Scheme of Study

Associate Degree/BS Physics

Department of Physics (ULM)

University of Lakki Marwat, Lakki Marwat, KPK.

Semester I

Course Code	Course Title	CrdHrs	Pre-Requisite
EW-101	English-I	3	
AH-105	Islamic History	3	
NS-101	Everyday Science	3	
NS-107	ICT	3	
SS-120	Sociology	3	
QR-104	Introduction to Statistics	3	
Total Credit Hrs		**18**	

Semester II

Course Code	Course Title	CrdHrs	Pre-Requisite
NS-120	An Introduction to Physics	**3**	
QR-101	Basic Mathematics	3	
AH-120	Constitutional Law	3	
SS-113	Introduction to Economics	3	
ENG-121	English II	3	
CIV-110	Islamic Studies	3	
Total Credit Hrs		**18**	

Semester III

ENG-231	English III	3
CIV-120	Pakistan Study	**3**
PHY-101	Mechanics	**4**
MATH-21	Calculus I	**3**
PHY102	Electricity& Magnetism	**3**
PHY101L	Lab-I	**1**
Total Credit Hrs		**17**

Semester IV

Course Code		
MATH-214	Calculus II	3
PHY-203	Waves and Oscillations	**3**
PHY-204	Heat &Thermodynamics	**3**
PHY-205	Modern Physics	**3**
PHY-351	Mathematical Methods of Physics-I	**3**
PHY-206	Optics	**3**
PHY-102L	Lab-II	**1**
Total Credit Hrs		**16**

Semester V

Course Code		
PHY-321	Electrodynamics-I	3
PHY-311	Classical Mechanics	**3**
PHY-391	Electronics	**3**
PHY-103L	Lab-III	**1**
PHY-352	Mathematical Methods of Physics-II	**3**
PHY-331	Quantum Mechanics-I	**3**
Total Credit Hrs		**16**

Semester VI

Course Code		
PHY-322	Electrodynamics-II	3
PHY-432	Quantum Mechanics-II	**3**
PHY-392	Optics	**3**
PHY-372	Statistical Physics	**3**
PHY-104L	Lab-IV	**1**
PHY-433	Atomic and Molecular Physics	**3**
Total Credit Hrs		**17**

Semester VII

Course Code		
PHY-441	Solid State Physics-I	3
PHY-493	Nuclear Physics	**3**
PHY-105L	Lab-V	**2**
PHY-	Elective-I	**3**
PHY-106L	Lab-VI	**2**
Total Credit Hrs		**13**

Semester VIII

Course Code		
PHY-442	Solid State Physics-II	3
PHY-	Elective-II	**3**
PHY-	Elective-III	**3**
PHY-500	Research Project	**3**
PHY-	Elective-IV	**3**
Total Credit Hrs		**15**

Total Credit Hrs: 134

NS- 120 **AN INTRODUCTION TO PHYSICS** **Credit Hrs: 03**

Course outline:

Introduction to Physics: Explore fundamental physics concepts, scientific notations,dimensional analysis, linear relationships and quadratic relationships.

Vectors: Describe types of vectors and the process to add, subtract and multiply vectors. Understand how to get a resultant vector and perform vector operations using components.

Kinematics: Differentiate between displacement and distance and speed and velocity. Determine acceleration using slope of speed and explain projectile, free fall and uniform circular motion.

Force and the Laws of Motion: Examine Newton's Laws of Motion. Explain the differences between mass, inertia and weight and describe action and reaction force pairs. Describe friction, inclined plane, the spring constant and centripetal force.

Work and Energy in Physics: Apply the work-energy theorem and describe relationship between kinetic and potential energy. Examine gravitational potential energy, conservative forces and power.

Linear Momentum in Physics: Describe the impulse-momentum change equation and apply the momentum conservation principle. Discuss elastic and inelastic collisions and isolated systems and find the centre of gravity.

Waves, Sound and Light: Define vibrations and explore wave parameters, electromagnetic waves and pitch and volume in sound waves. Discuss reflection, resonance, color, diffraction and the Doppler Effect.

Thermodynamics in Physics: Explore the relationship between temperature and heat, phase changes and heat transfer. Describe thermal expansion, the ideal gas law, entropy and the first and second laws of thermodynamics.

Electrostatics: Understand electric charge, force fields and Coulomb's Law. Solve parallel-plat capacitor problems and describe electric potential.

Recommended Books

1. College Physics by Raymond A. Serway and Chris Vuille, Volume 10, Publisher: Cengage Learning (2014)
2. University Physics by George Arfken, Academic Press (2012)
3. Fundamentals of Physics by Haliday & Resnick Walker.

NS- 101 EVERYDAY SCIENCE Credit Hrs: 03

Course outline:

Introduction, History of Science, Achievements of some giants of Science in Chronological order, Islamic Science, Contribution of Muslim Scientists, Famous muslim scientist,Nature of science, Scientific method, impact of science on society. Introduction, The origin, The Big Bang, The structure, the galaxies, solar system, The sun, the moon, the earth,structure of the earth, earth atmospheres, the green house effect, global warming, ozone depletion, acid rain, stattelites, earthquake, eclipses, the mystery of Stonehenge, day-night and seasons, volcanoes, minerals, glossary of cosmology Introduction and sources of energy, Fossil Fuels, Major oil producing countries, Global search of Crude oil, Petroleum products, natural gas, hydel power or hydro-electric power, solar energy, nuclear energy, the nuclear reactor, heavy water, nuclear safety, nuclear fusion, energy coversion, radiation and living things, Ceramics, Semi-conductors, Communications systems, Laser, Telescope, Camera, Fertilizers, Nanotechnology, Plastics, Computer, Brain, Heart, Tissues, Epithelial Cell, Origin of Modern Humans, Pest Control, Protein, Vertebrate, Invertebrate, Liver, Enzymes, Organisms (Common to all living things), Blood Group system. Plants, Seed, Flower, Gene, Evolution Laws, Nucleic Acid (DNA and RNA), **Diseases and Threats to Living organism:**

Swine flow, Hepatitis, Dengue fever, Corona virus, SARS (Severe acute respiratory syndrome virus), Plants and Crop Diseases (Rust, Smut, Late Blight, Canker).

Recommended Books:

1. Exploring physical science 1977 by walter A. Thurber
2. Exploring Life science 1975 by walter A. Thurber
3. Encyclopedic Manual of everyday science, Author, Dr. Rabnawaz Samo Publisher; Maktab e Faridi.

PHY- 101 Mechanics Credit Hrs: 03

Course outline:

Review of Newtonian Mechanics: Frame of reference, orthogonal transformations, angular velocity and angular acceleration, Newton's laws of motion, Galilean transformation, conservationlaws,systemsofparticles,motionunderaconstantforce,motionsundervariable 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.

CentralForceMotion: Thetwo-bodyproblem,effectivepotentialandclassificationoforbits, Kepler'slaws,stabilityofcircularorbits,hyperbolicorbitsandRutherfordscattering,centerof mass co-ordinate system, scatteringcross-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-freesymmetrical top, stability of rotationalmotion.

Recommended Books:

1. T. L. Chow, "Classical Mechanics", John Wiley, 1995.
2. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed. 2004.C
3. Classical Mechanics, H. Goldstein, 3rd Ed., Addison Wesley Reading, Massachusetts, 2006
4. Classical Dynamics of Particles and System, Jerry B. Marian, Stephen T.
5. Thornton, 4th Ed., Harcourt Brace & Company, 1995
6. Classical Mechanics, A. Douglas Davis, Academics Press, 1986HEME

PHY-391 Electronics I Credit Hrs: 03

Course Contents:

TheSemiconductorDiode: Metals,insulatorsandsemiconductors,ConductioninSiliconand Germanium,Theforbiddenenergygap,nandptypesemiconductors,thejunctiondiode,diode voltage-currentequation,Zenerdiodes,lightemittingdiodes,photodiodes,capacitanceeffects in the pnjunction.

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 capacitorfilter,the∏filter,the∏-Rfilter,thevoltagedoublingrectifiercircuit,rectifyingAC voltmeters, diode wave clippers, diodeclampers.

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 junctiontransistors,thevolt-amperecurveofatransistor,thecurrentamplificationfactors,the load line and Q point, the basic transistor amplifiers, the common emitter amplifier, the trans-conductancegm,performanceofaCEamplifier,relationbetweenAiandAv,theCBamplifier, the CC amplifier, comparison of amplifierperformance.

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.

Recommended Books

1. Imillman & c.Chalkaias , 'integrated Electronic ' ,McGraw hill Block Company , Singapore (Latest Edition)
2. T.L.Floyd , "electronic device", Merril Publishing company Columbus (1988)
3. A.P .Malvino , "electronic principle" , TATA McGraw Hill ,New Delhi (1980)
4. D.B.Bell , "Electronics devices &Circuits" ,Reston Publishing Company Inc, Virginia (1980)
5. C.J.Savant Jr.M.S .Roden, G.L.Carpenter, "Electronic Design Circuits & Systems", The B Engamin /Cummings Publishing Co, California (1991).
6. Larry D Jons, Principles and applications of Digital Electronics, Mic-Millian Publishing company, 1993.
7. Digital system design and microprocessor J.C. Bortie (NBF).
8. Mic-Millian, Micro electron, Megraw Hill.
9. Digital Logic and computer Design Morris Mono, 1995 Prentic Hall.
10. Tochim, Digital Electronics (1999).
11. Barrey B. Bery, Intel UPS architecture, Programming and interfacing, Printic Hall (1998).

PHY-311 Classical Mechanics Credit Hrs: 03

Course Contents:

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.

CentralForceMotion: 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-freesymmetrical top, stability of rotationalmotion.

Recommended Books:

1. T. L. Chow, "Classical Mechanics", John Wiley,1995.
2. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed.2004.
3. Classical Mechanics, H. Goldstein, 3rd Ed., Addison Wesley Reading, Massachusetts, 2006
4. Classical Dynamics of Particles and System, Jerry B. Marian, Stephen T. Thornton, 4th Ed., Harcourt Brace & Company, 1995
5. Classical Mechanics, A. Douglas Davis, Academics Press, 1986
6.

PHYS-321 ELECTRODYNAMICS-I Credit Hrs: 03

Course Contents:

Differential/integral calculus; Orthogonal coordinate systems (Cartesian/cylindrical/ spherical); Electrostatics in free space: Electrostatic force/field/potential/energy for discrete (a single point charge/a collection of point source charges) and continuous (line/surface/volume) charge distributions, Divergence/curl of E, Electrostatic boundary conditions (on E, V, and D), Conductors, Capacitors; Boundary value problems: Solutions of Laplace's equation for various symmetries (Cartesian/ cylindrical/spherical), Method of Images for various symmetries; Electric monopole/ dipole/quadrupole/octopole etc., Electric dipole moment for line/surface/volume charge; Electrostatics in matter: Polarization P, Bound surface/volume charge, Electric displacement D, Gauss's law for D & P−differential/integral forms and its uses/applications, Electric susceptibility/permittivity/relative permittivity; Electric line/surface/volume currents I/K/J, Equation of continuity.

Recommended Books:

1. D. J. Griffiths "Introduction to Electrodynamics", Prentice Hall, USA,3rd ed.(1999).
2. D. K. Cheng, "Field and Wave Electromagnetics", Addison Wesley, USA 2nd ed. (1983).
3. H. A. Haus and J. R. Melcher, "Electromagnetic Fields and Energy", Prentice Hall, USA,1sted. (1989).
4. Classical Electromagnetic Theory, by Jack Vanderlinde, Kluwer Academic, USA,2nd ed., (2004).
5. P. Lorrain and D. R. Corson, "Electromagnetic Fields and Waves", W. H. Freeman, USA,3rd ed. (1988).
6. J. R. Reitz, F. J. Milford, R. W. Christy,"Foundations of Electromagnetic Theory", Narosa, India,3rded. (1998).
7. Electronic Principles by A.P. Malvino, Tata McGraw Hill, New Delhi (1988).

PHYS-322 ELECTRODYNAMICS-II Credit Hrs: 03

Course Contents:

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'stheorem, 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 andB, 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 inconductors, reflection at a conducting surface, the frequency dependence ofpermittivity, guided waves: wave guides, the waves in a rectangular waveguide. The special theory of relativity: Einstein'spostulates, 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.

Recommended Books:

1. D.J. Griffiths,"Introduction to Electrodynamics", Prentice Hall, USA, 3rd ed. (1999).
2. David K. Cheng, "Field and Wave Electromagnetics", Addison Wesley, USA,2nd ed. (1983).
3. M.N.O. Sadiku, "Elements of Electromagnetics",Oxford University Press,5th ed. 2009.
4. H.A. Haus and J.R. Melcher, "Electromagnetic Fields and Energy", Prentice Hall, USA, 1st ed. (1989).
5. J,Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic, USA, 2nd ed. (2004).
6. P. Lorrain and Dale R. Corson, "Electromagnetic Fields and Waves", W. H. Freeman, USA,3rd ed. (1988).

PHYS-392 OPTICS Credit Hrs: 03

Course Contents:

Huygens' Principle, Fermat's Principle, Laws of Reflection and Refraction, Refraction at a Spherical Surface, Thin Lenses, Newtonian Equation for a Thin Lens. Ray Transfer Matrices, Thick Lens, Significance of System Matrix Elements, Cardinal Points of an Optical System with examples, Optical Instruments including Simple Magnifiers, Telescopes and Microscopes, Chromatic and Monochromatic

Aberrations, Spherical Aberrations, Coma, Distortion, Stops, Pupils, Windows. Superposition & Interference: Standing Waves, Beats, Phase and Group Velocities, Two-Beam and Multiple-Beam Interference, Thin Dielectric Films, Michelson and Fabry-Perot Interferometers, Resolving Power, Free-Spectral Range. Jones Matrices, Production of Polarized Light, Dichroism, Brewster's Law, Birefringence, Double Refraction. Fraunhofer Diffraction: from a Single Slit, Rectangular and Circular Apertures, Double Slit, Many Slits, Diffraction Grating, Dispersion, Resolving Power Blazed Gratings. Fresnel Diffraction: Zone Plates, Rectangular Apertures, Cornu's Spiral Coherence & Holography: Temporal Coherence, Spatial Coherence, Holography of a Point object and an Extended Object Laser Basics: Stimulated Emission, Population Inversion, Resonators, Threshold and Gain, Multi-layered Dielectric Films.

Recommended Books:

1. F. Pedrotti, L. S. Pedrotti, L. M. Pedrotti, "Introduction to Optics",3rd ed.Pearson Prentice Hall, (2007).
2. E. Hecht and A. Ganesan, "Optics", 4 th ed. Dorling Kindersley, (2008).
3. M. V. Klein, T. E. Furtak, "Optics", 2nd ed. John Wiley, (1986).
4. K. K Sharam, "Optics: Principles and Applications", Academic Press,(2006).
5. C. A. Bennett, "Principles of Physical Optics", John Wiley, (2008).

PHYS-102 ELECTRICITY AND MAGNETISM Credit Hrs: 02

Course Contents:

Electric charge (properties/quantization/conservation), Coulombs law in free space, Electric field due to discrete/continuous charges distributions, Electric dipole, Electric flux, Gauss's law and its applications, Electric potential due to discrete/continuous charges distributions, Work and Electric potential energy, Capacitors and capacitance, Capacitance for various geometries, Capacitance with Dielectrics, Electric Current, current density, Resistance and resistivity, Microscopic and macroscopic forms of Ohm's Law, Energy transfer in electric circuit, Power in electric circuits, Calculating current in a single loop and multiple loop by using Kirchhoff laws, Circuit analysis, Growth and decay of current in RC-circuits and its analytical treatment. Magnetic field, Magnetic forces on a single point charge/current carrying conductor, Torque on a current carrying loop and magnetic dipole, Biot & Savart Law and its analytical treatment and application, Ampere's law and its applications, Electromagnetic induction and its laws, Inductance, Inductance for various configurations, LR circuits, Growth and decay of current in RL circuits, Electromagnetic Oscillation (Qualitative and Quantitative analysis using differential equations), Forced electromagnetic oscillations and resonance, Alternating current circuits, Single loop RLC circuits (series and parallel), Power in AC circuits and phase angles, Maxwell's equations (integral/differential forms), Electromagnetic waves, Poynting vector, Magnetic

properties of materials.

Recommended Books:

1. D. Halliday, R. Resnick and K. S. Krane, "Fundamentals of Physics", John Wiley & Sons Inc., 5th Ed. (2003).
2. R. A. Freedman,H. D. Young and A. L. Ford(Seers and Zemansky's),"University Physics", Pearson Education Inc, 11th (2006).
3. D. C. Giancoli, "Physics for Scientist and Engineers with Modern Physics", 2nd ed. Prentice Hall Inc. (1988).

PHYS-372 STATISTICAL PHYSICS Credit Hrs: 03

Course Outlines:

Review of thermodynamics: Mathematical formulation of first and second law of thermodynamics, Maxwell's relation, Reduction of derivatives, General conditions of equilibrium. Partition Function: Partition Function, Relations of partition function with thermodynamical variables, examples (collection of simple harmonic oscillators, Half spin paramagnet. Basic Principles of statistical Mechanics: Microscopic and macroscopic states, Phase Space, Ensemles, Liouvillie theorem, Formation of Micro canonical, Canonical and Grand canonical partition function. Maxwell distribution of molecular speed: Probability of the particle in quantum state, Density of states in k-space, single particle density of states in energy, Maxwell-Boltzman Distribution Function, Validity of Maxwell-Boltzman statistics, Evaluation of constants α and β, Maxwell Speed distribution function. Theory of ideal Fermi System: Fermi-Dirac Distribution Function, Examples of the Fermi system (free electron theory of metals, Electrons in stars, electrons in white dwarf stars). Theory of Bose System: Bos-Einstein Distribution Function, Black body radiation, the photon gas, ideal bose gas model of liquid helium, Einstein's model of vibration in solids, Debye's model of vibration in solids.

Advanced Topics: Fluctuations, Bose-Einstein Condensation, Introduction to density matrix approach.

Recommended Books:

1. F. Reif, "Fundamentals of Statistical and Thermal Physics", Waveland PrInc, (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).

PHYS-204 HEAT AND THERMODYNAMICS Credit Hrs: 03

Course Contents:

Basic Concepts and Definitions in Thermodynamics, Properties and state of the substance,

Extensive and Intensive properties, Equilibrium, 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, 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 thermodynamics, 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.

Recommended Books:

1. B. N. Roy, "Principles of Modern thermodynamics",Institute of Physics, London (1995).
2. D. Halliday, R. Resnick K. S. Krane, "Fundamentals of Physics", John Wiley & Sons Inc., 5th Ed. (2003).
3. M. W. Zemansky, Heat and Thermodynamics, McGraw Hill, 7th ed. (1997).
4. M. Sprackling, "Thermal Physics", McMillan (1991).

PHYS-203 WAVES AND OSCILLATIONS Credit Hrs: 02

Course Contents:

Harmonic Oscillator Equation, Complex Number Notation, Simple Pendulum, Transverse Waves: Transverse Standing Waves, Normal Modes, General Time Evolution of a Uniform String, Phase velocity, Group Velocity. Longitudinal Waves: Spring Coupled Masses, Sound Waves in an Elastic Solid, Sound Waves in an Ideal Gas, Traveling Waves: Standing Waves in a Finite Continuous Medium, Traveling Waves in an Infinite Continuous Medium, Energy

Conservation, Reflection and Transmission at Boundaries, Electromagnetic Waves, Wave Pulses: Multi-Dimensional Waves: Plane Waves, Three-Dimensional Wave Equation, Waveguides, Cylindrical Waves, Interference and Diffraction of Waves: Double-Slit Interference, Single-Slit Diffraction.

Recommended Books:

1. J. Pain, "The Physics of Vibrations and Waves", John Wiley, 6th ed. 2005.
2. P. French, "Vibrations and Waves", CBS Publishers (2003).
3. F. S. Crawford, Jr., "Waves and Oscillations", Berkeley Physics Course,Vol. 3, McGraw-Hill, 1968.
4. A. Hirose, and K. E. Lonngren, "Introduction to Wave Phenomena",Krieger Publications, 2003.

PHYS-205 MODERN PHYSICS CREDIT Hrs: 02

Course Contents:

Motivation for Non--Classical Physics: Quantum interference, black body radiation and ultraviolet catastrophe, Planck's quantization. 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 wave function, 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. Concept of tunneling, reflection and transmission of wave functions from barriers, applications: radioactivity, scanning tunneling microscope, decay of black holes. 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 ED's and lasers, in traducing graphene. Nuclear Structure: Size and structure of nucleus, nuclear forces, radioactivity and nuclear reactions, radiocarbon dating.

Recommended Books:

1. R.A. Serway, C.J. Moses, C.A. Moyer, “Modern Physics”, BrooksCole, 3rd ed. (2004).
2. P. A. Tipler, R. A. Llewellyn, “Modern Physics”, W H Freemanand Company 6th ed. (2012).
3. A.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).

PHY- 351 Mathematical Methods ofPhysics-I CreditHrs:03

Course Contents:

Vector Analysis:

Review of vectors Algebra, Vector operations, Physical significance of DEL operator, Line integrals, Surface and Volume Integrals, Gradient of a scalar, Divergence of a vector , Directional derivatives and gradients, Curl of a vector , Gauss’s divergence theorem, Green’s theorem, Vector differentiation and gradient, Vector integration, , Stokes’s Curl theorem, , Cartesian coordinates systems, Polar coordinates systems, Spherical polar and Cylindrical coordinates systems.

Matrices:

Determinants, Matrices, Linear vector spaces, orthogonal matrices, Hermitian matrices, Unitary Matrices, Orthogonalization, Eigenvalues and eigenvectors of matrices, , Similarity transformations, Diagonalization of matrices.

Complex Variables:

Complex numbers , Functions of a complex variable, analytic functions of complex variables, De Moivre’s theorem, Taylor and Laurent series, Cauchy Riemann conditions and analytic functions, Cauchy integral theorem, Cauchy integral formula, Euler’s formula, harmonic functions, complex integration, Contour integrals, singularities and residues, residue theorem.

Recommended Books:

1. G. Arfken, Mathematical Physics, 2nd ed, Academic Press, 1970.
2. Dass H.K, R. Verma, 2011, 6th Edition, Mathematical Physics, S. Chand& Company Ltd. New Delhi.
3. E. Butkov, Mathematical Physics, Addison-Wesley 1968.
4. Pipes and Harvill, Applied Mathematics for Engineers and Physicists, McGraw Hill, 1971.
5. M. L. Boas, Mathematical Methods in Physical Sciences, John Wiley & Sons, New York (1989)
6. M. R. Speigel, Complex Variables Schaum’s Outline Series, McGraw Hill 1979

PHY- 352 Mathematical Methods of Physics-II Credit Hrs: 03

Course Contents:

Differential Equations in Physics: First and second order linear differential equations, partial differential equations in theoretical physics, separation of variables, homogeneous differential equations, Frobenius series solution of differential equations, second solution, non-homogeneous differential equations Special Functions: Bessel functions and Hankel functions, Spherical Bessel

functions, Legendre polynomials, associated Legnedre polynomials, spherical harmonics, Laugerre polynomials, Hermite polynomials Fourier Series: Definition and general properties, Fourier series of various physical functions, Uses and application of Fourier series.

Integral Transforms: The integral transforms, Fourier transform, Convolution theorem, Parseval's theorem, elementary La place transform and its applications Boundary Value Problems and Green's Functions: Boundary3 value problems in Physics, Non-homogeneous boundary value problems and Green's functions, Green's functions for one-dimensional problems, Eigenfunction expansion of Green's function, construction of Green's functions in higher dimensions.

Recommended Books:

1. M.L. Boas, 'Mathematical Methods in Physica Sciences', Jhon Wiley & Sons, New York (1989).
2. C. Wa Wong, 'Introduction to Mathematical Physics', OxfordUniversity 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 Jewrsey (1992)
6. Essential mathematical methods for Physicists, Webber and Arfken

PHY-331 Quantum Mechanics-I Credit Hrs: 03

Course Contents:

Energy the Hamiltonian and angular momentum, The state of a system, Properties of the one dimensional positional function, The works of Planck Black body radiation, The work of Einstein The photo electric effect, The work of Bohr. A Quantum theory of atomic states, Waves versus particles, The De Broglie hypothesis and the Davison-Gamer Experiment, The work of Heisenberg, The work of Born. Probability waves, Observable and operators, Measurement in Quantum Mechanics, The State Function and Expectation values, Time Development of the state function, Particle in a box, The Bohr correspondence principle, Dirac Notation, Hilbert space, Hermitian Operators, Properties of Hermitian operators, The superposition principal, Commutator relations and the uncertainty principal, Schrodinger wave equation, Time department and time independent, One dimensional positional step problem, The rectangular barrier (tunneling), The finite positional well.

Recommended Books:

1. Richard L. Liboff, 4th Edition, Person Education Introductory Quantum Mechanics,
2. Nouredine Zettli, John Wiley & Son, 2001Quantum Mechanics, Concepts and Application,
3. B.H. Bransden & C.J. Joachain: Introduction to Quantum Mechanics' Longman Scientific & Technical London (1990).

4. J. S. Townsedn, ‘A Modern Approach to Quantum Mechanics\, McGraw Hill Book Company, Singapore (1992).
5. W. Greiner, ‘Quantum Mechanics: An Introduction’, Addison Wesley Publishing Company, Reading Massachausetts (1980).
6. R.L. Liboff, ‘Introductory Quantum Mechanics’, Addison Wesley Publishing Company, Reading Massachusetts (1980).
7. Bialynicki-Birula, M. Cieplak & J. Kaminski, Theory of Quantua’, Oxford University Press, New York (1992).
8. W. Greiner, ‘Relativistic Quantum Mechanics’, Springer Verlag. Berlin (1990).
9. F. Schwable, ‘Quantum Mechanics’, Narosa Publishing House, New Delhi (1992)
10. David J. Griffths, Introduction to Quantum Mechanics. Prentice-Hall
11. S. Gasiorowiz, Quantum Physics. John Wiley and Sons Inc. Singapore

PHYS-432 QUANTUM MECHANICS-II Credit Hrs: 03

Course Contents:

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, addition of spherical harmonics, vector operators, Wigner-Eckart theorem, electric Multi-pole moments, Evolution of two angular momenta J1 and J2 coupled by an interaction aJ1 . J2.Stationary Perturbation Theory: Description of the method, perturbation of 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, vibrational method, energy bands of electrons in solids, a simple example of the chemical bond: The ion Applications of Perturbation Theory to Atomic Systems: fine and hyperfine structure of atomic levels in hydrogen, Calculation of the meanvalues of the spin-orbit coupling in the 1s, 2s and 2p levels, hyperfinestructure And the Zeeman effect for muonium and positronium, Stark effect Approximation Methods for Time-Dependent Problems: Statement of theproblem, approximate solution of the Schrodinger equation, An importantspecial case: Sinusoidal or constant perturbation, Interaction of an atom withelectromagnetic waves, linear and non-linear response of a two-level systemsubjected to a sinusoidal perturbation, Oscillations of a system between twodiscrete states under the effect of a resonant perturbation.

Recommended Books:

1. R.L. Liboff, “Introductory Quantum mechanics”, Addison Wesley Publishing Company, Reading Mass. (1980).
2. N. Zettili, “QUANTUM MECHANICS: Concepts and Applications” JOHN WILEY & SONS (2001)

3. J.S. Townsend "A Modern Approach to Quantum Mechanics" McGraw Hill Book Company, Singapore (1992).
4. W. Greiner, "Quantum Mechanics: An Introduction", Addison Wesley Publishing Company, Reading Mass. (1980).
5. Bialynicki-Birula, M. Cieplak, J. Kaminski "Theory of Quantua", Oxford University Press, New York (1992).
6. W. Greiner, "Relativistic Quantum Mechanics", SpringerVerlag, Berlin (1990).
7. F.S. Narosa "Quantum Mechanics", Publishing House, New Delhi (1992).
8. Gasiorowicz, "Quantum Physics", John Wiley & Sons, Inc., Singapore, (2003).
9. D. J. Griffiths, "Introduction to Quantum Mechanics", PRENTICE Hall, Int., Inc, (2005).

PHYS-441 SOLID STATE PHYSICS-I Credit Hrs: 03

Course Outlines:

Crystal structure in 2D and 3D, fundamental types of lattices, index system for crystal planes, simple crystal structures, X-ray diffraction, Braggs law, reciprocal lattice, Diffraction of waves by crystals, scattered wave amplitude, Brillouin zones, crystal binding and elastic constants, Classification of Solids, ionic crystals, covalent crystals, Ionic Radii, II-VI and III-V compounds, Molecular crystals, metals, Cohesive energy, The Lenard Jones Potential, Density, Cohesive energy and Bulk Modulus of crystalline solids, The Madelung constant, Cohesion in Covalent crystals, elastic waves in cubic crystals. Vibration of crystals with monatomic basis, two atoms per primitive basis, quantization of elastic waves, normal vibration modes and phonon, phonon momentum, inelastic scattering by phonons, Phonon heat capacity, lattice heat capacity, Einstein and Debye models, Somerfield model of free electron theory, Energy levels in one dimension, free electron gas in three dimensions, DC and AC electrical conductivity of metals

Recommended Books:

1. C. Kittle, "Introduction to Solid State Physics", John Wiley & Sons, Inc. 7th ed. (2005).
2. N.W. Ashecroft, N. David Mermin "Solid state physics", CBS Publishing Asia Ltd. (2003).
3. J.S. Blakemroe, "Solid State Physics", Cambridge University Press (1991).
4. M.A. Omar "Elementary solid state physics",(2003).
5. N.G.Szwachi and T.Szwacka "Basic elements of crystallography", (2010)
6. R.K.Puri and V.K.BabbarSolid State Physics and electronics", (2007)

PHY-442 Solid State Physics-II Credit Hrs: 03

Course outline:

Transport Properties of Solids: Motion of electron in bands, Effective mass, Electrical conductivity of metals, electrical Conductivity of localized electrons, Boltzmann equation.

Defects in Crystals: Crystal imperfections, Thermodynamics of Point defects, Schottky and Frenkel defects, color centres, Dislocations in Solids, Burgers vectors, edge dislocation, Screw

dislocation Slip and plastic deformation, Stacking faults and grain Boundaries, Strength of Crystals, Diffusion and Fick's law Dielectrics and Ferroelectrics: Maxwell Equations, Polarization, Dielectric Constant and Dielectric Polarizability, Susceptibility, Electronic Polarizablity, Clausius-Mossotti Relation, Structural Phase Transitions, Langevin theory of Dia and Paramagnetism, Ferro-magnetism, Domain theory, Weiss theory of Ferromagnetism, Magnetic relaxation and resonance phenomena.

Semiconductors and Superconductivity: Intrinsic Semiconductors, Extrinsic semiconductors, Band structure, Energy Gap, Donor and acceptor Level, Hall Effect, Superconductivity-an introduction, zero resistivity and Meissner effect, Diamagnetism, susceptibility, Critical field, temperature and current, Type-I and type-II superconductors, BCS theory, electron-phonon-electron interaction via lattice deformation, ground state of superconductors, Cooper pairs, Coherence length, the origin of energy gap, London equations (electrodynamics), London penetration depth, thermodynamics of superconductors, entropy and the Gibbs free energy, Josephson effect, superconductors applications.

Recommended Books Texts:

1. C. Kittle, Introduction to Solid State Physics, 7th edition 1996, John Wiley.
2. S.O.Pillai, Solid State Physics, New Age International Pub. 2003.
3. W.T. Read Jr. Dislocations in crystals, McGraw Hill, 1991.
4. C.M. Kachaava, Solid State Physics, Tata McGraw Hill. Co. New Delhi, 1989.
5. J.R. Christman, Solid State Physics, John Wiley & Sons, New York, 1988.
6. H.E. Hall, Solid State Physics, John Wiley & Sons, New York, 1982.
7. A. Guinier & R. Jullien, The Solid State, Oxford University Press, Oxford, 1989.

PHY-443 Atomic and Molecular Physics Credit Hrs: 03

Course outline:

Nuclear Atom, Rutherford's Scattering formula, Electron Orbits, Atomic spectra, The Bohr's atom, Energy levels and spectra, Origin of line spectra, Correspondence Principle, Nuclear motion, Atomic excitation, Laser, Wave function, Wave equation, Time dependant and Time independent Schrödinger equation, Harmonic oscillator, Schrödinger equation for Hydrogen Atom, Separation of variables, Quantum Numbers, Electron Probability Density, Radiative transitions, Selection rules, Zeeman effect, Electron spin, Strern-Gerlach experiment, Pauli Exclusion Principle, Symmetric and anti-symmetric wave functions, Periodic table, atomic structure, Explanation of Periodic table, Spin orbit coupling, Total angular momentum, LS

coupling, JJ coupling, Term symbols, X-ray spectra, Discrete X-ray spectra, Continuous X-ray Spectra, Auger effect.

Molecular bond, Electron sharing, H2+ molecular ion, Hydrogen molecule, complex molecules, Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational spectra, Vibration – Rotation spectra, Electron spectra of molecules

Recommended Books:

1. Anne, P. T.; 1988: Spectroscopics, 2nd edition Chapman
2. Bransden, B. H. and Joachain, C. J.; 1983: Physics of Atoms and Molecules. Longmans, London.
3. Eisberg, R. and Resnick, R.; 1985: Quatum Physics of Atoms, Molecules, Solids, Nuclie and Prtaicles, 2nd Edition. John Wiley and Sons.
4. Laud, B. B.; 1991: Lasers and Non-linear Optics, 2nd Edition. Wiley Eastern Limited. New Delhi
5. Koichi, S.; 1983: Introduction to laser's Physics. Springer verlag
6. Beiser, A. 1987: Concepts of Modern Physics. 4th edition. McGraw-Hill Book Company

PHY-493 Nuclear Physics Credit Hrs: 03

Course outline:

Nuclear Decay and Radioactivity: The basis of theory of radioactive disintegration, the disintegration constant, the half-life and the mean life, successive radioactive transformation, radioactive equilibrium, the natural radioactive series, units of radioactivity.

Alpha Decay: Why alpha decay occurs, Basic alpha decay process, the velocity and energy of alpha particle, Abortion of alpha particles: Range, ionization, and stopping power, Alpha decay systematic, Theory of alpha decay emission, Angular momentum and parity in alpha decay, Alpha decay spectroscopy

Beta Decay: Energy release in beta decay, Fermi theory of beta decay, The experimental test of Fermi theory, Angular momentum and parity selection rules, Neutrino Physics, Double beta decay, Beta-delayed nucleon emission, Gamma decay: Energetic of gamma decay, Classical electromagnetic radiation, Transition to quantum mechanics.

Nuclear Fission: Why Nuclear Fission, Characteristics of nuclear fission, Energy in fission, Fission and nuclear structure, Controlled fission reaction, Fission reactors, Radioactive fission products.

Nuclear Fusion: Basic nuclear fusion process, Characteristic of fusion, Solar fusion, Controlled fusion reactor.

Recommended Books:

1. K.S. Krane 'Introductory Nuclear Physics' John-Wiley (1987).
2. D. Evans 'The Atomic Nucleus' McGraw-Hill (1955).

3. W.E. Meyerhof 'Elements of Nuclear Physics' McGraw-Hill (1989).
4. B.L. Cohen 'Comcepts of Nuclear Physics' McGraw-Hill (1971).
5. L. Kaplan 'Nuclear Physics' Addison-Wesely (1979).
6. R. E. Lapp and H.L. Andrews 'Nuclear Radiation Physics' Prentice-Hall (1972).
7. H. A. Enge 'Introduction to Neclear Physics' Addison-Wesley (1969)

PHYS-000 DIGITAL ELECTRONICS Credit Hrs: 03

Course outline:

Review of Number Systems: Binary, Octal and Hexadecimal number system, their inter-conversion, concepts of logic, truth table, basic logic gates.Boolean Algebra: De Morgan's theorem, simplification of Booleanexpression by Boolean Postulates and theorem, K-maps and their uses.Don't care condition, Different codes. (BCD, ASCII, Gray etc.). Parity inCodes.IC Logic Families: Basic characteristics of a logic family. (Fan in/out,Propagation delay time, dissipation, noise margins etc. Different logic basedIC families (DTL, RTL, ECL, TTL, CMOS).Combinational Logic Circuit: Logic circuits based on AND – OR, OR-AND,NAND, NOR Logic, gate design, addition, subtraction (2's compliments, halfadder, full adder, half subtractor, full subtractor encoder, decoder, PLA.Exclusive OR gate.Sequential Logic Circuit: Flip-flops clocked RS-FF, D-FF, T-FF, JK-FF,Shift Register, Counters (Ring, Ripple, up-down, Synchronous) A/D and D/AConverters.Memory Devices: ROM, PROM, EAPROM, EE PROM, RAM, (Static anddynamic) Memory mapping techniquesMicro Computers: Computers and its types, all generation of computers,basic architecture of computer, micro processor (ALU, UP Registers, Controland Time Section). Addressing modes, Instruction set and their types,Discussion on 8085/8088, 8086 processor family, Intel MicroprocessorHierarchyMicro-controller/ Embedded System: Introduction to Embedded andmicrocontroller based systems, The Microprocessor and microcontrollerapplications and environment, microcontroller characteristics, features of ageneral purpose microcontroller, Microchip Inc and PIC microcontroller,Typical Microcontroller examples:, Philips 80C51 & 80C552 and Motorola68Hc05/08, interfacing with peripherals.

Recommended Books:

1. M. M. Mono, "Digital Logic and Computer Design", Prentice Hall, (1995).
2. R. Tokheim, "Digital Electronics", McGraw Hill, 7th ed. (2007).
3. B.B. Brey, "The Intel Microprocessors: Architecture, Programming andInterfacing", Merril, 2nd ed. (1991).
4. T.L. Floyd, "Electronics Fundamentals: Circuits, Devices andApplications", Prentice Hall, 8th ed. (2009).
5. T. Wilmshurst, "The Design of Small-Scale Embedded Systems",Palgrave, (2001).

PHYS-000 **METHOD OF EXPERIMENTAL PHYSICS** **CREDIT Hrs: 03**

Course outline:

Vacuum Techniques: Gas Transport: Throughout, Pumping Speed, Pump down Time Ultimate pressure. Fore-Vacuum Pumps: Rotary Oil pumps, sorption pumps. Diffusion pumps, sorption pumps (High Vacuum). Production of ultrahigh vacuum, Fundamental concepts, guttering pumps, Ion pumps, Cryogenic pumps, Turbo molecular pumps. Measurement of total pressure in Vacuums Systems, Units pressure ranges, Manometers, Perini gauges, TheMcLoad gauges, Mass spectrometer for partial measurement of pressure, Design of high Vacuum system, Surface to Volume ratio, Pump Choice, pumping system design. Vacuum Components, Vacuum valves, vacuum Flanges, Liquid Nitrogen trap, Mechanical feed through & Electrical feed through Leak detection: Basic consideration, leak detection equipment, Special Techniques and problems, Repair Techniques, Radiation Detection and Measurement: GM tubes, scintillation detector,channeltron, photo multipliers, neutron detectors, alpha/beta detectors, x-rays/gamma detectors, cosmic rays detectors, Spectrographs and Interferometers, Sensor Technology: Sensors for temperature, pressure displacement, rotation, flow, level, speed, rotation position, phase, current voltage, power magnetic field, tilt, metal, explosive and heat, Electronics and Electronic Instruments: Operational amplifiers, summing amplifiers, difference amplifiers, Differentiators, Integrators, Logarithmic amplifiers, current to voltage converter, Spectroscopy amplifiers, charge sensitive pre-amplifiers, Coincidence circuits, Isolators, Ramp Generators, and single channel analyzer. Power supplies, Signal Generators, Counters, Multichannel analyzer, Lock in Amplifiers, Boxcar averages, Computer Introduction: Introduction to computers, GPIB Interface, RS 232.Interfacing, DA/AD conversion, Visual c/visual Basic, Data Analysis: Evaluation of measurement: Systematic Errors, Accuracy,Accidental Errors, Precision, Statistical Methods, Mean Value and Variance,Statistical Control of Measurements, Errors of Direct measurements,Rejection of data, Significance of results, Propagation of errors, preliminaryEstimation, Errors of Computation. Least squares fit to a polynomial, Nonlinear functions, Data manipulation, smoothing, interpolation andextrapolation, linear and parabolic interpolation.

Recommended Books:

1. F. James, “Statistical Methods in Experimental Physics”, World Scientific Company, 2nd ed. 2006.
2. M. H. Hablanian, “High-Vacuum Technology”, Marcel Dekker, 2nd ed.1997.
3. P. Bevington and D. K. Robinson, “Data Reduction and Error Analysis forPhysical Science”, McGraw-Hill, 3rd ed. 2002.

PHYS- 000 INTRODUCTION TO NANO SCIENCE AND NANOTECHNOLOGIES Credit Hrs: 03

Course outline:

Introduction: Feynman talks on small structures, Nano scale dimension, Course goals and objectives, Quantum Effects: Wave particle duality, Energy quanta, Uncertaintyprinciple, De Broglie relation, Quantum Dots, Moore's law, tunneling, Surfaces and Interfaces: Interfaces, Surface chemistry and physics,Surface modification and characterization, Thin Films, Sputtering, Self assembled films, Material Properties: Subatomic physics to chemical systems, types ofchemical bonds, solid state physics / Material properties, Tools and Instrumentation: STM, AFM, Electron Microscopy, Fluorescence, methods, Synchrotron Radiation, Fabricating Nano Structures: Lithography (photo and electron beam), MBE,Self-assembled masked, FIB, Stamp technology, Nano junctions, Electrons in Nano Structures: Variation in electronic properties, freeelectron model, Bloch's theorem, Band structure, Single electron transistor, Resonant tunneling, Molecular Electronics: Lewis structures, Approach to calculate Molecularorbitals, Donor Acceptor properties, Electron transfer between molecules,Charge transport in weakly interacting molecular solids, Single molecule electronics, Nano Materials: Quantum dots, nano wires, nano photonics, magnetic nanostructures, Nano thermal devices, Nano fluidic devices, biomimetic materials, Nano Biotechnology: DNA micro-arrays, Protein and DNA Assembly, Digitalcells, genetic circuits, DNA computing, Nanotechnology the Road Ahead: Nanostructure innovation, QuantumInformatics, Energy solutions.

Recommended Books:

1. E.L. Wolf: Nanophysics and Nanotechnology,
2. An introduction to Modern Concept in Nanoscience, Wiley VCH, (2004)
3. A. Ratner, D. Ratner, “Nanotechnology: A Gentle Introduction to the Next Big Idea”, Prentice Hall Professional, (2003).
4. J I Goldstein et al, Scanning Electron Microscopy and X-ray Microanalysis, Kluwer Academic/Plenum Publishers, (2003).
5. S. Lindsay, “Introduction to Nanoscience”, Oxford University Press, (2009).
6. C. Binns, “Introduction to Nanoscience and Nanotechnology’ Wiley(2010).

PHYS-000 INTRODUCTION TO PHOTONICS Credit Hrs: 03

Course outline:

Guided Wave Optics: Planar slab waveguides, Rectangular channelwaveguides, Single and multi-mode optical fibers, waveguide modes andfield distributions, waveguide dispersion, pulse propagationGaussian Beam Propagation: ABCD matrices for transformation ofGaussian beams, applications to simple resonatorsElectromagnetic Propagation in Anisotropic Media: Reflection andtransmission at anisotropic interfaces, Jones Calculus, retardation plates,polarizersElectro-optics and Acousto-optics: Linear electro-optic effect, Longitudinaland transverse modulators, amplitude and phase modulation, Mach-Zehndermodulators, Coupled mode theory, Optical coupling between waveguides,Directional couplers, Photoelastic effect, Acousto-optic interaction and Bragg's diffraction, Acousto-optic modulators, deflectors and scannersOptoelectronics: p-n junctions, semiconductor devices: laser amplifiers,injection lasers,photoconductors, photodiodes, photo detector noise.

Recommended Books:

1. B. E. A. Saleh and M. C. Teich, "Fundamentals of Photonics", John Wiley,2nd ed. (2007).
2. J-M. Liu, "Photonic Devices", Cambridge University Press, (2009).
3. A. Yariv and P. Yeh, "Photonics: Optical Electronics in Modern Communications", Oxford University Press, (2006).
4. E. Hecht, "Optics", Addison-Wesley, 4th ed. (2001).

PHYS-000 INTRODUCTION TO MATERIALS SCIENCE Credit Hrs: 03

Course outline:

Atomic Structure of Materials: The packing of atoms in 2-D and 3-D, unitcells of the hexagonal close packing (hcp) and cubic closed packing (ccp)structures, interstitial structures, density computation, lattices and symmetry elements, indexing lattice directions and lattice planes, interplanar spacing,lattices and crystal systems in 3-D, symmetry, crystallographic point groupsand space groups, Bragg's law and the intensities of Bragg reflections, Imperfections in Solids: Vacancies, impurities, dislocations, interfacialdefects, bulk or volume defects, atomic vibrations, Microstructure and microscopy, pressure vs. temperaturephase diagrams, temperature vs. composition phase diagrams, equilibrium,thermodynamic functions, variation of Gibbs energy with temperature andcomposition, general features of equilibrium phase diagrams, solidification, diffusion mechanisms, nucleation of a new phase, phase diagrams of Fe-Csystem and other important alloys, materials fabrication, Mechanical Behavior of Materials: Normal stress and normal strain, shear stress and shear strain, elastic deformation, plastic deformation,

Young's modulus, shear modulus, Poisson's ratio, elastic strain energy, thermal expansion, estimate of the yield stress, dislocations and motion ofdislocations, slip systems, dislocations and strengthening mechanisms,fracture mechanics, ductile fracture, brittle fracture, Griffith criterion, ductilefracture, toughness of engineering materials, the ductile-brittle transitiontemperature, cyclic stresses and fatigue, creep, Polymer basics, polymer identification, polymer molecules,additional polymerization, step growth polymerization, measurement ofmolecular weight, thermosetting polymers and gels, rubbers and rubberelasticity, configuration and conformation of polymers, the glassy state andglass transition, determination of T_g, effect of temperature and time,mechanical properties of polymers, case studies in polymer selection and processing, Biomaterials: Introduction to biomaterials, materials selection, biopolymers,structural polysaccharides, hard materials, biomedical materials.

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).

PHYS-000 LASERS Credit Hrs: 03

Course outline:

Introductory Concepts: Spontaneous Emission, Absorption, StimulatedEmission, Pumping Schemes, Absorption and Stimulated Emission Rates, Absorption and Gain Coefficients, Resonance Energy Transfers. Properties of Laser Beam: Mon chromaticity, Coherence, Directionality, Brightness Spectroscopy of Molecule and Semiconductors: Electronic Energy Levels, Molecular Energy Levels, Level Occupation at Thermal Equilibrium, Stimulated Transition, Selection Rules, Radiative and Non-radiative Decay,SemiconductorOptical Resonators: Plane Parallel (Fabry-Perot) Resonator, Concentric(Spherical) Resonator, Confocal, Resonator, Generalized Spherical Resonator, Ring Resonator, Stable Resonators, Unstable Resonators. ,Matrix Formulation of Geometrical Optics, Wave Reflection and Transmissionat a Dielectric Interface, Stability Condition Standing and Traveling Waves ina two Mirror Resonator, Longitudinal and Transverse Modes in a Cavity,Multilayer Dielectric Coatings, Fabry-Perot Interferometer. Small Signal Gainand Loop Gain Pumping Processes: Optical pumping: Flash lamp and Laser, Threshold Pump Power, pumping efficiency, Electrical

Pumping: Longitudinal Configuration and Transverse Configuration, Gas Dynamics Pumping,Chemical Pumping, Continuous Wave (CW) and Pulsed Lasers: Rate Equations, ThresholdCondition and Output Power, Optimum Output Coupling, Laser Tuning,Oscillation and Pulsations in Lasers, Q-Switching and Mode-LockingMethods, Phase Velocity, Group Velocity, and Group-Delay Dispersion, Line broadening, Lasers Systems: Solid State Lasers: Ruby Laser, Nd: YAG &Nd: GlassLasers and Semiconductor Lasers: Homojunction Lasers Double-Heterostructure lasers, Gas lasers: Helium Neon laser, CO2 laser, NitrogenLaser and Excimer Lasers, Free-Electron and X-Ray Lasers, Laser Applications: Material Processing: Surface Hardening, Cutting, Drilling, Welding etc, Holography, Laser Communication, Medicine, DefenseIndustry, Atmospheric Physics.

Recommended Books:

1. O. Svelto, "Principles of Lasers", Springer, 5th ed. (2009).
2. J. Eberly and P. Milonni, "Lasers Physics", John Wiley, 2nd ed. (2010).
3. M. O. Scully and M. S. Zubairy, "Quantum Optics", Cambridge University Press, 1997.
4. W. T. Silfvast, "Laser Fundamentals", Cambridge University Press, 2nd ed. (2008).
5. W. M. Steen, J. Mazumder and K. G. Watkins, "Laser Material Processing", Springer, 4th ed. (2010).

PHYS-000 PARTICLE PHYSICS Credit Hrs: 03

Course outline:

Particle Classification, Quantum numbers, leptons, hadrons, baryons, mesons, quarks, The Fundamental Interactions, The electromagnetic coupling, the strong coupling, the weak coupling, Symmetry Transformation and Conservation Laws, Translation in space, rotation in space, the group SU (2), systems of identical particles, parity, iso-spin charge conjugation, time reversal, G parity, CPT theorem, The Electromagnetic Field, Gauge invariance and Maxwell's equations, polarization ad photon spin, angular momentum, parity and C parity of photon, Hadron Spectroscopy, Formation experiment, partial wave formalism and the optical theorem, the Breit-Wigner resonance formula, baryon resonances, phase space considerations, production experiments, The Quark Model, The group SU (3), quarks, hadrons baryons, mesons in quark model, heave meson spectroscopy, the quarkonium model, The Standard Model (qualitative treatment only), Unification of weak and electromagnetic interactions Glashow-Salam-Weinberg Model.

Recommended Books:

1. J.D.Bjorken and S.D Drell, "Relatvistic Quantum Mechanics", McGraw Hill, (1995).

2. F. Halzen, and A.D.Martin , “Quarks and Leptons”, John-Wiley and Sons. (1984).
3. Riazuddin and Fayyazuddin, “Quantum Mechanics”, World Scientific, (1990).
4. D.Griffiths, “Introduction to Elementary Particles”, John-Wiley and Sons, (1987).

PHYS-000 PLASMA PHYSICS Credit Hrs: 03

Course outline:

Introduction: Occurrence of plasma, Concept of temperature, Debyeshielding, the plasma parameter, Criteria for plasma, Applications of Plasma Physics: Single-particle motion in electromagneticfield, Uniform and non-uniform E and B fields, Time-variant E and B fields,Fluid description of plasma, Wave propagation in plasma, Derivation ofdispersion relations for simple electrostatic and electromagnetic modes,Introduction to Controlled Fusion, Basic nuclear fusion reactions, Reactionrates and power density, radiation losses from plasma, operationalconditions.

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: withspace and laboratory application”, Cambridge University Press, (2005).
3. T. J. M. Boyd and J. J. Sanderson, “The Physics of Plasmas”, Cambridge University Press, (2003).

PHYS-000 PLASMA PHYSICS Credit Hrs: 03

Course outline:

Basics of Surface Science: Surface reactions, Heterogeneous catalysis,Semiconductor technology, Corrosion, Nanotechnology, Surface Structureand Reconstruction: Electronic Structure of Surfaces: Band structure of metals,insulators and semiconductors, Fermi level, Screening, Work Function,Surface States, Electron Affinity, Ionization Potential, Surface Chirality,Thermodynamics of Surfaces, Equilibrium Crystal Shape, Quantum confinement of Electrons at Surfaces: Interference of ElectronWaves, Quantum size effects, Quantum wells, Mechanical Quantum Wells,Quantum Wires, Chemist’s Approach, Bonds to Bands, Surface Dynamics: Nucleation and growth of nanostructures and filmsSurface Magnetism and magnetic imaging, Diamagnetism, Paramagnetism,Anti-Ferromagnetism, Magnetism in thin films, , Magnetic Force Microscopy (MFM).Surface Study Techniques: Surface Sensitivity and specificityAuger Electron Spectroscopy (AES), X-Ray Photo-electronSpectroscopy, Scanning

TunnelingMicroscopy (STM), Photovoltaic and Organic Electronics: Different types of semiconductors(organic, inorganic, conjugated polymers), intra-molecularbonding, Van der Waals, electronic properties, polarization effects,Field effect Transistors, basics of excitonic solar cells.

Recommended Books:

1. A. Zangwill, "Physics at Surfaces", Cambridge University Press, (1988).
2. D. P. Woodruff and T. A. Delchar, "Modern Techniques of SurfaceScience", Cambridge University Press, 2nd ed. (1994).
3. D. Briggs and M. P. Seah, "Practical Surface Analysis", Vol-I, John Wiley,2nd ed. (1990).
4. J. B. Hudson, "Surface Science, an Introduction", Wiley-Interscience,(1998).
5. H. Luth, "Surfaces and Interfaces of Solids", Springer-Verlag, 2nd ed.(1993).
6. M. Prutton, "Introduction to Surface Physics", Oxford University Press,(1994).
7. R. I. Masel, "Principles of Adsorption and Reaction on Solid Surfaces",Wiley-Interscience, (1996).

PHYS-000 ELECTRONIC MATERIALS AND DEVICES Credit Hrs: 03

Course outline:

Semiconductor Fundamentals: Composition, purity and structure ofsemiconductors, energy band model, band gap and materials classification,charge, effective mass and carrier numbers, density of states, the Fermifunction and equilibrium distribution of carriers, doping, n and p-typesemiconductors and calculations involving carrier concentrations, EF etc.,temperature dependence of carrier concentrations, drift current, mobility,resistivity and band bending, diffusion and total currents, diffusioncoefficients, recombination-generation, minority carrier life times andcontinuity equations with problem solving examples, Device Fabrication Processes: Oxidation, diffusion, ion implantation,lithography, thin-film deposition techniques like evaporation, sputtering,chemical vapor deposition (CVD), epitaxy etc.PN Junction and Bipolar Junction Transistor: Junction terminology,Poisson's equation, qualitative solution, the depletion approximation,quantitative electrostatic relationships, ideal diode equation, non-idealities,BJT fundamentals, Junction field effect transistor, MOS fundamentals, the essentials of MOSFETs, Dielectric Materials, Optoelectronic and spintronics devices Magnetism and Magnetic Materials, data storage devices.

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).

PHYS-000 ENVIRONMENTAL PHYSICS Credit Hrs: 03

Course outline:

Introduction to the Essentials of Environmental Physics: The economic system, living in green house, enjoying the sun, Transport of matter, Energy and momentum, the social and political context, Basic Environmental Spectroscopy: Black body radiation, The emission spectrum of sun, The transition electric dipole moment, The Einstein Coefficients, Lambert – Beer’s law, The spectroscopy of bi-molecules, Solar UV and life, The ozone filter, The Global Climate: The energy Balance, (Zero-dimensional GreenhouseModel), elements of weather and climate, climate variations and modeling, Transport of Pollutants: Diffusion, flow in reverse, ground water. Flowequations of fluid Dynamics, Turbulence, Turbulence Diffusion, Gaussianplumes in air, Turbulent jets and planes, Noise: Basic Acoustics, Human Perceptions and noise criteria, reducing thetransmission of sound, active control of sound, Radiation: General laws of Radiation, Natural radiation, interaction ofelectromagnetic radiation and plants, utilization of photo synthetically active radiation, Atmosphere and Climate: Structure of the atmosphere, vertical profiles inthe lower layers of the atmosphere, Lateral movement in the atmosphere,Atmospheric Circulation, cloud and Precipitation, The atmospheric greenhouse effect, Topo Climates and Micro Climates: Effects of surface elements in flat andwidely unduling areas, Dynamic action of seliq. Thermal action of selief, Climatology and Measurements of Climate Factor: Data collection andorganization, statistical analysis of climatic data, climatic indices, Generalcharacteristics of measuring equipment. Measurement of temperature, air humidity, surface wind velocity, Radiation balance, precipitation, Atmospheric Pressure, automatic weather stations.

Recommended Books:

1. E. Booker and R. Van Grondelle, “Environmental Physics”, John Wiley, 3rd ed. (2011).
2. G. Guyot, “Physics of Environment and Climate”, John Wiley, (1998).

PHYS-101L LAB-I (MECHANICS) Credit Hrs: 01

Course outline:

Experiments with pendulums, stop watches, one-dimensional motion and verification of Newton's laws of motion, measurement of forces, speed, acceleration and linear momentum,

collisions and conservation of momentum, impacts, free fall and acceleration due to gravity, gyroscopes, rotational motion, conservation of angular momentum, friction, static and dynamic equilibrium, compound pendulum, rolling motion along inclined planes, simple harmonic motion, masses attached to springs and Hooke's law, damped motion and the regimes of damping (overdamped, underdamped and critically damped), pressure in fluids, experiments demonstrating continuity, Bernoulli's principle, buoyancy and Archimedes' principle, Atwood machine, fluid viscosity, surface tension.

PHYS-102LLAB-II (Heat and thermodynamics) Credit Hrs: 01

Course outline:

Heat: Calorimetry, heat transfer, Newton's cooling under ambient and forced convection and radiation, measurement of temperature using Si diodes, thermistors, thermocouples and RTD's, blackbodies, heat pumps and heat engines, investigation of gas laws and laws of thermodynamics, thermal conductivity by pulsed heating of a metal rod, measurement of latent heats and specific heat capacities, temperature control using PID (proportional-integral derivative) schemes, thermal expansivity and its measurement using strain gauges.

PHYS-103L LAB-III (ELECTRICITY AND MAGNETISM) Credit Hrs: 01

Course outline:

Static charge and electric fields, direct and alternating currents, electrical measurement instrumentation (voltmeters, ammeters, power supplies, variable transformers, cathode ray oscilloscope, electrometer), passive electronic components (resistors, capacitors, inductors), measurement of resistance, capacitance and inductance, electromagnetic induction, inductors and transformers, motors, magnetic fields due to currents and permanent magnets, ferromagnetism and ferroelectricity, determination of hysteresis curves, determination of Curie point, magnetic susceptibility and its temperature dependence, dielectric properties measurement, mapping of magnetic fields using Hall sensors, experiments on noise, properties of the light bulb

PHYS-104L LAB-IV (Waves and oscillations) Credit Hrs: 01

Course outline:

Resonance in a stretched string, normal modes of oscillation, dispersion relations for mono and diatomic lattice, coupled oscillators, nonlinear oscillations exemplified by resistance inductance-diode circuits, magnetic pendulums, accelerometers, measurement of the speed of sound under conditions of varying temperature, Lorentz pendulum, waves in water, beats.

PHYS-105L LAB-V (ELECTRONICS) Credit Hrs: 02

Course outline:

DC voltages and current measurement, simple DC circuits,generating and analyzing time-varying signals, opamps and comparators,amplifier design, RC transients, filters, frequency response, LC circuits,resonance, transformers, diodes, modulation and radio reception, MOSFETcharacteristics and applications, principles of amplification, bipolar transistorsand amplifiers, digital logic circuits, gates and latches, D-flip flops and shiftregisters, JK flip-flops and ripple counters.

PHYS-106L LAB-VI (MODERN PHYSICS) Credit Hrs: 02

Course outline:

photoelectric effect, determination of Planck's constant (e.g. using a light bulb), verificationof Moseley's law using X-ray fluorescence, Compton effect, Millikan'sexperiment for determination of charge of electron, properties of nuclearradiation,Geiger-Muller tubes, cloud chambers, energy spectroscopy ofgamma rays, experiments on medical physics.