SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

CURRICULUM FOR M.Sc-PHYSICS
SESSION (2016-18) & (2017-19)

PHYSICS

DEPARTMENT OF PHYSICS

CURRICULUM
M.Sc-PHYSICS

Year	**Semester**	**Course Code**	**Course Title**	**Credit Hours**
1st	1st	PH-511	Mathematical Methods of Physics- I	3
		PH-512	Electrodynamics-I	3
		PH-513	Modern Physics	3
		PH-514	Classical Mechanics	3
		PH-515	Heat & Thermodynamics	3
		PH-516	Lab-V	3
		PH-517	Functional English-I	2
		Total Credit Hours		**20**
	2nd	PH-521	Mathematical Methods of Physics-II	3
		PH-522	Electrodynamics-II	3
		PH-523	Electronics-I	3
		PH-524	Statistical Physics	3
		PH-525	Lab-VI	3
		PH-526	Functional English-II	2
		Total Credit Hours		17

Year	Semester	Course Code	Course Title	Credit Hours
2nd	3rd	PH-631	Quantum Mechanics-I	3
		PH-632	Solid state Physics-I	3
		PH-633	Electronics-II	3
		PH-634	Nuclear Physics	3
		PH-635	Lab-VII	3
			Elective-I	3
			Elective-II	3
		Total Credit Hours		21
		PH-641	Quantum Mechanics -II	3
		PH-642	Solid State Physics -II	3
		PH-643	Atomic & Molecular Physics	3
			Elective –III	3
		PHY-481/--	Research Project/Two Elective Courses	6/3+3
		Total Credit Hours		18

Total Credit Hours: 76

List of Elective courses

S.No	Course Codes	Electives	Credit Hours
1.	PH-675	Introduction to Plasma Physics	3
2.	PH-676	Introduction to Material Science	3
3.	PH-677	Environmental Physics	3
4.	PH-678	Renewable energy Resources	3
5.	PH-679	Computer Simulations in Physics	3
6.	PH-683	Computational Physics	3
7.	PH-684	Methods of Experimental Physics	3
8.	PH-685	Introduction to Lasers Physics	3
9.	PH-686	Electronic Materials & Devices	3
10.	PH-687	Functional Material	3
11.	PH-688	Introduction to Nanoscience & Nanotechnology	3

M.Sc-PHYSICS
SEMESTER-I

Course Code	PH-511
Course Title	Mathematical Methods of Physics-I
Credit Hours	3
Prerequisite / Co requisite	Mechanics, Differential Equations, Linear Algebra /None
Remarks	Maj-6
Recommended Books	1. G. Arfken, H. J. Weber, and F. E. Harris, "Mathematical Methods for Physicists", Academic Press, 7th ed. 2012. 2. K. F. Riley, M. P. Hobson, S. J. Bence, "Mathematical Methods for Physicists", Cambridge University Press, 2006 3. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley, 8th ed. 1999.
Course Description	
Partial Differential Equations: Introduction to important PDEs in Physics (wave equatio diffusion equation, Poisson's equation, Schrodinger's equation), general form of solutio general and particular solutions (first order, inhomogeneous, second order), characteristi and existence of solutions, uniqueness of solutions, separation of variables in Cartesia coordinates, superposition of separated solutions, separation of variables in curviline coordinates, integral transform methods, Green's functions Complex Analysis: Review of polar form of complex numbers and de Moivre's theorer complex logarithms and powers, functions of a complex variable, Cauchy-Riemar conditions, power series in a complex variable and analytic continuation with example multi-valued functions and branch cuts, singularities and zeroes of complex function complex integration, Cauchy's theorem, Cauchy's integral formula, Laurent series ar residues, residue integration theorem, definite integrals using contour integration.	

Course Code	PH-512
Course Title	Electrodynamics-I

Credit Hours	3
Prerequisite / Co requisite	Electricity & Magnetism, Calculus-II / None
Remarks	Maj-8
Recommended Books	1. D. J. Griffiths, “Introduction to Electrodynamics”, Prentice Hall, 3rd ed. 1999. 2. M. N. O. Sadiku, ”Elements of Electromagnetics”, Oxford University Press, 5th ed. 2009 3. F. Melia, “Electrodynamics”, University of Chicago Press, 2001. 4. Hearld J and W. Muller-Kristen, “Electrodynamics”, World Scientific Publishing, 2nd ed. 2011
Course Description	
The Dirac Delta Function: Review of vector calculus using example of Dirac Delta function, the divergence of r/r2, the one-dimensional and the three dimensional Dirac delta functions. The theory of vector fields: the Helmoholtz theorem, potentials. **Electrostatics:** The electric field: introduction, Coulomb’s law, the electric field, continuous charge distributions. Divergence and curl of electrostatic fields: field lines, flux and Gauss’s law, the divergence of E, applications of Gauss’s law, the curl of E. Electric potential: introduction to potential, comments on potential, Poisson’s equation and Laplace’s equation, the potential of a localized charge distribution, summary, electrostatics boundary conditions, Work and energy in electrostatics: the work done to move a charge, the energy of a point charge distribution, the energy of a continuous charge distribution, comments on electrostatic energy. Conductors: basic properties, induced charges, surface charge and the force on a conductor, capacitors. **Special Techniques:** Laplace’s equation: introduction, Laplace’s equation in one, two and three dimensions, boundary conditions and uniqueness theorems, conductors and second uniqueness theorems. **The Method of Images:** The classic image problem, induced surface charge, force and energy, other image problems.	

Multi-pole Expansion: Approximate potential at large, the monopole and dipole terms, origin of coordinates in multi-pole, expansions, the electric field of a dipole. **Electric Fields in Matter: Polarization:** dielectrics, induced dipoles, alignment of polar molecules, polarization. The field of a polarized object: bound charges, physical interpretation of bound charges, and the field inside a dielectric. The electric displacement: Gauss's law in the presence of dielectrics, a deceptive parallel, boundary conditions. Linear Dielectrics: susceptibility, permittivity, dielectric constant, boundary value problems with linear dielectrics, energy in dielectric systems, forces on dielectrics. **Magnetostatics:** The Lorentz Force law: magnetic fields, magnetic forces, currents. The Biot-Savart Law: steady currents, the magnetic field of a steady current. The divergence and curl of B: straight-line currents, the divergence and curl of B, applications of Ampere's law, comparison of magnetostatics and electrostatics. Magnetic Vector Potential: the vector potential, summary, magnetic boundary conditions, multi-pole expansion of the vector potential. **Magnetic Fields in Matter:** Magnetization, diamagnets, paramagnets,ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization. The Field of a Magnetized Object:bound currents,physical interpretation of bound currents, and the magnetic field inside matter. The auxiliary field H: Ampere's law in magnetized materials, a deceptive parallel, boundary conditions. Linear and nonlinear media: magnetic susceptibility and permeability, ferromagnetism.

Course Code	PH-513
Course Title	Modern Physics
Credit Hours	3
Prerequisite /Co requisite	Mechanics, Electricity & Magnetism / None
Remarks	Found-5
Recommended Books	1. R.A. Serway, C.J. Moses and C.A. Moyer, "Modern Physics", Brooks sCole, 3rd ed. 2004.

	2. Paul A. Tipler and Ralph A. Llewellyn, "Modern Physics", W H Freeman and Company 6th ed. 2012. 3. Arthur Beiser, "Concepts of Modern Physics", McGraw-Hill, 6th ed. 2002. 4. R. M. Eisberg and R. Resnick, "Quantum Physics of Atoms, molecules, Solids, Nuclei and Particles", John Wiley, 2nd ed. 2002.
Course Description	
Motivation for Non--Classical Physics: Quantum interference, blackbody radiation and ultraviolet catastrophe, Planck's quantization. **Wace-Particle Duality:** Photoelectric effect, Compton effect, production and properties of X-rays, diffraction of X-rays, concept of matter waves, de Broglie relationship, electrons are waves, electron diffraction, particulate nature of matter, contributions of Faraday (atoms exist), Thomson (electron exists), Rutherford (nucleus exists) and Bohr (quantization of energies inside an atom), wave packets and wave groups, dispersion, Heisenberg uncertainty principle, direct confirmation of quantization through Franck-Hertz experiment and spectroscopy, working of electron microscopes. **Quantum Mechanics in One Dimension:** The concept of a wavefunction,time independent Schrodinger equation and interpretation of the equation, solving the Schrodinger equation for a free particle, for a particle inside an infinite box, relationship between confinement and quantization, working of a CCD camera. **Quantum Mechanical Tunneling:** Concept of tunneling, reflection and transmission of wave functions from barriers, applications: radioactivity, scanning tunneling microscope, decay of black holes. **Quantum Mechanics in Three Dimensions:** The Hydrogen atom, orbitals, angular momentum and its quantization, orbital magnetism, Zeeman effect, concept of spin, Pauli's exclusion principle, Building of the periodic table, magnetic resonance and MRI, why is iron magnetic? White dwarfs, and neutron stars. **From Atoms to Molecules and Solids:** Ionic bonds, covalent bonds, hydrogen bonds, molecular orbitals, how crystals are different from amorphous solids? Why and how do	

metals conduct electricity? Bands in solids, semiconductors, introduction to LED's and lasers, introducing grapheme. **Nuclear Structure:** Size and structure of nucleus, nuclear forces, radioactivity and nuclear reactions, radiocarbon dating.

Course Code	PH-514
Course Title	Classical Mechanics
Credit Hours	3
Prerequisite / Co requisite	Mechanics / None
Remarks	Maj-3
Recommended Books	1. T. L. Chow, "Classical Mechanics", John Wiley, 1995. 2. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed. 2004.
Course Description	

Review of Newtonian Mechanics: Frame of reference, orthogonal transformations, angular velocity and angular acceleration, Newton's laws of motion, Galilean transformation, conservation laws, systems of particles, motion under a constant force, motions under variable force, time-varying mass system. **The Lagrange Formulation of Mechanics and Hamilton Dynamics:** Generalized co-ordinates and constraints, D'Alembert's principle and Lagrange's Equations, Hamilton's principle, integrals of motion, non conservative system and generalized potential, Lagrange's multiplier method, the Hamiltonian of a dynamical system, canonical equations, canonical transformations, Poisson brackets, phase space and Liouville's theorem. **Central Force Motion:** The two-body problem, effective potential and classification of orbits, Kepler's laws, stability of circular orbits, hyperbolic orbits and Rutherford scattering, center of mass co-ordinate system, scattering cross-sections. **Motion in Non-inertial Systems:** Accelerated translational co-ordinate system, dynamics in rotating co-ordinate system, motion of a particle near the surface of the earth. **The Motion of Rigid Bodies:** The Euler angles, rotational kinetic energy and angular momentum, the inertia tensor, Euler equations of motion, motion of a torque-free symmetrical top, stability of rotational motion.

Course Code	PH-515
Course Title	Heat & Thermodynamics
Credit Hours	3
Prerequisite / Co requisite	Mechanics / Calculus-II
Remarks	Found-4
Recommended Books	1. D. Halliday, R. Resnick and K. Krane, "Physics", John Wiley, 6th ed. 2002. 2. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley, 9th ed. 2010 3. M. W. Zemansky, "Heat and Thermodynamics", Mc Graw Hill, 7th ed. 1997. 4. M. Sprackling, "Thermal Physics" McMillan 1991. 5. B. N. Roy, "Principle of Modern Thermodynamics", Institute of Physics, London 1995.
Course Description	
Basic Concepts and Definitions in Thermodynamics: Thermodynamic system, Surrounding and Boundaries. Type of systems. Macroscopic and microscopic description of system. **Properties and state of the substance:** Extensive and Intensive properties, Equilibriur Mechanical and Thermal Equilibrium. Processes and Cycles: Isothermal, Isobaric and Isochoric. Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics. The state of the system at Equilibrium. **Heat and Temperature:** Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Review of previous concepts. Internal energy of an ideal gas: Equipartition of Energy, Intermolecular forces, Qualitative discussion, The Virial expansion, The Van der Waals equation of state. **Thermodynamics:** First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reversible and irreversible	

processes. Second law of thermodynamics, Carnot theorem and Carnot engine. Heat engine, Refrigerators. Calculation of efficiency of heat engines. Thermodynamic temperature scale: Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and Second law of thermodynamic Entropy and Probability. Thermodynamic Functions: Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions), Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Joule-Thomson effect and its equations. Thermoelectricity: Thermocouple, Seabeck's effect, Peltier's effect, Thomson effect. **Introduction to Statistical Mechanics:** Statistical distribution and mean values, Mean free path and microscopic calculations of mean free path. Distribution of Molecular Speeds, Distribution of Energies, Maxwell distribution, Maxwell Boltzmann energy distribution, Internal energy of an ideal gas, Brownian Motion Legvaian equation, Qualitative description

Course Code	PH-516
Course Title	LAB-V (Electronics)
Credit Hours	2
Prerequisite	Electronics-I
Remarks	Maj-16
Course Description	
Electronics: **List of Experiments** 1. Determination of e/m of an electron. 2. Determination of ionization potential of mercury. 3. Characteristics of a semiconductor diode (Compare Si with Ge diode) 4. Setting up of half & full wave rectifier & study of following factors 5. Smoothing effect of a capacitor 6. Ripple factor & its variation with load.	

7. Study of regulation of output voltage with load.

8. To set up a single stage amplifier & measure its voltage gain and band width.

9. To set up transistor oscillator circuit and measure its frequency by an oscilloscope.

10. To set up and study various logic gates (AND, OR, NAND etc.) using diode and to develop their truth table.

11. To set up an electronic switching circuit using transistor LDR and demonstrate its use as a NOT Gate.

12. Characteristics of a transistor.

13. To study the characteristic curves of a G. M. counter and use it to determine the absorption co-efficient of β-particle in Aluminum.

14. Determination of range of α-particles.

15. Mass absorption coefficient of lead for γ-rays using G.M counter.

16. Use of computer in the learning of knowledge of GATE and other experiments.

M.Sc-PHYSICS
SEMESTER-II

Course Code	PH-521
Course Title	Mathematical Methods of Physics-II
Credit Hours	3
Prerequisite / Co requisite	Mathematical Methods of Physics-I
Remarks	Maj-7
Recommended Books	1. M.L. Boas, 'Mathematical Methods in Physical Sciences', John Wiley & Sons, New York (1989). 2. C. Wa Wong, 'Introduction to Mathematical Physics', Oxford University Press, New York (1991). 3. Hassani, 'Foundations of Mathematical Physics', Prentice Hall International Inc" Singapore. 4. Chattopadhyay, 'Mathematical Physical', Wiley Eastern Limited, New Delhi, (1990). 5. H, Cohen, 'Mathematics for Scientists & Engineers' Prentice Hall International Inc., New Jersey (1992).
Course Description	

Group Theory and Representations for finite groups: Transformations, groups definitions and examples, subgroups and Cayley's theorem, cosets and Lagrange's theorem, conjugate classes, invariant subgroups, factor groups, homomorphism, direct products, mappings, linear operators, matrix representations, similarity transformation and equivalent matrix representations, group representations, equivalent representations and characters, construction of representations and addition of representations, invariance of functions and operators, unitary spaces and Hermitian matrices, operators: adjoint, self-adjoint, unitary, Hilbert space, reducibility of representations, Schur's lemmas, orthogonality relations, group algebra, expansion of functions in basis of irreducible representations, Kronecker product, symmetrized and anti-symmetrized representations, adjoint and complex-conjugate representations, real representations, Clebsch-Gordan series and coefficients, applications of these ideas to classification of spectral terms, perturbation theory and coupled systems

Tensor Analysis: Vector calculus (differentiation, integration, space curves, multi-variable vectors, surfaces, scalar and vector fields, gradient, divergence and curl, cylindrical and spherical corrdinates, general curvilinear coordinates), change of basis, Cartesian tensor as a geometrical object, order/rank of a tensor, tensor algebra, quotient

law, pseudotensors, Kronecker delta and Levi cevita, dual tensors, physical applications, integral theorems for tensors, non-Cartesian tensors, general coordinate transformations and tensors, relative tensors, Christoffel symbols, covariant differentiation, vector operators in tensor form, absolute derivatives along curves, geodesics.

Course Code	PH-522
Course Title	Electrodynamics-II
Credit Hours	3
Prerequisite / Co requisite	Electrodynamics-I / None
Remarks	Maj-9
Recommended Books	1. D. J. Griffiths, "Introduction to Electrodynamics", ed. Prentice Hall, 3rd ed. 1999. 2. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 5th ed. ed. 2009. 3. F. Melia, "Electrodynamics", University of Chicago Press, 1st ed. 2001. 4. Hearld J and W. Muller-Kristen, "Electrodynamics", World Scientific Publishing, 2nd ed. 2011
Course Description	
Electrodynamics: Electromotive force: Ohm's law, electromotive force, motional emf, electromagnetic induction: Faraday's law, the induced electric field, inductance, energy in magnetic fields, Maxwell's equations: electrodynamics before Maxwell, how Maxwell fixed Ampere's law, Maxwell's equations, magnetic charges, Maxwell's equations in matter, boundary conditions. **Conservation Laws:** Charge and energy: the continuity equation, Poynting's theorem, momentum: Newton's third law in electrodynamics, Maxwell's stress tensor, conservation of momentum, angular momentum. **Electromagnetic Waves:** Waves in one dimension: the wave equation, sinusoidal waves, boundary conditions, reflection and transmission, polarization, electromagnetic waves in vacuum: the wave equation for E and B, monochromatic plane waves, energy and momentum in electromagnetic waves, electromagnetic waves in matter: propagation in linear media, reflection and transmission at normal incidence, reflection and transmission at oblique incidence, absorption and dispersion: electromagnetic waves in conductors, reflection at a conducting surface, the frequency dependence of permittivity, guided waves: wave guides, the waves in a rectangular wave guide, the coaxial transmission line.	

Potentials and Fields: The potential formulation: scalar and vector potentials, gauge transformations, Coulomb gauge and Lorentz gauge, continuous distributions: retarded potentials, Jefimenko's equations, point charges: Lienard-Wiechert potentials, the field of a moving point charge. **Radiation, Dipole Radiation:** What is radiation, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, point charges: power radiated by a point charge, radiation reaction, the physical basis of the radiation reaction. **Electrodynamics and Relativity:** The special theory of relativity: Einstein's postulates, the geometry of relativity, the Lorentz transformations, the structure of space-time, relativistic mechanics: proper time and proper velocity, relativistic energy and momentum, relativistic kinematics, relativistic dynamics, relativistic electrodynamics: magnetism as a relativistic phenomenon, how the field transform, the field tensor, electrodynamics in tensor notation, relativistic potentials.

Course Code	PH-523
Course Title	Electronics-I
Credit Hours	3
Prerequisite / Co requisite	Modern Physics /None
Remarks	Maj-4
Recommended Books	1. Thomas L. Floyd, "Electronics Fundamentals: Circuits, Devices and Applications", Prentice Hall, 8th ed., 2009. 2. B. Grob, "Basic Electronics", McGraw-Hill, Tch ed. 1997. 3. B. Streetman and S. Banerjee "Solid State Electronics Devices", Prentice Hall, 6th ed. 2005. 4. A. Bar-lev, "Semiconductor and Electronics Devices", Prentice Hall, 3rd ed. 1993. 5. D. H. Navon and B. Hilbert, "Semiconductor Micro-devices and Materials", CBS College Publishing, 1986. 6. A. P. Malvino, "Electronic Principles", McGraw-Hill, 7th ed. 2006. 7. R. T. Paynter, "Introductory Electric Circuits", Prentice Hall, 1998.

Course Description
The Semiconductor Diode: Metals, insulators and semiconductors, Conduction in Silicon and Germanium, The forbidden energy gap, n and p type semiconductors, the junction diode, diode voltage-current equation, Zener diodes, light emitting diodes, photodiodes, capacitance effects in the pn junction. **The Diode as Rectifier and Switch:** The ideal diode model, the half wave rectifier, the full wave rectifier, the bridge rectifier, measurement of ripple factor in the rectifier circuit, the capacitor filter, the Π filter, the Π-R filter, the voltage doubling rectifier circuit, rectifying AC voltmeters, diode wave clippers, diode clampers. **Circuit Theory and Analysis:** Superposition theorem, Thevenin's Theorem, Norton's Theorem, Model for circuit, one port and two-port network, Hybrid parameter equivalent circuit, Power in decibels. **The Junction Transistor as an Amplifier:** Transistor voltage and current designations, the junction transistors, the volt-ampere curve of a transistor, the current amplification factors, the load line and Q point, the basic transistor amplifiers, the common emitter amplifier, the trans-conductance gm, performance of a CE amplifier, relation between Ai and Av, the CB amplifier, the CC amplifier, comparison of amplifier performance. **DC Bias for the Transistor:** Choice of Q point, variation of Q point, fixed transistor bias, the four resistor bias circuit, design of a voltage feedback bias circuit, Common emitter, common collector, common base biasing. **Field Effect Transistor:** What is /field effect transistor, JFET: Static characteristics of JFET, Metal oxide semiconductor Field Effect Transistor (MOSFET of IGFET): enhancement and depletion mode, FET biasing techniques, Common drain, common source and common gate, fixed bias and self-bias configurations, Universal JFET bias curve, Darlington pair. **Operational Amplifiers:** The integrated amplifier, the differential amplifier, common mode rejection ratio, the operational amplifier, summing operation, integration operation, comparator, milli-voltmeter.

Course Code	PH-524
Course Title	Statistical Physics
Credit Hours	3
Prerequisite / Co requisite	Heat & Thermodynamics, Calculus-II, Statistics /None
Remarks	Maj-10
Recommended Books	1. F. Reif, "Fundamentals of Statistical and Thermal Physics", Waveland Pr Inc, 2008.

	2. W. Brewer, F. Schwabl, "Statistical Mechanics", Springer, 2nd ed. 2006. 3. T. L. Hill, "Statistical Mechanics", World Scientific Publishing Company, (2004). 4. K. Huang, "Statistical Mechanics", John Wiley, 2nd ed. 1987.
Course Description	

Review of Classical Thermodynamics: States, macroscopic vs. microscopic, "heat" and "work", energy, entropy, equilibrium, laws of thermodynamics, Equations of state, thermodynamic potentials, temperature, pressure, chemical potential, thermodynamic processes (engines, refrigerators), Maxwell relations, phase equilibria.

Foundation of Statistical Mechanics: Phase Space, Trajectories in Phase Space, Conserved Quantities and Accessible Phase Space, Macroscopic Measurements and Time Averages, Ensembles and Averages over Phase Space, Liouville's Theorem, The Ergodic Hypothesis, Equal a priori Probabilities. Specification of the state of a system, concept of ensembles, elementary probability calculations, distribution functions, statistical interpretation of entropy (Boltzmann theorem).

Statistical Ensembles: Microcanonical ensemble, canonical ensemble and examples (e.g., paramagnet), calculation of mean values, calculation of partition function and its relation with thermodynamic quantities, the grand canonical ensemble and examples (e.g. adsorption), calculation of partition function and thermodynamic quantities.

Simple Applications of Ensemble Theory: Monoatomic ideal gas in classical and quantum limit, Gibb's paradox and quantum mechanical enumeration of states, equipartition theorem and examples (ideal gas, harmonic oscillator), specific heat of solids, quantum mechanical calculation of para-magnetism.

Quantum Statistics: Indistinguishability and symmetry requirements, Maxwell-Boltzmann statistics, Bose-Einstein and photon statistics, Fermi- Dirac statistics (distribution functions, partition functions). Examples: polyatomic ideal gas (MB), black body radiation (photon statistics), conduction electrons in metals (FD), Bose condensation (BE).

Systems of Interacting Particles: Lattice vibrations in solids, van der Waals gas, mean field calculation, ferromagnets in mean field approximation.

Course Code	PH-525
Course Title	LAB-VI (Modern Physics)

Credit Hours	2
Prerequisite / Co requisite	Modern Physics / None
Remarks	Maj-17
Course Description	

Modern Physics :

List of Experiments:

1. To study the characteristics of a Geiger-Muller counter and to examine the attenuations of beta particles in Al-and Pb foils.
2. Measurement of the half-life of a radio nuclide. To study the pulse-height as a function of the H.H.T. in a scintillation counter.
3. Measurement of the spectrum of gamma rays from a radioisotope. Shielding and attenuation of gamma rays.
4. To study the characteristics of a solid-state detector and use it to measure the spectra of alpha and beta particles.
5. Use of a Lithium-drifted Ge-counter for gamma spectroscopy and to compare its performance with that of a NA l-detector.
6. AC circuits and dielectric constants of water and ice.
7. Radio frequency measurement. Skin-effect, etc.
8. Experiments with transmission lines.
9. Measurement of characteristic impedance. Velocity. Standing wave ratio, etc.

M.Sc-PHYSICS
SEMESTER-III

Course Code	PH-631
Course Title	Quantum Mechanics-I
Credit Hours	3
Prerequisite / Co requisite	Modern Physics /None
Remarks	Maj-1
Recommended Books	1. D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.R. 2. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4 ed. 2002. 3. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.
Course Description	

Waves and Particles: Introduction to the fundamental ideas of quantum mechanics: Electromagnetic waves and photon, material particles and matter waves, quantum description of a particle, wave packets, particle in a time-independent scalar potential, order of magnitude of the wavelength associated with material particles, constraints imposed by uncertainty relations, one-dimensional Gaussian wave packet: Spreading of the wave packet, stationary states of a particle in one-dimensional square potential, behavior of a wave packet at a potential step.

The Mathematical Tools of Quantum Mechanics: One-particle wave function space, state space, Dirac notation, representations in the state space, observable, representations, review of some useful properties of linear operators, unitary operators, study of the $\{|r>\}$ and $\{|P>\}$ representations, some general properties of two observable, Q and P, whose commutator is equal to $i\hbar$, the two-dimensional infinite well.

The Postulates of Quantum Mechanics: Statement of the postulates and their physical interpretation, the physical implications of the Schrodinger equation, the superposition principle, particle in an infinite potential well, study of the probability current in some special case, root-mean-square deviations of two conjugate observables, the density and evolution operators, Schrodinger and Heisenberg pictures, Gauge invariance, bound states of a particle in a potential well of arbitrary shape, unbound states of a particle in the presence of a potential well or barrier of arbitrary shape, quantum properties of a particle in a one-dimensional periodic structure.

Application of The Postulates to Simple Cases: Spin ½ And Two-Level Quantum Systems: Spin ½ particles, quantization of the angular momentum, illustration of the

postulates in the case of a spin ½, general study of two level systems, Pauli matrices, diagonalization of a 2×2 hermitian matrix, System of two spin ½ particles, Spin ½ density matrix, Spin ½ particle in a static magnetic field and a rotating field, Magnetic resonance. **The One-Dimensional Harmonic Oscillator:** Importance of the harmonic oscillator in physics, eigenvalues and eigenstates of the Hamiltonian, mean value and root-mean-square deviations of *X* and *P* in state $\|\varphi_n>$, Some examples of harmonic oscillators, study of the stationary states in the $\{\|r>\}$ representation, Hermite polynomials, solving the Eigenvalues of the harmonic oscillators by the polynomial method, study of the stationary states in the $\{\|P>\}$ representation, isotropic three-dimensional harmonic oscillator, charged harmonic oscillator placed in a uniform electric field, coherent states, Normal vibrational modes of coupled harmonic oscillators, vibrational modes of an infinite linear chain of coupled harmonic oscillators, phonons, one dimensional harmonic oscillator in thermodynamics equilibrium at a temperature T. **General Properties of Angular Momentum in Quantum Mechanics:** concept of angular momentum in quantum mechanics, commutation relations, application to orbital angular momentum, spherical harmonics, rotation operators, rotation of diatomic molecules, angular momentum of stationary states of a two-dimensional harmonic oscillator, charged particle in a magnetic field and Landau levels. **Particle in a Central Potential:** The Hydrogen atom, Stationary states of a particle in a central potential, motion of the center of mass and relative motion for a system of two interacting particles, Hydrogen atom, Hydrogen like systems, A solvable example of a central potential: the isotropic three dimensional harmonic oscillator, probability currents associated with the stationary states of the hydrogen atom, The hydrogen atom placed in a uniform magnetic field, para-magnetism and diamagnetism, Zeeman effect, study of some atomic orbitals, vibrational-rotational levels of diatomic molecules.

Course Code	PH-632
Course Title	Solid State Physics-I
Credit Hours	3
Prerequisite / Co requisite	Quantum Mechanics-I, Statistical Physics / None
Remarks	Maj-12
Recommended Books	1. C. Kittle, "Introduction to Solid State Physics", John Wiley, 8th ed. 2005. 2. N. W. Ashcroft and N. D. Mermin, "Solid State Physics", Rinehart & Winston, 1976. 3. S. R. Elliott, "The Physics and Chemistry of Solids", John Wiley, 1998

	4. M. A. Omar, "Elementary and Solid State Physics", Pearson Education, 2000. 5. H. M. Rosenberg, "The Solid State", Oxford Science Publication, 3rd ed. 1988. 6. M. A. Wahab, "Solid State Physics", Narosa Publishing House, 1999
Course Description	

Crystal Structure: Lattices and basis, Symmetry operations, Fundamental Types of Lattice, Position and Orientation of Planes in Crystals, Simple crystal structures.
Crystal Diffraction and Reciprocal Lattice: Diffraction of X-rays, Neutrons and electrons from crystals; Bragg's law; Reciprocal lattice, Ewald construction and Brillouin zone, Fourier Analysis of the Basis.
Phonons and Lattice: Quantization of Lattice Vibrations, Phonon momentum, inelastic scattering by phonons, Lattice Vibrations for Monoatomic and diatomic basis, Optical Properties in the Infrared Region.
Thermal Properties of Solids: Lattice heat Capacity, Classical model, Einstein Model, Enumeration of normal modes, Density of state in one, two or three dimensions, Debye model of heat capacity, Comparison with experimental results, thermal conductivity and resistivity, Umklapp processes.
Electrical Properties of Metals: Classical free electron theory of metals, energy levels and density of orbital's in one dimension, effect of temperature on the Fermi–Dirac distribution function, properties of the free electron gas, electrical conductivity and Ohm's Law, thermal and electrical conductivities of metals and their ratio, motion of free electrons in magnetic fields, cyclotron frequency, static magneto conductivity and Hall Effect along with applications.

Course Code	PH-633
Course Title	Electronics-II
Credit Hours	3
Prerequisite / Co requisite	Electronic-I/None
Remarks	Maj-5
Recommended Books	1. Thomas L. Floyd, "Electronics Fundamentals: Circuits, Devices and Applications", Prentice Hall, 8th ed. 2009. 2. B. Grob, "Basic Electronics", McGraw-Hill, Tch ed. 1997.

	3. B. Streetman and S. Banerjee "Solid State Electronics Devices", Prentice Hall, 6th ed. 2005. 4. A. Bar-lev, "Semiconductor and Electronics Devices", Prentice Hall, 3rd ed. 1993. 5. D. H. Navon and B. Hilbert, "Semiconductor Micro-devices and Materials", CBS College Publishing, 1986. 6. A. P. Malvino, "Electronic Principles", McGraw-Hill, 7th ed. 2006. 7. R. T. Paynter, "Introductory Electric Circuits", Prentice Hall, 1998.
Course Description	

Amplifiers and their Frequency Response: Cascade amplifier, The Amplifier pass band, The frequency plot, Low frequency plot, Low frequency limit, The un-bypassed emitter resistor, high frequency equivalent circuit, The Miller Effect, high frequency limit of transistor, bandwidth of a cascade amplifier.
Feedback: Positive and Negative feedback, Principle of feedback amplifier, stabilization of gain by negative feedback, Bandwidth improvement with negative feedback, Reduction of nonlinear distortion, control of amplifier output and input resistance, current series feedback circuit, voltage shunt feedback circuit.
Oscillators: Introduction, Classification of oscillators, Damped and undamped oscillators, the oscillatory circuit, frequency stability of an oscillator, essentials of a feedback LC oscillator, tuned base oscillator, Hartley oscillator, Colpitis oscillator, crystal oscillator.
Power Amplifiers: Introduction, Power relation in class-A amplifiers, effect of thermal environment, determination of the output distortion, class-B amplifier, efficiency of class-A and class-B amplifiers.
Modulation and Demodulation: Introduction, carrier wave modulation, Need for modulation, radio Broadcasting, Methods of modulation, amplitude modulation, Forms of amplitude modulation, single side band system of modulation, Diode for linear detector for amplitude modulation, High power level amplitude modulation, automatic volume control, Frequency modulation.
Multivibrators: Multivibrators, Basic types of Multivibrators, uses of Multivibrators, Astable Multivibrators, Mono-stable Multivibrators, Bi-stable Multivibrators, Schmitt Trigger Circuit.
Integrated Circuits: Introduction, Integrated circuit advantages and drawbacks, scale of integration, classification of integrated circuit by structure, Classification of integrated

circuit by function, comparison between different integrated circuit. Integrated circuit terminology, Integrated circuit fabrication, Basic processing steps. Silicon device processes Silicon wafer preparation, diffusion, Oxidation photolithography, Chemical vapour deposition, Metallization, Circuit probing, Scribing and separating into chips, Mounting and packing applications of integrated circuit. **Digital Circuits:** Decimal, Binary, Octal, hexadecimal number systems, conversion of decimal numbers to any other number system and vice-versa, Binary codes, OR, AND, NOT, NAND, NOR logic gates, Boolean Algebra. Boolean expressions, simplification of Boolean expression using Boolean Algebra.

Course Code	PH-634
Course Title	Nuclear Physics
Credit Hours	3
Prerequisite / Co requisite	Modern Physics / None
Remarks	Maj-11
Recommended Books	1. E. Segre, "Nuclei and Particles", Bejamin-Cummings, 2nd ed. 1977. 2. Kaplan, "Nuclear Physics", Addison-Wisely, 1980. 3. Green, "Nuclear Physics", McGraw-Hill, 1995. 4. K. S. Krane, "Introducing Nuclear Physics", John Wiley, 3rd ed. 1988. 5. B. Povh, K. Rith, C. Scholtz, F. Zetsche, "Particle and Nuclei", 1999.
Course Description	
History: Starting from Bacqurel's discovery of radioactivity to Chedwick's neutron. **Basic Properties of Nucleus:** Nuclear size, mass, binding energy, nuclear spin, magnetic dipole and electric quadrupole moment, parity and statistics. **Nuclear Forces:** Yukawa's theory of nuclear forces. Nucleon scattering, charge independence and spin dependence of nuclear force, isotopic spin. **Nuclear Models:** Liquid drop model, Fermi gas model, Shell model, Collective model. **Theories of Radioactive Decay:** Theory of Alpha decay and explanation of observed phenomena, measurement of Beta ray energies, the magnetic lens spectrometer, Fermi theory of Beta decay, Neutrino hypothesis, theory of Gamma decay, multipolarity of	

Gamma rays, Nuclear isomerism. **Nuclear Reactions:** Conservation laws of nuclear reactions, Q-value and threshold energy of nuclear reaction, energy level and level width, cross sections for nuclear reactions, compound nucleolus theory of nuclear reaction and its limitations, direct reaction, resonance reactions, Breit-Wigner one level formula including the effect of angular momentum.

Course Code	PH-635
Course Title	LAB-VII
Credit Hours	2
Prerequisite / Co requisite	Modern Physics / Nuclear Physics
Remarks	Maj-18
Course Description	

Advanced Experiments:

List of Experiments:

1. Measurement of the total neutron cross-section

2. To prove the Rutherford law of scattering of charged particles.

3. Measurement of the spectrum of gamma rays from a radioisotope (e.g.Cs) and study of their photoelectric and Compton absorption.

4. Source strength of C060 by gamma coincidence methods.

5. Determination of the constituents of substance by activation analysis.

6. To examine the characteristics of a Solid-State detector and to use it for alpha and beta Spectroscopy and compare the results with those obtained by a scintillation counter.

7. . The use of an analogue computer for solving differential equations.

8. To examine the stopping-power of various substances for thermal neutrons.

9. Determination of Planck's constant (h) by using the photoelectric effect.

10. Determination of the charge on an electron (e) by Millikan's method.

11. The Frank-hertz experiment (Measurement of excitation potential of Hg).

12. Determination of the Rydberg constant from the spectrum of hydrogen.

13. Fabry-Perot interferometer used as a gas refractometer.

14. To study the Zeeman effect for a line in the spectrum of helium.

15. Experiments with microwaves. Study of their optical properties.

16. Electron spin resonance (E.S.R.) by microwave absorption.

17. Nuclear magnetic resonance (N.M.R.) of protons in water.

18. The study of the Mossba uer effect.

19. The measurement of Hall effect in germanium and silicon.

20. To build a medium or short-wave transmitter.

21. Measurement of the conductivity of Si and Ge as a functions of temperature.

22. To determine the energy gap in silicon and Germanium.

23. Drift mobility. (Shockley-Haynes experiments for Germanium, demonstrating transistor action).

24. Simple diode manufacture and point-contact transistor.

Note: At least 12 experiments to be performed.

M.Sc-PHYSICS
SEMESTER-IV

Course Code	PH-641
Course Title	Quantum Mechanics-II
Credit Hours	3
Prerequisite / Co requisite	Quantum Mechanics-I /None
Remarks	Maj-2
Recommended Books	1. D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004. 2. R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4th ed. 2002. 3. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.
Course Description	

Addition of Angular Momenta: Total angular momentum in classical mechanics, total angular momentum in quantum mechanics, addition of two spin ½ angular momenta, addition of two arbitrary angular momenta, Clebsch-Gordon coefficients, sddition of spherical harmonics, vector operators, Wigner-Eckart theorem, electric Multi-pole moments, Evolution of two angular momenta J_1 and J_2 coupled by an interaction $aJ_1 \cdot J_2$.
Stationary Perturbation Theory: Description of the method, perturbation of a non-degenerate level, perturbation of a degenerate level, one-dimensional harmonic oscillator subjected to a perturbing potential, interaction between the magnetic dipoles of two spin ½ particles, Van der waals forces, volume effect and The influence of the spatial extension of the nucleus on the atomic levels, variational method, energy bands of electrons in solids, a simple example of the chemical bond: The H_2^+ ion
Applications of Perturbation Theory to Atomic Systems: fine and hyperfine structure of atomic levels in hydrogen, Calculation of the mean values of the spin-orbit coupling in the 1*s*, 2*s* and 2*p* levels, hyperfine structure And the Zeeman effect for muonium and positronium, Stark effect.
Approximation Methods for Time-Dependent Problems: Statement of the problem, approximate solution of the Schrodinger equation, An important special case: Sinusoidal or constant perturbation, Interaction of an atom with electromagnetic waves, linear and non-linear response of a two-level system subjected to a sinusoidal perturbation, Ooscillations of a system between two discrete states under the effect of a resonant perturbation, Rabi flopping, decay of discrete state resonantly coupled to a continuum of final states, Fermi's golden rule.
Systems of Identical Particles: Identical particles, Permutation operators, The

symmetrization postulate, difference between bosons and fermions, Pauli's exclusion principle, many-electrons atom and their electronic configurations, energy levels of the helium atom, configurations, terms, multiplets, spin isomers of hydrogen (ortho and parahydrogen). **Scattering by a Potential:** Importance of collision phenomena, Stationary scattering states, scattering cross section, scattering by a central potential, method of partial waves, phenomenological description of collisions with absorption.

Course Code	PH-642
Course Title	Solid State Physics-II
Credit Hours	3
Prerequisite	Solid State Physics-I
Remarks	Maj-13
Recommended Books	1. C. Kittle, "Introduction to Solid State Physics", John Wiley, 8th ed. 2005. 2. N. W. Ashcroft and N. D. Mermin, "Solid State Physics", Rinehart & Winston, 1976. 3. G. Burns, "High Temperature Superconductivity: An Introduction", Academic Press, 1992. 4. M. Fox, "Optical Properties of Solids", Oxford University Press, 2nd ed. 2010. 5. N. A. Spaldin, "Magnetic Materials: Fundamentals and Device Applications", Cambridge University Press, 2nd ed. 2010.
Course Description	
Dielectric Properties of Solids: Polarization, Depolarization, Local and Maxwell field, Lorentz field, Clausius-Mossotti relation, Dielectric Constant and Polarizability, Masurement of dielectric constant, ferro electricity and ferroelectric crystals, Phase Transitions, First and 2nd order phase transitions, Applications **Semiconductors:** General properties of semiconductors, intrinsic and extrinsic semiconductors, their band structure, carrier statistics in thermal equilibrium, band level treatment of conduction in semiconductors and junction diodes, diffusion and drift currents, collisions and recombination times **Optical Properties:** Interaction of light with solids, Optical Properties of Metals and Non-Metals, Kramers Kronnig Relation, Excitons, Raman Effect in crystals, optical	

spectroscopy of solids. **Magnetic Properties of Materials:** Magnetic dipole moment and susceptibility, different kinds of magnetic materials, Langevin diamagnetic equation, Paramagnetic equation and Curie law, Classical and quantum approaches to paramagnetic materials. Ferro-magnetic and anti-ferromagnetic order, Curie point and exchange integral, Effect of temperature on different kinds of magnetic materials and applications. **Superconductivity:** Introduction to superconductivity, Zero-Resistance and Meissner Effect , Type I and Type II superconductors, Thermodynamic fields, Tow fluid model, London equations , BCS and Ginzburg Landau Theory, Vortex Behaviour, Critical Current Density, Josephson effect applications.

Course Code	PH-643
Course Title	Atomic & Molecular Physics
Credit Hours	3
Prerequisite / Co requisite	Quantum Mechanics-I / Quantum Mechanics-II
Remarks	Maj-14
Recommended Books	1. C. J. Foot, “Atomic Physics”, Oxford University Press, 2005. 2. B. H. Bransden and C. J. Joachain, “Physics of Atoms and Molecules”, Pearson Education, 2nd ed. 2008. 3. W. Demtroder, “Atoms, Molecules and Photons”, y, Springer, 2nd ed. 2010. 4. C. N. Banwell and E. M. McCash, “Fundamentals of Molecular Spectroscopy”, McGraw-Hill, 4th ed. 1994. 5.J. M. Hollas, “Basic Atomic & Molecular Spectroscopy”, John Wiley, 2002.
Course Description	
One Electron Atoms: Review of Bohr Model of Hydrogen Atom, Reduced Mass, Atomic Units and Wavenumbers, Energy Levels and Spectra, Schrodinger Equation for One-Electron Atoms, Quantum Angular Momentum and Spherical Harmonics, Electron Spin, Spin-Orbit interaction. Levels and Spectroscopic Notation, Lamb Shift, Hyperfine Structure and Isotopic Shifts. Rydberg Atoms. **Interaction of One-Electron Atoms with Electromagnetic Radiation:** Radiative Transition Rates, Dipole Approximation, Einstein Coefficients, Selection Rules, Dipole	

Allowed and Forbidden Transitions. Metastable Levels, Line Intensities and Lifetimes of Excited States, Shape and Width of Spectral Lines, Scattering of Radiation by Atomic Systems, Zeeman Effect, Linear and Quadratic Stark Effect.

Many-Electron Atoms: Schrodinger Equation for Two-Electron Atoms, Para and Ortho States, Pauli's Principle and Periodic Table, Coupling of Angular Momenta, L-S and J-J Coupling. Ground State and Excited States of Multi- Electron Atoms, Configurations and Terms.

Molecular Structure and Spectra: Structure of Molecules, Covalent and Ionic Bonds, Electronic Structure of Diatomic Molecules, Rotation and Vibration of Diatomic Molecules, Born-Oppenheimer Approximation. Electronic Spectra, Transition Probabilities and Selection Rules, Frank-Condon Principle, H2+ and H2. Effects of Symmetry and Exchange. Bonding and Anti-bonding Orbitals. Electronic Spin and Hund's Cases, Nuclear Motion: Rotation and Vibrational Spectra (Rigid Rotation, Harmonic Vibrations). Selection Rules. Spectra of Triatomic and Polyatomic Molecules, Raman Spectroscopy, Mossbauer Spectroscopy.

ELECTIVE COURSES
M.Sc PHYSICS

Course Code	PH-675
Course Title	Introduction to Plasma Physics
Credit Hours	03
Remarks	Elective
Recommended Books	1. F. F. Chen, "Introduction to Plasma Physics", 2nd ed. Plenum, 1995. 2. D. A. Gurnett and A. Bhattacharjee, "Introduction to Plasma Physics: with space and laboratory application", Cambridge University Press, 2005. 3. T. J. M. Boyd and J. J. Sanderson, "The Physics of Plasmas", Cambridge University Press, 2003.
Course Description	
Introduction: Occurrence of plasma, Concept of temperature, Debye shielding, the plasma parameter, Criteria for plasma.	

Course Code	PH-676
Course Title	Introduction to Material Science
Credit Hours	03
Remarks	Elective
Recommended Books	1. W. D. Callister, "Materials Science and Engineering: An Introduction", Wiley, 7th ed. 2006. 2. W. D. Callister and D. G. Rethwisch "Fundamentals of Materials Science and Engineering: An Integrated Approach", Wiley, 4th ed. 2012. 3. J. F. Shackelford, "Introduction to Materials Science for Engineers", Prentice Hall, 7th ed. 2008. 4. http://www.msm.cam.ac.uk/teaching/index.php, 5. http://www.doitpoms.ac.uk/

Course Description
Atomic Structure of Materials, Imperfections in Solids, Microstructure, Mechanical Behavior of Materials, Polymers.

Course Code	PH-677
Course Title	Environmental Physics
Credit Hours	03
Remarks	Elective
Recommended Books	1. E.t Booker and R. Van Grondelle, "Environmental Physics", John Wiley, 3rd ed. 2011. 2. G. Guyot, "Physics of Environment and Climate", John Wiley, 1998.
Course Description	
Introduction to the Essentials of Environmental Physics, Basic Environmental Spectroscopy, The Global Climate, Transport of Pollutants Noise, Radiation, Atmosphere and Climate, Topo Climates and Micro Climates, Climatology and Measurements of Climate Factor.	

Course Code	PH-678
Course Title	Renewable energy Recourses
Credit Hours	03
Remarks	Elective
Recommended Books	1. J. W. Twidell and A. D. Weir; Renewable Energy Resources; E & F.N. Spon. Ltd. London. (1986). 3. M. Iqbal; An Introduction to Solar Radiation: Academic Press, Canada. (1983). 4. S. Roberts, A Practical Guide to Solar Electricity, Prentice Hall Inc. USA, (1991). 5. M. A. Green; Solar Cells, Operating Principles, Technology, and system Application: Prentice Hall, In

	USA, (1982). 6. T. J. Jansen, Solar Engineering Technology; Prentice Hall Inc. USA, (1985). 7. V. D. Hunt, Wind Power, A Book on Wind Energy Conversion System; Litton Educational Publishing Inc. (1981). 8. E. C. Price, P. N. Cheremisinoff; Biogas, Production and Utilization; Ann Arbor Science, USA, (1981). 9. I. Campbell, Biomass, Catalysts and liquid fuels; Technonic Publishing Co. Inc. USA, (1983).

Course Description

Energy Scenarios: Importance of energy, world primary energy sources, energy deman supplies, reserves, growth in demand, life estimates, and consumption pattern conventional energy sources: oil, gas, coal, hydro, nuclear etc.

Energy & Environment: Emission of pollutants from fossil fuels and their damagi effects, and economics impact; Renewable energy and its sustainability. Renewab Scenarios: Defining renewable, promising renewable energy sources, their potenti availability, present status, existing technologies and availability.

Solar Energy: Sun-Earth relationship, geometry, sun path and solar irradiance, sol spectrum, solar constant, atmospheric effects, global distribution, daily and season variations, effects of till angle, resource estimation, extraterrestrial, global, direct, diffus radiation, sun shine hours, air mass, hourly, monthly and annual mean, radiation on t surface, measuring instruments.

Solar Thermal: Flat plate collectors, their designs, heat transfer, transmission through glas absorption transmission of sun energy, selective surfaces, performance, and efficiency; lo temperature applications: water heating, cooking, drying, desalination, their designs ar performance; concentrators, their designs, power generation, performance and problems.

Photovoltaics: PV effect, materials, solar cell working, efficiencies, different types of sol cells, characteristics, (dark, under illumination), efficiency limiting factors, power, spectr response, fill-factor, temperature effect; PV systems, components, packing fractio modules, arrays, controllers, inverters, storage, PV system sizing, designing, performan and applications.

Wind: Global distribution, resource assessment, wind speed, height and topographic effect power extraction for wind energy conversion, wind mills, their types, capacity, propertie wind mills for water lifting and power generation, environmental effect.

Hydropower: Global resources, and their assessment, classification, micro, mini, small ar large resources, principles of energy conversion; turbines, types, their working ar efficiency for micro to small power systems; environmental impact.

Biogas: Biomass sources; residue, farms, forest. Solid wastes: agricultural, industrial ar municipal wastes etc; applications, traditional and non-traditional uses: utilization proces gasification, digester, types, energy forming, Environment issues. Resources availabilit digester, their types, sizes, and working, gas production, efficiency; environmental effects;

Geothermal: Temperature variation in the earth, sites, potentials, availability, extractio techniques, applications; water and space heating, power generations, problem environmental effects.

Waves and Tides: Wave motion, energy, potentials, sites, power extraction, ar transmission, generation of tides, their power, global sites, power generation, resour assessment, problems, current status and future prospects.

Hydrogen Fuel: Importance of H_2 as energy carrier, Properties of H_2, productio hydrolysis, fuel cells, types, applications, current status and future prospects.

Nuclear: Global generations of reserves through reprocessing and breeder reactors, grow rate, prospects of nuclear fusion, safety and hazards issue.

Energy Storage: Importance of energy storage, storage systems, mechanical, chemica biological, electrical, fuel cells etc.

Course Code	PH-679
Course Title	Computer Simulations in Physics
Credit Hours	3
Remarks	Elective
Recommended Books	1. T. Pang, "An Introduction to Computational Physics", Cambridge University Press, 2008.

	2. R. Landau, M. Paez, C. Bordeianu, "A Survey of Computational Physics", Princeton University Press, 2008
Course Description	

Programming for Scientific Computation: unix/linux basics, the editingcoding-compiling-debugging-optimizing-visualizing-documenting production chain, Fortran95.
Numerical Programming: Functions: approximation and fitting, Numerical calculus. Ordinary differential equations, Matrices, Spectral analysis, Partial differential equations.
Modeling and Simulation: Molecular dynamics simulations, modeling continuous media Monte Carlo simulations.
Project: A project will be chosen by the student in consultation with the instructor. Selection of the project should be done soon after the module on modelling and simulation starts and continue over the course of the rest of the semester. The final part of the course is reserved for presentation of preliminary and final results.

Course Code	PH-683
Course Title	Computational Physics
Credit Hours	3
Remarks	Elective
Recommended Books	1. M. L. De Jong, "Introduction to Computational Physics", Addison Wesley, 1991. 2. S. T. Koonini, "Computational Physics", the Benjamin-Cummings, 1985 3. H. Gould, J. Tobochnik and W. Christian, "An Introduction to Computer Simulation Methods", Addison Wesley, 3rd ed. 2006. 4. S. C. Chapra and R. P. Chanle, "Numerical Methods for Engineers with Personal Computer Applications", McGraw-Hill,1990. 5. S. C. Chapra, "Applied Numerical Methods with MATLAB for Engineers and Scientists", McGraw-Hill,

	2_{nd} ed. 2006.
Course Description	
Computer Languages: A brief introduction of the computer languages like Basic, C. Pascal etc. and known software packages of computation **Numerical Methods:** Numerical Solutions of equations, Regression and interpolation, Numerical integration and differentiation. Error analysis and technique for elimination of systematic and random errors **Modeling & Simulations:** Conceptual models, the mathematical models, Random numbers and random walk, doing Physics with random numbers, Computer simulation, Relationship of modeling and simulation. Some systems of interest for physicists such as Motion of Falling objects, Kepler's problems, Oscillatory motion, Many particle systems, Dynamic systems, Wave phenomena, Field of static charges and current, Diffusion, Populations genetics etc.	

Course Code	PH-684
Course Title	Methods of Experimental Physics
Credit Hours	3
Remarks	Elective
Recommended Books	1. F. James, "Statistical Methods in Experimental Physics World Scientifi Company, 2nd ed. 2006. 2. M. H. Hablanian, "High-Vacuum Technology", Marc Dekker, 2nd ed.1997 3. P. Bevington and D. K. Robinson, "Data Reduction and Err Analysis for Physical Science", McGraw-Hill, 3rd ed. 2002 4. S. Tavernier, "Experimental Techniques in Nuclear ar Particle Physics",Springer, 2010. 5. J. B. Topping, "Errors of Observations and Their Treatment Springer, 4^{th} ed. 1972.
Course Description	

Vacuum Techniques, Radiation Detection and Measurement, Sensor Technology, Electronics and Electronic Instruments, Computer Introduction: Introduction to computers, Data Analysis.

Course Code	PH-685
Course Title	Introduction to Laser Physics
Credit Hours	3
Remarks	Elective
Recommended Books	1. W.T selfvast, "Laser Fundamentals", Cambridge University Press, 2nd ed.(2008). 2. O. Sevelto, "Principles of Lasers", Springers, 5th ed.(2009) 3. J. Hecht Understanding lasers: an entry-level guide, New York: IEEE Press(1994). 4. K. Thyagarajan, A.K Ghatak. "Laser Theory and Applications" New Jersey Prentice Hall. (1995).
Course Description	
Introductory concepts, energy levels of molecules and semiconductors, Radiation & thermal equilibrium, population inversion & gain, laser systems, laser applications.	

Course Code	PH-686
Course Title	Electronic Materials & Devices
Credit Hours	3
Remarks	Elective
Recommended Books	1. R. F. Pierret, "Semiconductor Device Fundamentals", Addison Wesley, 2nd ed. 1996. 2. N. Braithwaite, and G. Weaver, "Electronic Materials", MA: Butterworth, 2nd ed. 1990. 3. S. O. Kasap, "Electronic Materials and Devices", McGraw-Hill, 3rd ed. 2005. 4. R. C. O'Handley, "Modern Magnetic Materials: Principles and Applications", Wiley Inter-Science, 1999.

	5. D. Jiles, "Introduction to Magnetism and Magnetic Materials", Chapman & Hall, 2nd ed. 1998.
Course Description	
Semiconductor Fundamentals, Device Fabrication Processes, *PN* Junction and Bipolar Junction Transistor, Dielectric Materials, Optoelectronic Devices, Magnetism and Magnetic Materials.	

Course Code	PH-687
Course Title	Functional Materials
Credit Hours	3
Remarks	Elective
Recommended Books	1. Moulson, A. J. and Herbert, J. M. "Electro-ceramics: Materials, Properties, and Applications". John and Wiley and Sons, 2003. 2. Pillai, S. O, Pillai, Sivakami, "Rudiments of Materials Science". New Age International (P) Limited Publishers, New Delhi, 2005. 3. Gersten J. I. and Smith F. W. "The Physics and Chemistry of Materials" John Wiley & Sons, Inc. New York, 2001. 4. Hidayat Ullah Khan, thesis on "Phase Transition s in Li-doped Ag(NbxTa1-x)O3 perovskite ceramics". Department of Materials Science and Engineering, The University of Sheffield, UK. Available at the Department of Physics, University of Peshawar. 5. Gersten J. I. and Smith F. W. "The Physics and Chemistry of Materials" John Wiley & Sons, Inc. New York, 2001.
Course Description	
Introduction to the functions of materials, Dielectrics, Pyroelectrics, Piezoelectrics, Ferroelectrics, Electro-Optic Materials.	

Course Code	PH-688

Course Code	PH-688
Course Title	Introduction to Nanoscience & Nanotechnology
Credit Hours	3
Remarks	Elective
Recommended Books	1. S. Lindsay, "Introduction to Nanoscience", Oxford University Press, 2009. 2. C. Binns, "Introduction to Nanoscience and Nanotechnology (Wiley Survival Guides in Engineering and Science)", Wiley, 2010.
Course Description	
Introduction, Quantum Effects, Surfaces and Interfaces, Material Properties, Tools and Instrumentation, Fabricating Nano Structures, Electrons in Nano Structures, Molecular Electronics, Nano Materials Nano Biotechnology, Nanotechnology the Road Ahead.	