS

Unit-I. Group Theory and Polyatomic Molecules: **15 Periods**

Symmetry Operations and Symmetry Elements, Point groups, Classification of Molecules into Point Groups, Infrared and Raman spectra of Polyatomic Molecules.

Unit-II. Vibrational motion and Modes of Vibration: **15 Periods**

Vibrational Motion, Normal Co-ordinates and Normal Modes of Vibration, Quantized Vibrational Motion, Vibrational Energy, Symmetry Co-ordinates, Symmetries of Normal Modes of Vibration of M_2O and CO_2 Molecules.

Unit-III. Polyatomic Molecule and Rigid Rotator: **10 Periods**

Polyatomic Molecules as a Rigid Rotator and Symmetric Top, Pure Rotational Structure in the Raman and Far Infrared Spectra of Linear Molecules, Alternation of Intensity.

Unit-IV Rotational Vibrational Spectra of Linear Molecules: **10 Periods**

Rotational Vibration Spectra of Linear Molecule, Selection Rules and Transition of Rigid Rotator, Parallel and Perpendicular Bands in Linear Molecules.

SUGGESTED READING:

1. G. Aruldhas, Molecular Structure and Spectroscopy.
2. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy.
3. S. Chandra, Molecular Spectroscopy.
4. S. Chandra, Physics of Atoms and Molecules.
5. W. Demtroder, Molecular Physics.
6. S.L. Gupta, V. Kumar and R.C. Sharma, Elements of Spectroscopy.
7. J. M. Hollas, Modern Spectroscopy.
8. V.K. Jain, Introduction to Atomic and Molecular Spectroscopy.
9. Sune Svanberg, Atomic and Molecular Spectroscopy.
10. Herzberg, G., Spectra of Diatomic Molecules.