Minutes of Meeting

A meeting of Board of Studies Applied Science and Material Science held on 20th Jan 2016 at 11:00 am at the office of Dean Academics, IKG Punjab Technical University.

The following members were present:

1. Dr. Ravi Kumar, BCET Gurdaspur, (Chairman)
2. Dr. N.K. Verma, Thaper University, Patiala (Member)
3. Dr.A.K. Tyagi, SBSCET, Ferozepur (Member)
4. Dr. Rakesh Dogra, BCET Gurdaspur,(Member)
5. Dr. Kanchan L Singh DAVIET, Jalandhar (Member)
6. Dr. Hitesh Sharma, Punjab Technical University (Coordinator)

The following members were not present:

1. Dr. R. C. Singh, GNDU, Amritsar (Member)
2. Dr.Ajay Kumar SBSCET, Ferozepur (Member)

The Board took the agenda and following recommendations were made:

1. The course credits of Engineering Physics are as per Choice based credit guidelines of IKG PTU, therefore no change is required. The syllabus was discussed and revised syllabus was approved, copy enclosed as Annexure-A.
2. Post graduate course in Physics should be named as M.Sc. (Physics) instead of M.Sc.(Applied Physics), should be adopted uniformly for the University campus as well as for affiliated colleges
3. The course scheme and syllabus contents of M.Sc. (Physics) for PITK, IKG PTU campus as formulated by a committee headed by Prof KN Pathak was presented in the BOS (Physics) meeting. Committee approved the item as presented. An approved copy of the same is enclosed-Annexure-B.
   Committee members further appreciated the efforts of the committee headed by Prof. K.N. Pathak and decided that same scheme and credits of M.Sc. (Physics) be implemented uniformly for all Colleges and University Campus from 2016-2017 after minor changes, copy Enclosed- Annexure-C
4. The new course scheme and credits for M.Tech (Nanotechnology) was discussed thoroughly and committee felt need for revising the contents of course. Members discussed that since the course was running only in two colleges and at present there is no admission since last two years, so it was recommended that course be renamed either as M.Tech Material Science & Nano Technology or M.Tech Material Science and Engineering (with specialization in Nanotechnology) and syllabus be formulated accordingly.

Meeting ended with the vote of thanks to the Chairman, BOS (Physics, Material Science and Nanotechnology)

20/01/16
Dr. Hitesh Sharma

20/1/16
Dr. Kanchan L Singh

Dr. Rakesh Dogra

20/1/16
Dr. N.K. Verma

Dr.A.K. Tyagi 20/1

Dr. Ravi Kumar

IKGPTU/AS/1342
22/10/16

(1)

Subject: Minutes of Board of Studies in Physics, Material Science and Nanotechnology on 20th Jan 2016

A meeting of Board of Physics, Material Science and Nanotechnology held on 20th Jan 2016 at 11:00 am at the office of Dean Academics, IKG Punjab Technical University.

Dean Academic
No. 212
Date 27/1/16

The following members were present:

1. Dr. Ravi Kumar, BCET Gurdaspur, (Chairman)
2. Dr. A.K. Tyagi, SBSCET, Ferozpur (Member)
3. Dr. N.K. Verma, Thaper University (Member)
4. Dr. Rakesh Dogra, BCET Gurdaspur(Member)
5. Dr. Kanchan L Singh , DAVIET, Jalandhar (Member)
6. Dr. Hitesh Sharma, IKG Punjab Technical University (Coordinator)

The minutes of same are enclosed for necessary action.

22/01/16
Dr. Hitesh Sharma
Coordinator-BOS(Physics, Material Science and Nanotechnology)

Dr. Buta Singh
Dean, Academics

Incharge (BOS)

27/1/16

Copy to: Dr. Hitesh to forward these minutes directly to the Incharge (BOS) in future

Annexure-A

BTPH-101 (Engineering Physics)

Objective/s and Expected outcome:

The objective of the course is to develop a scientific temper and analytical capability in the engineering graduates through the learning of physical concepts and their application in engineering & technology. Comprehension of some basic physical concepts will enable graduates to think logically the engineering problems that would come across due to rapidly developing new technologies. The student will be able to understand the various concepts effectively: logically explain the physical concepts; apply the concept in solving the engineering problem; realize, understand and explain scientifically the new developments and breakthroughs in engineering and technology; relate the developments on Industrial front to the respective physical activity, happening or phenomenon.

PART A

1. Electromagnetic Waves: Physical significance of Gradient, Divergence & Curl, Displacement current, Maxwell equations, Equation of EM waves in free space, velocity of EM waves, Poynting vector, Electromagnetic Spectrum (Basic ideas of different region). **(6)**

2. Magnetic Materials & Superconductivity: Basic ideas of Dia, Para, Ferro &Ferri, Ferrites, Superconductivity, Superconductors as ideal diamagnetic materials, Signatures of Superconducting state, Meissner Effect, Type I & Type II superconductors, London equations, Introduction to BCS theory. **(8)**

3. Elements of crystallography: Unit cell, Basis, Space lattice, Crystal Systems, Miller Indices of Planes & Directions in cubic system, Continuous & Characteristic X-Rays, X- ray diffraction and Bragg's Law, Bragg's spectrometer, X-ray radiography. (6)

PART B

4. Lasers:

Coherence, Stimulated and spontaneous emissions, Einstein coefficients, Population Inversion, Pumping Mechanisms, Components of a laser System, Three & four level laser systems; Ruby, He-Ne, CO_2 and semiconductor Lasers, Introduction to Holography. (5)

5. Fibre Optics: Introduction, Acceptance Angle, Numerical Aperture, Normalized frequency, Modes of propagation, material dispersion & pulse broadening in optical fibres, fibre connectors, splices and couplers, applications of optical fibres. (5)

6. Quantum Theory: Need and origin of quantum concept, Wave-particle duality, Matter waves, Group & Phase velocities, Uncertainty Principle, Significance & normalization of wave function, Schrodinger wave equation: time independent & dependent, Eigen functions & Eigen values, particle in a box. Quantum confinement nano physics and related applications **(10)**

Reference Books:

1. Introduction to Electrodynamics by David J. Griffiths
2. Materials science and engineering: a first course by V. Raghvan
3. Optics by Ajay Ghatak
4. Optical Fibre Communication: Principles And Practice by Senior
5. Concepts of Modern Physics by Arthur Beiser

FIRST SEMESTER ***Contact Hours: 23 Hrs.***

Code	Course Title	Load Allocation			Total Marks	Credits
		L	T	P		
PHS411	Mathematical Physics-I	3	1	-	100	4
PHS412	Classical Mechanics	3	1	-	100	4
PHS413	Quantum Mechanics-I	3	1	-	100	4
PHS414	Statistical Physics	3	1	-	100	4
PHS415	Atomic and Molecular Physics	3	1	-	100	4
PHS416	Physics Lab-I	-	-	3	75	3
TOTAL		15	5	3	575	23

SECOND SEMESTER ***Contact Hours: 26 Hrs.***

Code	Course Title	Load Allocation			Total Marks	Credits
		L	T	P		
PHS421	Mathematical Physics-II	3	1	-	100	4
PHS422	Nuclear Physics	3	1	-	100	4
PHS423	Quantum Mechanics-II	3	1	-	100	4
PHS424	Computational Physics	3	1	-	100	4
PHS425	Condensed Matter Physics-I	3	1	-	100	4
PHS426	Physics Lab ï II	-	-	3	75	3
PHS427	Computational Lab	-	-	3	75	3
TOTAL		15	5	6	650	26

THIRD SEMESTER ***Contact Hours: 23 Hrs.***

Code	Course Title	Load Allocation			Total Marks	Credits
		L	T	P		
PHS531	Condensed Matter Physics-II	**3**	**1**	**-**	**100**	**4**
PHS532	Classical Electrodynamics	**3**	**1**	**-**	**100**	**4**
PHS533	Particle Physics	**3**	**1**	**-**	**100**	**4**
PHS534	Electronics	**3**	**1**	**-**	**100**	**4**
PHS535 PHS536 PHS537 PHS538	Elective Subject-I	**3**	**1**	**-**	**100**	**4**
PHS 539	Seminar	**-**	**-**	**-**	**Satisfactory/ Unsatisfactory**	**2**
PHS540	Physics Lab-III	**-**	**-**	**3**	**75**	**3**
TOTAL		**15**	**5**	**3**	**575**	**25**

FOURTH SEMESTER ***Contact Hours: 08 Hrs.***

Code	Course Title	Load Allocation			Total Marks	Credits
		L	T	P		
PHS541 PHS542	Elective Subject-II	**3**	**1**	**-**	100	4
PHS543 PHS544	Elective Subject-II	**3**	**1**	**-**	100	4
PHS545	Research Project	**-**	**-**	**-**	Satisfactory/ Unsatisfactory	12
TOTAL		**6**	**2**	**-**	**200**	**20**

ELECTIVE SUBJECTS:

S.No.	**Name of the Subject**	**Code**
1	Fiber optics and non-linear optics	PHS-535
2	Plasma Physics	PHS-536
3	Nonlinear Dynamics	PHS-537
4	Structures, Spectra and Properties of Biomolecules	PHS-538
5	Experimental techniques in Nuclear Physics and particle Physics	PHS 541
6	Physics of Nanomaterials	PHS 542
7	Environmental Physics	PHS 543
8	Science of Renewable source of Energy	PHS 544

Examination and Evaluation :

S.No.		Weightage	Remarks
Theory			
1.	Mid term sessional Test (I/II/III)	25 %	Best of two test will be considered for evaluation and quizzes etc constitute internal evaluation
2	Attendance /Seminars/Assignments	5 %	
3	End semester examination	70%	Conduct and checking of the answer sheets will at the Department level in case of University teaching Department or Autonomous institutions. For other colleges examination will be conducted at the university level
	Total	100%	Marks may be rounded off to nearest integer
Practical			
1	Daily evaluation of practical record Assignment/Viva Voice/ Attendance etc	50%	Internal evaluation
2	Final Practical Performance + Viva Voice	50%	External evaluation
3	Total	100%	Marks may be rounded off to nearest integer

PHS411- MATHEMATICAL PHYSICS-I

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Vector fields and Tensors :**Scalar and Vector fields, Scalar and Vector products: Curl, Divergent and Introduction to tensors and definitions, contraction, direct product. Quotient rule, Levi-Civita symbol, Non-Cartesian tensors, metric tensor, Covariant differentiation.

2. **Complex Variables** : Introduction, Cauchy-Riemann conditions, Cauchyӧs Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation.

3. **Differential Equations :** Partial differential equations of theoretical physics, boundary value, problems, Neumann &Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution.

4. **Integral Equations :**Definitions and classifications, integral transforms and generating functions. Neumann series, Separable Kernels, Hilbert-Schmidt theory. Green's functions in one dimension.

5. **Numerical Techniques:** Roots of functions, Interpolation, Extrapolation, Differentiation, integration by trapezoid and Simpsonӧs rule, RungeKutta method and finite difference method.

6. **Elementary Statistics:** Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution

Suggested Readings/Books :

- Mathematical Methods for Physicists : G. Arfken and H.J. Weber (Academic Press, SanDiego) 7th edition, 2012.
- Mathematical Physics : P.K. Chattopadhyay (Wiley Eastern, New Delhi), 2004.
- Mathematical Physics : A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi),1986.
- Mathematical Methods in the Physical Sciences ï M.L. Boas (Wiley, New York) 3rd edition,2007.
- Special Functions : E.D. Rainville (MacMillan, New York), 1960.
- Mathematical Methods for Physics and Engineering :K.F.Riley, M.P.Hobson and S.J. Bence (Cambridge University Press, Cambridge) 3rd ed., 2006.

PHS412 CLASSICAL MECHANICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Lagrangian Formulation:** Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity - dependent forces and the dissipation function, Applications of Lagrangian formulation.

2. **Hamilton's Principles:** Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

3. **Hamilton's Equations:** Legendre Transformation, Hamilton's equations of motion, Cyclicco-ordinates, Hamilton's equations from variational principle, Principle of least action.

4. **Canonical Transformation and Hamilton-Jacobi Theory:** Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton- Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom.

5. **Rigid Body Motion:** Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

TUTORIALS : Relevant problems given at the end of each chapter in different books.

Suggested Readings/Books :

- Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi), 3rded 2002.
- Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, NewDelhi), 1988.

PHS413 QUANTUM MECHANICS-I

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Linear Vector Space and Matrix Mechanics:** Vector spaces, Schwarz inequality, Orthonormal basis, Operators: Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator and identical particles. Density Matrix and Mixed Ensemble.

2. **Angular Momentum:** Angular part of the Schrödinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigen values and eigenvectors of L2 and Lz. Spin angular momentum, General angular momentum, Eigen values and eigenvectors of J2 and Jz. Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients.

3. **Stationary State Approximate Methods:** Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator and other sample systems.

4. **Time Dependent Perturbation:** General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.

5. **Scattering Theory :** Scattering Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.

Suggested Readings/Books :

- A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill,New Delhi) 2nd edition, 2004.
- Quantum Mechanics : V.K. Thankappan (New Age, New Delhi), 2004.
- Quantum Mechanics : M.P. Khanna, (HarAnand, New Delhi), 2006.
- Modern Quantum Mechanics : J.J. Sakurai (Addison Wesley, Reading), 2004.
- Quantum Mechanics : J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
- Quantum Physics : S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.

PHS 414 STATISTICAL PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **The Statistical Basis of Thermodynamics:** The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.

2. **Ensemble Theory:** Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations.

3. **Quantum Statistics of Ideal Systems:** Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures, Pauli paramagnetism.

4. **Elements of Phase Transitions:** Introduction, a dynamical model of phase transitions, Ising model in zeroth approximation.

5. **Fluctuations:** Thermodynamic fluctuations, random walk and Brownian motion, introduction tononequilibrium processes, diffusion equation.

TUTORIALS: Relevant problems given in the end of each chapter in the text book.

Suggested Readings/Books :

- Statistical Mechanics: R.K. Pathria and P.D. Beale (Butterworth-Heinemann, Oxford), 3rdedition, 2011.
- Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi), 1987.
- Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) 2nd edition, 2011.
- Elementary Statistical Physics: C. Kittel (Wiley, New York), 2004.
- Statistical Mechanics: S.K. Sinha (Tata McGraw Hill, New Delhi), 1990.

PHS415 ATOMIC AND MOLECULAR PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Electronic Spectroscopy of Atoms:** Electronic wave function and atomic quantum numbers ï hydrogen spectrum ï orbital, spin and total angular momentum - fine structure of hydrogen atom ï many electron spectrum: Lithium atom spectrum, angular momentum of many electrons ï term symbols ï the spectrum of helium and alkaline earths ï equivalent and non equivalent electrons ï basics of X-ray photoelectron spectroscopy.

2. **Electronic Spectroscopy of Molecules** Diatomic molecular spectra: Born-Oppenheimer approximation ï vibrational spectra and their progressions ï Franck-Condon principle ï dissociation energy and their products ïrotational fine structure of electronic-vibration transition - molecular orbital theory ï the spectrum of molecular hydrogen ï change of shape on excitation ï chemical analysis by electronic spectroscopy ï reemission of energy ï fundamentals of UV photoelectron spectroscopy.

3. **Microwave and Raman Spectroscopy:** Rotation of molecules and their spectra ï diatomic molecules ï intensity of line spectra ï the effect of isotropic substitution ï non-rigid rotator and their spectra ï polyatomic molecules (linear and symmetric top molecules) ï Classical theory of Raman effect - pure rotational Raman spectra (linear and symmetric top molecules).

4. **Infra-red and Raman Spectroscopy:** The energy of diatomic molecules ï Simple Harmonic Oscillator ïthe Anharmonic oscillatorï the diatomic vibrating rotator ï vibration-rotation spectrum of carbon monoxide ïbreakdown of Born-Oppenheimer approximation ï the vibrations of polyatomic molecules ï influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) ï Raman activity of vibrations ï vibrational Raman spectra ï vibrations of Spherical top molecules.

5. **Spin Resonance Spectroscopy** Spin and magnetic field interaction ï Larmor precession ï relaxation time ï spin-spin relaxation - spinïlattice relaxation - NMR chemical shift - coupling constants ï coupling between nuclei ï chemical analysis by NMR ï NMR for nuclei other than hydrogen ï ESR spectroscopy - fine structure in ESR.

Suggested Readings/Books :

- Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash (Tata McGraw - Hill Publishing Company limited)
- Physical method for Chemists (Second Edition) by Russell S. Drago (Saunders College Publishing)
- Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934.
- Spectroscopy Vol. I, II & III: Walker &Straughen
- Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1962.
- Spectra of diatomic molecules: Herzberg-New York, 1944.

PHS416-Physics Lab-I

Total Marks	Credits
75	3

L	T	P
-	-	3

S.No.	Name of the Experiment
1	Study the forward and reverse characteristics of a Zener diode.
2	Construction of adder, subtracter, differentiator and itergrator circuits using the given OP-Amp.
3	Study the static and drain characteristics of a JFET
4	Construction of an Astablemulti-vibrator circuit using transistor
5	Construction of a single FET amplifier with common source configuration
6	Construction of an A/D converter circuit and study its performance
7	Construction of an D/A converter circuit and study its performance
8	Construction of a low-pass filter circuit and study its output performance
9	Construction of a high-pass filter circuit and study its output performance
10	Electron Spin Resonance Spectrometer Experiment
11	Four Probe Method- Determination of resistivity of semiconductor at different temperature
12	To study pulse amplitude, Pulse width and Pulse position modulation
13	To study the frequency response of an operational amplifier
15	To study the characteristics of multivibrators- bistable, Astable, monostable
16	To find the wavelength of sodium light using Michelson interferometer

PHS421 MATHEMATICAL PHYSICS-II

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Group Theory :**What is a group ? Multiplication table, conjugate elements and classes, subgroups, Isomorphism and Homomorphism, Definition of representation and its properties, Reducible and irreducible representations, Schur's lemmas (only statements), characters of a representation. Example of C4v, Topological groups and Lie groups, three dimensional rotation group, special unitary groups SU(2) and SU(3).

2. **Delta and Gamma Functions :**Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function.

3. **Special Functions :**Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions : generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynominals. Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.

4. **Fourier Series and Integral Transforms :**Fourier series, Dirichlet conditions. General properties. Advantages and applications, Gibbs phenomenon. Fourier transforms, Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives; Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation.

Suggested Readings/Books :

- Group Theory for Physicists : A.W. Joshi (Wiley Eastern, New Delhi) 2011.
- Mathematical Methods for Physicists : G. Arfken and H.J. Weber, (Academic Press, San Diego)7th edition, 2012.
- Matrices and Tensors in Physics : A.W. Joshi (Wiley Eastern, New Delhi) 2005.
- Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co., Kolkata) 4th edition.
- A First Course in Computational Physics: P.L. Devries (Wiley, New York) 1994.
- Mathematical Physics : P.K. Chatopadhyay (Wiley Eastern, New Delhi) 2011.
- Introduction to Mathematical Physics : C. Harper (Prentice Hall of India, New Delhi) 2006.

PHS422NUCLEAR PHYSICS

Total Marks	Credits
100	**4**

L	T	P
3	**1**	**-**

1. **Nuclear Models:** Liquid drop model, Binding energy; fission and fusion, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Application of Shell Model like Angular momenta and parities of nuclear ground states, Collective model- nuclear vibrations spectra and rotational spectra.
2. **Static properties of nucleus:** Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfinestructure, effect of external magnetic field, Nuclear magnetic resonance.
3. **Nuclear decay:** Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Double beta decay, Neutrino,detection of neutrinos, measurement of the neutrino helicity. Multipolarity of gamma transitions, internal conversion process, transition rates,
4. **Nuclear forces:** Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, n-p scattering at low energies, partial wave analysis, scattering length, spin-dependence of n-p scattering, effective-range theory, coherent and incoherent scattering, central and tensor forces, p-p scattering, exchange forces & single and triplet potentials, meson theory of nuclear forces.
5. **Neutron physics:** Neutron production, slowing down power and moderating ratio, neutron detection.
6. **Nuclear reactions:** Nuclear reactions and cross-sections, Resonance, Breitï Wigner dispersion formula for l=0 and higher values, compound nucleus, Coulomb excitation,nuclear kinematics and radioactive nuclear beams.

Suggested Readings/Books :

- Nuclear Physics : Irving Kaplan (Narosa), 2002.
- Theory of Nuclear Structure : R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.
- Basic Ideas and Concepts in Nuclear Physics : K. Hyde (Institute of Physics) 2004.
- Nuclear physics: Experimental and Theoretical, H.S. Hans (New Academic Science) 2nded (2011).
- Nuclear Physics and its applications by John Liley
- Nuclear Physics V. Devnathan

PHS423 QUANTUM MECHANICS –II

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Relativistic Quantum Mechanics-I :** Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle. The non-relativistic limit of Dirac equation,

2. **Relativistic Quantum Mechanics-II** Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lambshift.

3. **Quantum Field Theory :** Resume of Lagrangian and Hamiltonian formalism of a classical field, Quantization of real scalar field, complex scalar field, Dirac field and e.m. field, Covariant perturbation theory,

4. **Feynman diagrams**: Feynman diagrams and their applications, Wick's Theorem. Scattering matrix. QED.

Suggested Readings/Books :

- Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata McGraw Hill 2010
- Quantum Mechanics ï G Aruldhas - Prentice Hall of India 2006
- Introduction to Quantum Mechanics ï David J.Griffiths Pearson Prentice Hall, 2005
- Quantum Mechanics ï A Devanathan - Narosa Publishing-New Delhi
- Quantum Mechanics ï L.I Schiff - McGraw Hill 1968
- Quantum Mechanics - A.K. Ghatak and S. Loganathan-McMillan India
- Principles of Quantum Mechanics - R.Shankar, Springer 2005
- Quantum Mechanics ï Satya Prakash- KatharNathRamnath ï Meerut

PHS424 COMPUTATIONAL PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Introduction to high level language:** Need and advantages of high level language in physics, programming in a suitable high level language (Matlab/Mathematica/Scilab/ Octave), input/output, interactive input, loading and saving data, loops branches and control flow. Matrices and Vectors, Matrix and array operations, eigenvalues and eigen vectors.
2. **Sub programs:** Advantages of modular programming, built-in functions, scripts, functions, sharing of variables between modules.
3. **Graphics:** 2D plots, style options, axis control, overlay plots, subplot, histogram, 3D plots, mesh and surface plots, contour plots.
4. **Numerical computation**: Computer programs for: solving linear system of simultaneous equations, nonlinear algebraic equation, roots of polynomials, curve fitting, polynomial curve fitting, least square curve fitting, interpolation, data analysis and statistics, numerical integration, Monte-Carlo simulation, ordinary differential equation, first order and second order ODEs, event location.
5. **List of Experiments**

   a) Black body radiation (computation and graphical representation)
   b) Reflection and transmission of an electromagnetic wave
   c) Statistical distributions at different temperatures
   d) Binding energy curve for nuclei using liquid drop model
   e) Eigen-value problem: 1-D square potential well
   f) Eigen-values and wave-functions of a simple harmonic oscillator
   g) Monte-Carlo simulation
   h) Linear/Projectile motion (simulation and solutions)

Suggested Readings/Books :

- Pratap R, "Getting started with MATLAB 7", Oxford Univ. Press, 2006
- Gilat A, "Matlab: An introduction with applications", Wiley, 2008
- Eaton J W, Batchman D and Hauberg S "GNU Octave Manual Version 3", Network Theory Ltd. 2008
- Campbell S, Chancelier J P and Nikoukhah R, "Modeling and simulation in Scilab", Springer 2005
- Mathematica Information Center ('MathSource'): http://library.wolfram.com/infocenter/ 2009
- Gerald C F and Wheatley P O, "Applied Numerical Analysis", 7th Ed, Addison Wesley,2003

PHS425 CONDENSED MATTER PHYSICS-I

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Elastic constants :**
   Binding in solids; Stress components, stiffness constant, elastic constants, elastic waves in crystals.

2. **Lattice Dynamics and Thermal Properties :**
   Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamic properties of crystal, anharmonic effects, thermal expansion.

3. **Energy Band Theory:**
   Electrons in a periodic potential: Bloch theorem, Nearly free electron model; tight binding method; Semiconductor Crystals, Band theory of pure and doped semiconductors; elementary idea of semiconductor superlattices.

4. **Transport Theory:**
   Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magneto resistance.

5. **Dielectric Properties of Materials:**
   Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity.

6. **Liquid Crystals :**
   Thermotropic liquid crystals, Lyotropic liquid crystals, long range order and order parameter, Various phases of liquid crystals, Effects of electric and magnetic field and applications, Physics of liquid crystal devices.

Suggested Readings/Books :

- Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- Quantum Theory of Solids : C. Kittel (Wiley, New York) 1987.
- Principles of the Theory of Solids : J. Ziman (Cambridge University Press) 1972
- Solid State Theory : Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
- Liquid Crystals : S. Chandrasekhar (Cambridge University), 2nd ed. 1992.

PHS426-PHYSICS LAB-II

Total Marks	Credits
75	3

L	T	P
-	-	3

S.No.	Name of the Experiment
1	Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer
2	To verify the existence of Bohr's energy levels with Frank-Hertz experiments.
3	Determination of Lande's factor of DPPH using Electron-spin resonance (E.S.R.) spectrometer
4	Determination of ionization Potential of Lithium
5	Analysis of pulse height of gamma ray spectra
6	To study the characteristics of G.M. counter
7	To determine the dead time of G.M. counter
8	To study absorption of beta particles is matter
9	To study Gaussian distribution using G.M. counter
10	Source strength of a beta source using G.M counter
11	Determination of Planck's constant using Photocell and interference filters.
12	Recording and calibrating a gamma ray spectrum by scintillation counter
13	Detecting gamma radiation with a scintillation counter
14	To study absorption of gamma radiation by scintillation counter
15	Identifying and determining the activity of weakly radioactive samples

PHS427-COMPUTATIONAL LAB

Total Marks	Credits
75	3

L	T	P
-	-	3

List of Experiments

1. Black body radiation (computation and graphical representation)
2. Reflection and transmission of an electromagnetic wave
3. Statistical distributions at different temperatures
4. Binding energy curve for nuclei using liquid drop model
5. Eigen-value problem: 1-D square potential well
6. Eigen-values and wave-functions of a simple harmonic oscillator
7. Monte-Carlo simulation
8. Linear/Projectile motion (simulation and solutions)

PHS531 CONDENSED MATTER PHYSICS-II

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Optical Properties :**Macroscopic theory ï generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect; interband transitions.

2. **Magnetism :**Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian ï mean field theory; Ferro-, ferri- and antiferromagnetism; spin waves, Bloch T3/2 law.

3. **Principles of Magnetic Resonance:** ESR and NMR ï equations of motion, line width, motional narrowing, Knight shift.

4. **Superconductivity :**Experimental Survey; Basic phenomenology; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Vortex state of a Type II superconductors; Tunneling Experiments; High Tc superconductors.

5. **Disordered Solids :** Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, glasses, amorphous semiconductors and ferromagnets, heat capacity and thermal conductivity of amorphous solids, nanostructures ï short expose; Quasicrystals.

Suggested Readings/Books :

- Introduction to Solid State Physics : C. Kittel (Wiley, New York) 2005.
- Quantum Theory of Solids : C. Kittel (Wiley, New York) 1987.
- Principles of the Theory of Solids : J. Ziman (Cambridge University Press) 1972.
- Solid State Physics : H. Ibach and H. Luth (Springer, Berlin), 3rd. ed. 2002.
- A Quantum Approach to Solids : P.L. Taylor (Prentice-Hall, Englewood Cliffs), 1970.
- Intermediate Quantum Theory of Solids : A.O.E. Animalu (East-West Press, New Delhi),1991.
- Solid State Physics : Ashcroft and Mermin (Reinhert& Winston, Berlin), 1976.

PHS532 CLASSICAL ELECTRODYNAMICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Electrostatics :** Laplace and Poisson's equations, Electrostatic potential and energy densityof the electromagnetic field, Multipole expansion of the scalar potential of a charge distribution, dipole moment, quadrupole moment, Multipole expansion of the energy of a charge distribution in an external field, Static fields in material media, Polarization vector, macroscopic equations, classification of dielectric media, Molecular polarizability and electrical susceptibility, Clausius-Mossetti relation, Models of Molecular polarizability, energy of charges in dielectric media (Maxwell stress tensor).
2. **Magnetostatics :**The differential equations of magnetostatics, vector potential, magnetic fields of a localized current distribution, Singularity in dipole field, Fermi-contact term, Force and torque on a localized current distribution. (Magnetic stress tensor)
3. **Boundary value problems :** Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems.
4. **Time varying fields and Maxwell equations :** Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.
5. **Electromagnetic Waves :** wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, Stoke's parameters, EM wave guides, Cavity resonators, Dielectric waveguide, optical fibre waveguide, Waves in rarefied plasma (ionosphere) and cold magneto-plasma, Frequency dispersive characteristics of dielectrics, conductors and plasmas.

Suggested Readings/Books :

- Classical Electrodynamics : S.P. Puri (Narosa Publishing House) 2011.
- Classical Electrodynamics : J.D. Jackson, (New Age, New Delhi) 2009.
- Introduction to Electrodynamics: D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2012.
- Classical Electromagnetic Radiation : J.B. Marion and M.A. Heald, (Saunders CollegePublishing House) 3rd edition, 1995.
- Electromagnetic Fields, Ronald K. Wangsness (John Wiley and Sons) 2nd edition,1986 .
- Electromagnetic Field Theory Fundamentals :Bhag Singh Guru and H.R. Hiziroglu

PHS533 PARTICLE PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Introduction :** Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture,types of interactions - electromagnetic, weak, strong and gravitational, units.

2. **Invariance Principles and Conservation Laws :** Invariance in classical mechanics and in quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay. Time reversal invariance, CPT theorem.

3. **Hadron-Hadron Interactions :** Cross section and decay rates, Pion spin, Isospin, Twonucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy.

4. **Relativistic Kinematics and Phase Space :** Introduction to relativistic kinematics, particlereactions, Lorentz invariant phase space, two-body and three-body phase space, recursion relation, effective mass, dalitz, K-3 p-decay, t-ɗ puzzle, dalitz plots for dissimilar particles,Breit-Wigner resonance formula, Mandelstem variables.

5. **Static Quark Model of Hadrons :** The Baryon decuplet, quark spin and color, baryon octer,quark-antiquark combination.

6. **Weak Interactions :** Classification of weak interactions, Fermi theory, Parity nonconservationin ß-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K-decay and its experimental determination.

Suggested Readings/Books :

- Introduction to High Energy Physics : D.H. Perkins (Cambridge University Press).
- Elementary Particles : I.S. Hughes (Cambridge University Press), 3rded. 1991.
- Introduction to Quarks and Partons : F.E. Close (Academic Press, London), 1979.
- Introduction to Particle Physics : M.P. Khanna (Prentice Hall of India, New Delhi), 2004.

PHS534 ELECTRONICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Analog and Digital Instruments:** Introduction-Basic Emitter Follower Voltmeter; FET Input Voltmeter; Voltage Follower Voltmeter; Amplifier Type OP AMP Voltmeter; Voltage to Current Converter; Current Measurement with Analog Electronic Instrument; Time Base; Basic Digital Frequency Meter System; Reciprocal Counting Technique; Digital Voltmeter System; Digital LCR Measurements.
2. **UJTs and Thyristors:** Operational Principle of UJT: UJT Relaxation Oscillator circuit; PNPN Diode: Characteristics- As a Relaxation Oscillator-Rate Effect; SCR: V-I Characteristics ï Gate Triggering Characteristics; DIAC and TRIAC; Thyristors: Basic Parameters- As Current Controllable Devices-Thyristors in Series and in Parallel; Applications of Thyristors-As a Pulse Generator, BistableMultivibrator, Half and Full Wave Controlled Rectifier, TRIAC based AC power control, SCR based Crowbar Protection; Gate Turn-Off Thyristors; Programmable UJT.
3. **Digital Integrated Circuits:** 7400 TTL; TTL Parameters; TTL-MOSFETøs; CMOS FETøs;Three State TTL Devices; External drive for TTL Loads; TTL Driving External Loads; 74C00 CMOS; CMOS Characteristics; TTL to CMOS Interface; CMOS to TTL interface; Current Tracers.
4. **Integrated Circuits as Analog System Building Blocks:** Electronic Analog Computation; Active Filters: Butterworth Filter-Practical Realization-High Pass Filter-Band Pass Filter-Band Reject Filter; Delay Equalizer; Switched Capacitor Filters; Comparators; Sample and Hold Circuits; Waveform Generators: Square Wave Generator Pulse Generator-Triangle wave Generator-Sawtooth Generator; Regenerative Comparator: Schmitt Trigger.
5. **Integrated Circuits as Digital System Building Blocks:** Binary Adders: Half Adder-Parallel Operation-Full Adder-MSI Adder-Serial Operation; Decoder/Demultiplexer: BCD to Decimal Decoder-4-to-16 line Demultiplexer; Data Selector/Multiplexer:16-to-1 Multiplexer; Encoder; ROM:Code Converters-Programming the ROM-Applications; RAM:Linear Selection-Coincident Selection-Basic RAM ElementsBipolar RAM-Static and Dynamic MOS RAM; Digital to Analog Converters: Ladder Type D/A Converter-Multiplying D/A Converter; Analog to Digital Converters: Successive Approximation A/D Converter.

Suggested Readings/Books :

- Text Book of Electronics by S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- Digital Principles and Applications by A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.
- Electronics Principles and Applications by A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
- Integrated Electronics Analog and Digital Circuits and Systems by Jacob Millman, Christos C Halkins and Chetan Parikh, 2nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

PHS-535 FIBRE OPTICS AND NON-LINEAR OPTICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Optical fibre and its properties:** Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types.
2. **Fiber fabrication and cable design:**Fibre fabrication, mass production of fiber, comparison of the processes, fiber drawing process, coatings, cable design requirements, typical cable design, testing.
3. **Optics of anisotropic media:** Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/ polarizer combinations.
4. **Electro-optic and acousto-otpic effects and modulation of light beams**: Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electro optic modulation, electro optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of LM for a logitudinal acoustic wave in isotropic medium, Raman-Nath diffraction, Raman-Nath acousto-optic modulator.
5. **Non-linear optics/processes**: Introduction, anharmonic potentials and nonlinear polarization, non-linear susceptibilities and mixing coefficients, parametric and other nonlinear processes, macroscopic and microscopic susceptibilities.

Suggested Readings/Books :

- The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall), 1993.
- Lasers and Electro-Optics: C.C. Davis (Cambridge University Press), 1996.
- Optical Electronics :Gathak&Thyagarajan (Cambridge Univ. Press), 1989.
- The Elements of Non-linear Optics: P.N. Butcher & D. Cotter (Cambridge University Press), 1991.

PHS-536 PLASMA PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Introductio**n to the Plasma State, elementary concepts and definitions of temperature and other parameters, occurrence and importance of plasma for various applications, Production of Plasma in the laboratory, Physics of glow discharge, electron emission, ionization, breakdown of gases, Paschenӧs laws and different regimes of E/p in a discharge, Townsend discharge and the evolution of discharge.
2. **Plasma diagnostics:** Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts.
3. **Single particle orbit theory:** Drifts of charged particles under the effect of different combinations of electric and magnetic fields, Crossed electric and magnetic fields, Homogenous electric and magnetic fields, spatially varying electric and magnetic fields, time varying electric and magnetic fields, particle motion in large amplitude waves.
4. **Fluid description of plasmas:** distribution functions and Liouvilleӧs equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations.dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion- acoustic waves, Alfven waves, Magneto sonic waves.
5. **Stability of fluid plasma:** The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of Alfven waves, plasma supported against gravity by magnetic field, energy principle.microscopic equations for my body system: Statistical equations for many body systems, Vlasov equation and its properties, drift kinetic equation and its properties.

Suggested Readings/Books :

- Introduction to Plasma Physics, F.F. Chen
- Principles of Plasma Physics, Krall and Trievelpice
- Introduction to Plasma Theory, D.R. Nicholson
- The Plasma State, J.L.Shohet
- Introduction to Plasma Physics, M.Uman
- Principles of Plasma Diagnostic, I.H. Hutchinson

PHS-537 NONLINEAR DYNAMICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Phenomenology of Chaos** :Linear and nonlinear systems, A nonlinear electrical system, Biological population growth model, Lorenz model; determinism, unpredictability and divergence of trajectories, Feigenbaum numbers and sizescaling, self similarity, models and universality of chaos.

2. **Dynamics in State Space:** State space, autonomous and nonautonomous systems, dissipative systems, one dimensional state space, Linearization near fixed points, two dimensional state space, dissipation and divergence theorem. Limit cycles and their stability, Bifurcation theory, Heuristics, Routes to chaos. Three-dimensional dynamical systems, fixed points and limit cycles in three dimensions, Lyapunov exponents and chaos. Three dimensional iterated maps, U-sequence.

3. **Hamiltonian System** : Non-integrable systems, KAM theorem and period doubling, standard map. Applications of Hamiltonian Dynamics, chaosand stochasticity.

4. **Quantifying Chaos** :Time series, Lyapunov exponents. Invariant measure, Kolmogorov - Sinai entropy. Fractal dimension, Statistical mechanics and thermodynamic formalism.

5. **Quantum Chaos** : Quantum Mechanical analogies of chaotic behaviour. Distribution of energy eigenvalue spacing, chaos and semi-classical approachto quantum mechanics.

Suggested Readings/Books :

- Chaos and Non Linear Dynamics : R.C. Hilborn (Oxford Univ. Press), 2001.
- Chaos in Dynamical Systems : E. Ott (Cambridge Univ. Press), 2002.
- Applied Nonlinear Dynamics : A.H. Nayfeh and B. Balachandran (Wiley), 1995.
- Chaos in Classical and Quantum Mechanics : M.C. Gutzwiller (Springer-Verlag), 1990.

PHS-538 STRUCTURES, SPECTRA AND PROPERTIES OF BIOMOLECULES

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Structure Aspects of Biomolecule:** Conformational Principles, Conformation and Configuration Isomers and Derivatives, Structure of Polynucleotides, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Structure of Polysaccharides.

2. **Theoretical Techniques and Their Application to Biomolecules:** Hard Sphere Approximation, Ramachandran Plot, Potential Energy Surface, Outline of Molecular Mechanics Method, Brief ideas about Semi-empirical and Ab initio Quantum Theoretical Methods, Molecular Charge Distribution, Molecular Electrostatic Potential and Field and their uses.

3. **Spectroscopic Techniques and their Application to Biomolecules:** Use of NMR in Elucidation of Molecular Structure, Absorption and Fluorescence Spectroscopy, Circular Dichroism, Laser Raman Spectroscopy, IR spectroscopy, Photoacoustic Spectroscopy, Photo-biological Aspects of Nucleic Acids.

4. **Structure- Function Relationship and Modeling:** Molecular Recognition, Hydrogen Bonding, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model.

Suggested Readings/Books :

- Srinivasan &Pattabhi: Structure Aspects of Biomolecules.
- Govil&Hosur: Conformations of Biological Molecules
- Price: Basic Molecular Biology
- Pullman: Quantum Mechanics of Molecular Conformations
- Lehninger: Biochemistry
- Mehler&Cordes: Biological Chemistry
- Smith and Hanawait: molecular Photobiology, Inactivation and Recovery

PHS539-SEMINAR

Total Marks	Credits
Satisfactory/ Unsatisfactory	2

L	T	P
-	-	-

The aim of Seminar in M.Sc. 3th semesters is to expose some of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, analysis of data, etc. related to research Project work which can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department in the start of the 3rd semester. These seminars are aimed to develop in-depth subject knowledge and skill. Besides subject expertise, they help train students in the presentation and communication skill.

PHS540-PHYSICS LAB-III

Total Marks	Credits
75	3

L	T	P
-	-	3

S.No.	Name of the Experiment
1	To study temperature dependence of conductivity of a given semiconductor crystal using four probe method
2	Temperature dependence of a ceramic capacitor-verification of curie-weiss law for the electrical susceptibility of a ferroelectric material
3	To determine charge carrier density and Hall coefficient by Hall effect
4	To determine the band gap of a semiconductor using p-n junction diode
5	To determine magnetic susceptibility of material using Quink 's tube method
6	To determine energy gap and resistivity of the semiconductor using four probe method
7	To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization
8	To determine dielectric constant of a material with Microwave set up
9	To study the series and parallel characteristics of photovoltaic cell
10	To study the spectral characteristics of photovoltaic cell
11	To determine the g-factor using ESR spectrometer

PHS-541 EXPERIMENTAL TECHNIQUES IN NUCLEAR PHYSICS AND PARTICLE PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1.Detection of radiations: Interaction of gamma-rays, electrons, heavy charged particles, neutrons, neutrinos and other particles with matter. General properties of Radiation detectors, energy resolution, detection efficiency and dead time. Statistics and treatment of experimental data. Gas-filled detectors, Proportional counters, space charge effects, energy resolution, time characteristics of signal pulse, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber. Organic and inorganic scintillators and their characteristics, light collection and coupling to photomultiplier tubes and photodiodes, description of electron and gamma ray spectrum from detector, Cherenkov detector. Semiconductor detectors, Ge and Si(Li) detectors, Charge production and collection processes, semiconductor detectors in X- and gamma-ray spectroscopy, Pulse height spectrum, Compton-suppressed, Semiconductor detectors for charged particle spectroscopy and particle identification.

2**. Electromagnetic and Hadron calorimeters:** Motion of charged particles in magnetic field, Magnetic dipole and quadrupole lenses, beta ray spectrometer. Detection of fast and slow neutrons - nuclear reactions for neutron detection. General background and detector shielding.

3. Experimental methods : Detector systems for heavy-ion reactions : Large gamma and charge particle detector arrays, multiplicity filters, electron spectrometer, heavy-ion reaction analysers, nuclear lifetime measurements (DSAM and RDM techniques), production of radioactive ion beams. Detector systems for high energy experiments :Collider physics (brief account), Particle Accelerators (brief account), Secondary beams, Beam transport, Modern Hybrid experiments- CMS and ALICE.

Suggested Readings/Books :

- Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001.
- Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010.
- Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994.
- Detectors for particle radiation by Konrad Kleinknecht(Cambridge University Press), 1999.

PHS 542 PHYSICS OF NANOMATERIALS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Introductory Aspects :**Free electron theory and its features, Idea of band structureð metals, insulators and semiconductors. Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.

2. **Preparation of Nanomaterials :**Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.

3. **General Characterization Techniques :** Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy.

4. **Quantum Dots :** Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots.

5. **Other Nanomaterials :**Properties and applications of carbon nanotubes and nanofibres, Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

TUTORIALS : Relevant problems pertaining to the topics covered in the course.

Suggested Readings/Books :

- Nanotechnology - Molecularly Designed Materials : G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.
- Nanotechnology Molecular Speculations on Global Abundance : B.C. Crandall (MIT Press), 1996.
- Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley),1998.
- Nanoparticles and Nanostructured Filmsï Preparation, Characterization and Application :J.H.Fendler (Wiley), 1998.
- Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski (Cambridge Univ. Press), 1996.
- Physics of Semiconductor Nanostructures: K.P. Jain (Narosa), 1997.
- Physics of Low-Dimension Semiconductors: J.H. Davies (Cambridge Univ. Press) 1998.
- Advances in Solid State Physics (Vo.41) : B. Kramer (Ed.) (Springer), 2001.

PHS-543 ENVIRONMENTAL PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Essentials of Environmental Physics:** Structure and thermodynamics of the atmosphere, Composition of air, Greenhouse effect, Transport of matter, energy and momentum in nature, Stratification and stability of atmosphere, Lass of motion, hydrostatic equilibrium, General circulation of the topics, Elements of weather and climate of India.
2. **Solar and Terrestrial Radiation :**Physics of radiation, Interaction of light with matter, tayleigh and Mie scattering, Laws of radiation (Kirchoffs law, Planck's law, Beer's law, Wien's displacement law, etc.), Solar and terrestrial spectra, UV radiation, Ozone depletion problem, IR absorption energy balance of the earth atmosphere system.
3. **Environmental Pollution and degradation:** Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors governing air, Water and noise pollution, Air and water quality standards, Waste disposal, Heat island effect, Land and sea breeze, Puffs and plumes, Gaseous and particulate matters, Wet and dry deposition.
4. **Environmental Changes and remote sensing:** Energy sources and combustion processes, Renewable sources of energy, Solar energy, Wind energy, bioenergy, hydropower, fuel cells, nuclear energy, Forestry and bioenergy.
5. **Global and Regional Climate:** Elements of weather and climate, Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, Viscous forces, Reynolds number, Enhanced Greenhouse Effect, Energy balance-a Zero-dimensional Greenhouse model, Global climate models.

Suggested Readings/Books :

- Egbert Boeker & Rienk Van Groundelle: Environmental Physics (John Wiley).
- J. T Hougtion: The Physics of atmosphere (Cambrige University Press, 1977).
- J Twidell and J Weir: Renewable energy Resources (Elbs, 1988).
- Sol Wieder: An introduction t solar energy for scientists and Engineers (John Wiley, 1982)
- R. N. Keshavamurthy and M. Shanker Rao: The Physics of Monsoons (Allied Publishers, 1992).
- G.J. Haltiner and R.T. Williams: Numerical Weather Prediction (John Wiley, 1980).

PHS 544 SCIENCE OF RENEWABLE SOURCE OF ENERGY

Total Marks	Credits
100	4

L	T	P
3	1	-

1. **Introduction** : Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources.

1. **Solar Energy** :Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, interrelationship between absorption coefficients and band gap recombination of carriers. Types of solar cells, p-n junction solar cell, Transport equation, current density, open circuit voltage and short circuit current, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells, solid-liquid junction solar cells and semiconductor-electrolyte junction solar cells. Principles of photo electrochemical solar cells. Applications.

2. **Hydrogen Energy**: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.

3. **Other sources** : Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC.

Suggested Readings/Books :

- Solar Energy : S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.
- Solar Cell Devices :Fonash (Academic Press, New York),2010.
- Fundamentals of Solar Cells, Photovoltaic Solar Energy : Fahrenbruch and Bube (Springer, Berlin), 1983.
- Photoelectrochemical Solar Cells : Chandra (New Age,New Delhi).

PHYS 545 RESEARCH PROJECT

Total Marks	Credits
Satisfactory/ Unsatisfactroy	12

L	T	P
-	-	3

The aim of project work in M.Sc. 4th semesters is to expose some of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc. Project work can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Head of Department.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc as per course guidelines.