# GC UNIVERSITY, FAISALABAD


# Scheme of Studies

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## M.Sc Physics

*4 Semesters / 2 years Degree Program for the year 2014 and onward*

**Department of Physics**

## MSc Physics 4 Semesters (2 years program)

| Code | Title | Credit Hour |
|---|---|---|
| **Semester 1** | | |
| PHY-551 | Methods of Mathematical Physics-I | 3 (3 – 0) |
| PHY-553 | Classical Mechanics | 3 (3 – 0) |
| PHY-555 | Electrodynamics-I | 3 (3 – 0) |
| PHY-557 | Electronics-I | 3 (3 – 0) |
| PHY-559 | Relativity and Cosmology | 3 (3 – 0) |
| PHY-561 | Lab Course-I (Electromagnetism) | 3 (0 – 3) |
| | **Total** | **18** |
| **Semester 2** | | |
| PHY-552 | Methods of Mathematical Physics-II | 3 (3 – 0) |
| PHY-554 | Quantum Mechanics-I | 3 (3 – 0) |
| PHY-556 | Nuclear Physics-I | 3 (3 – 0) |
| PHY-558 | Electrodynamics-II | 3 (3 – 0) |
| PHY-560 | Electronics-II | 3 (3 – 0) |
| PHY-562 | Lab Course-II (Atomic & Nuclear Physics) | 3 (0 – 3) |
| | **Total** | **18** |
| **Semester 3** | | |
| PHY-651 | Quantum Mechanics-II | 3 (3 – 0) |
| PHY-653 | Nuclear Physics-II | 3 (3 – 0) |
| PHY-655 | Statistical Mechanics | 3 (3 – 0) |
| PHY-657 | Solid State Physics-I | 3 (3 – 0) |

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| PHY-659 | Particle Physics-I* | 3 (3 – 0) |
| PHY-661 | Advanced Electronics* | 3 (3 – 0) |
| PHY-663 | Environmental Physics-I* | 3 (3 – 0) |
| PHY-665 | Health and Medical Physics-I* | 3 (3 – 0) |
| PHY-667 | Climatology and Metrology-I* | 3 (3 – 0) |
| PHY-669 | Lab Course-III (Electronics) | 3 (0 – 3) |
| | **Total** | **18/15**** |
| **Semester 4** | | |
| PHY-652 | Plasma Physics | 3 (3 – 0) |
| PHY-654 | Computational Physics | 3 (3 – 0) |
| PHY-656 | Solid State Physics-II | 3 (3 – 0) |
| PHY-658 | Laser and Optics | 3 (3 – 0) |
| PHY-660 | Particle Physics-II* | 3 (3 – 0) |
| PHY-662 | Advanced Electronics Lab Course* | 3 (3 – 0) |
| PHY-664 | Environmental Physics Lab Course | 3 (3 – 0) |
| PHY-666 | Health and Medical Physics -II* | 3 (3 – 0) |
| PHY-668 | Climatology and Metrology-II* | 3 (3 – 0) |
| PHY-679 | Seminar | 1 (1 – 0) |
| PHY-680 | Thesis*** | 6 (0 – 6) |
| PHY-681 | Project** | 3 (0 –3) |
| | **Total** | **16/19**** |

**Note:**

* One optional subject to be chosen in 3rd and 4th semester.

** Projects may be opted in lieu of option-II of the subject already taken by the student in 3rd semester.

*** Thesis will be allotted in the 3rd semester. However, the credit hours for thesis will only count towards the 4th semesters.

+ Internship will be offered to students during summer vacations as an optional activity.

# M.Sc Physics

## 1st Semester

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| PHY-551 | Methods of Mathematical Physics-I | 3 (3 – 0) |

Vector operations, Physical significance of DEL operator, Gauss's divergence theorem, Green's theorem, Stokes's theorem, Orthogonal curvilinear coordinates system, Gradient, Divergence, Curl and Laplacian in orthogonal curvilinear coordinates, Spherical polar and Cylindrical coordinates systems. Complex numbers, Euler's formula, De Moivre's theorem, elementary functions, analytic functions of complex variables, Cauchy-Riemann equation, harmonic functions, complex integration, Cauchy's theorem, Cauchy's integral formula, Taylor and Laurent series, Contour integrals, singularities and residues, residue theorem, branch points and integrals of multivalued functions. Tensors Analysis and applications.

Recommended Books:


1. Dass H.K, R. Verma, 2011, 6th Edition, Mathematical Physics, S. Chand & Company Ltd. New Delhi.
2. Kreyszig E. 2011, 10th Edition, Advanced Engineering Mathematics. Wiley, New York.
3. Riley K F, M P Hobson and S J Bence. 2006, 3rd Edition, Mathematical Methods for Physics and Engineering, Cambridge University Press, Cambridge.
4. Arfken G.B and H.J Weber, F.E Harris, 2012, 7th Edition, Mathematical Methods for Physicists, A. Press, New York.
5. Spiegel M.R 2009, 1st Edition Advanced Mathematics for Engineers and Scientists, Schaum's outlines series, McGraw Hill.
6. Collins R.E, 2011, 2nd Edition, Mathematical Methods for Physicists and Engineers, Dover Publications.
7. Tang K.T, 2010, 2nd Edition, Mathematical Methods for Engineers and Scientists 2, Springer.


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| PHY-553 | Classical Mechanics | 3 (3 – 0) |

Historical development of classical mechanics, Newtonian mechanics of single particle & system of particles, constraints, generalized coordinates, D'Alembert's Principle , Derivation of Lagrange's equations, simple applications of the lagrangian formulation, Hamilton's Principle, Techniques of the calculus of variation, Derivation of Lagrange's equation from Hamilton's principle, Applications of Hamilton's principle, shortest distance between two points in a plane and space, minimum surface of revolution, the Brachistochrone problem, conservation theorem , Two body central force problem & its reduction to the equivalent one body problem, Kepler's law as an inverse square law problem, Differential equation for the orbits and the different shapes of the orbit, planetary orbits & their equations, Legendre transformations and its applications, Derivation of Hamilton's equation of motion, Hamiltonian, cyclic coordinates, Routh's Procedure, The equations & examples of canonical transformations, Poisson's brackets & their properties, Poisson's brackets & other canonical invariants, Poisson's theorem, invariance of Poisson's bracket under canonical transformation.

Recommended Books:

1. Goldstein H, P Charle and J L Safko. 2001, Classical Mechanics. Addison-Wesley.
2. Hand L N and J.D Finch. 1998, Analytical Mechanics. Cambridge University Press, Cambridge.
3. Barger V D and M G Olsson. 1995, Classical Mechanics. McGraw-Hill, New York.
4. Landau L D and E M Lifshitz. Mechanics. 1960, Pergamon, Oxford.
5. Classical Mechanics by J.W. Leech Methuen and Co. Ltd., London, 1958.

| PHY-555 | Electrodynamics-I | 3 (3 – 0) |
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*Electric dipole*, Electric field and electric potential at a point due to dipole, mutual interaction energy of two dipoles, Force and Couple on the dipole placed in an external electric field, *Dielectrics:* Polarization and polarization density vector, surface and volume charge densities due to polarization, electric field inside the dielectric, electric susceptibility and dielectric constant, *Poisson and Laplace equations* both for dielectric and space, Solution to Laplace equation in Cartesian, spherical and cylindrical coordinates, Uncharged conducting and dielectric sphere in uniform electric field, Electrostatic Images, Point charge near an infinite grounded conducting plane, Electric potential, electric field intensity and surface charge density in case of point charge and conducting sphere.*Electric current:* nature of electric current, current density, equation of continuity, Ohm's law, steady current in media without source of e. m. f., Approach to electrostatic equilibrium, *Magnetic properties of steady current:* Current carrying element, Force on current carrying conductor, Biot-savart law and their applications, Ampere's circuital law and their applications, Magnetic vector and scalar potential, Magnetic field of a distant circuit, *Magnetic properties of matter*: Magnetization vectors M, Magnetic current densities due to surface and volume currents and vector potential, Magnetic field due to the magnetized material, Magnetic scalar potential and pole density, Magnetic intensity vector H, Relation between H and M, Field equation, Magnetic susceptibility and permeability, Boundary conditions on the field vectors.

Recommended Books:

1. Griffiths D.J. 1999, Introduction to Electrodynamics, 3rd Edition
2. John R. Reitz, 1992, Foundations of Electromagnetic Theory, 4th Edition

| PHY-557 | Electronics-I | 3 (3 – 0) |
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Liner network analysis; superposition, Thevenin, Norton and Mill man's theorems, Electronics: the p-n junction, Bias the p-n junction diode, diode, characteristics of diode, different models and types of diodes, half-wave and full-wave rectifier, full-wave bridge rectifier, capacitor, inductive, and πR filters, Clipping and clamping circuits, Zener voltage regulators, regulated power supply, varactor diodes, Optical diodes, Light emitting Diodes. Bipolar junction transistor (BJT), transistor characteristics, biasing circuits such as base bias, emitter bias, voltage-divider bias, feedback bias circuits, amplifier classifications, common emitter amplifier, the emitter followers, the common base amplifier. RC-coupled amplifiers, Power amplifiers, (class A, class B amplifiers, class C amplifier), introduction to Junction field-effect transistors (JFET), JFET biasing circuits, the common source follower, introduction to MOSFET.

Recommended Books:

1. Floyd, T. L. 2010. Electronic Devices 9TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
2. Nashelsky, L. & Robert, L. B. 2009. Electronic Devices and Circuit Theory 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
3. Malvino, A. P. 2008. Electronic Principles. 7TH Ed. Glencoe-McGraw-Hill Book Co.
4. Grob, B. 2003. Basic Electronics 9TH Ed. McGraw-Hill.

| PHY-559 | Relativity and Cosmology | 3 (3 – 0) |
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Special Relativity, Galilean relativity, Einstein's postulates of special relativity. Consequences of special relativity. Michelson-Morley experiment, Lorentz transformations, consequences of Lorentz transformations (the relativity of length, the relativity of time, concept of simultaneity) Relativistic Mechanics, Transformation of relativistic velocities, addition of relativistic velocities, Relativity of mass,

Force equation in relativity, rest mass ,KE and total energy, conservation of energy and momentum,

the conversion of mass to kinetic energy in Uranium Fission, pair production and annihilation, The Cerenkov Effect and Cerenkov radiation, Einstein's mass-energy relationship and its practical examples, particle of Zero rest mass, Relativistic Doppler Effect, Aberration of Light, Tachyons, structure of space time, Geometry of space time, Minkowski space time tensors, the light cone, and four vectors (position four vector, four velocity, four momentum, four force). General relativity, Gravity as a Geometry, The equivalence principle, clocks in a gravitation field, space time is curved, geodesics, the geodesic equation, equation of geodesic deviation, Einstein field equation Manifolds and coordinates, curves and surfaces, tensor fields, metric tensor. Cosmology cosmological redshift, Hubble's law, microwave background, the Big Bang, Theory, Historical background of universe, stars , neutron stars, pulsars , black holes, quasars, singularity, measuring the distance to stars, concept of open, closed and flat universe, dark matter(MACHOs and WIMPs-)

Recommended Books:


1. James B. 2005, An Introdu ing to Einstein's General Relativity. Hartle Pearson Education
2. Beiser A. 2002. 6th E. Perspectives of Modern Physics. McGraw-Hill.
3. Resnick, Halliday and Krane. 2002, Physics Vol. I, 5th Ed. John Wiley and Sons Inc, New York.
4. Inverno R.D. Introducing Einstein's Relativity.1992, Oxford University Press.
5. McComb W D. 1999, Dynamics and Relativity. Oxford University Press.
6. Narlikar J V. 1989, Introduction to Cosmology. Cambridge University Press.


| PHY-561 | Lab Course-I (Electromagnetism) | 3 (0 – 3) |
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1. To determine the resistance of various DC conductors by recording their current / voltage characteristics.
2. To study the internal resistance and matching in various voltage sources and draw their power diagrams.
3. Establishment of relationship between electrostatic force and charge, electrostatic force and distance between charges and to determine the electric constant using Coulomb's Law / image charge.
4. To study the ferromagnetic hysterisis of a two ring-shaped iron cores by continuous adjustable direct current and to determine the remanence and coersive field strength.
5. Investigation of induced current and voltage in secondary coil of a transformer as a function of number of turns and current flowing in the primary coil.
6. To determine the inductance and phase displacement of coil (single, parallel and series formations) in AC circuit as a function of frequency of voltage source.
7. To determine the capacitance and phase displacement of capacitor (single, parallel and series formations) in AC circuit as a function of frequency of voltage source.
8. To determine the dielectric constants of different materials.
9. To study the ripple of the output voltage of various rectifier circuits as a function of the load current strength and the charging capacitance.
10. To study the frequency response of simple RC filters by point-by-point measurements and the sweep displayed on the oscilloscope.
11. To investigate the filter characteristics as a function of frequency of a coil, a capacitor, an Ohmic resistance and combinations of these components and to determine the phase displacement of the filters as a function of frequency.
12. To study the behavior of RLC series and parallel circuit and determination of its resonance frequency. (Optional: To determine the dielectric constant using RLC series circuit.)

Recommended Books:-


1. Kraftmakers, Y. 2007. Experiments and demonstrations in Physics, World Scientific Publishing Co. Ltd.
2. Griffiths D J., Introduction to Electrodynamics, 3rd Edition
3. Isenberg, C. 1996. Physics Experiments and Projects for students (Physics experiments & Projects). Taylor and Francis, USA.

## 2nd Semester

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| PHY-552 | Methods of Mathematical Physics-II | 3 (3 – 0) |

Fourier Analysis, Fourier cosine and sine series, change of interval, Fourier integral, complex form of Fourier series, Fourier transform, Fourier transform of derivatives, Laplace transform, Inverse Laplace Transform, Convolution theorem, Initial boundary value problem, Laplace transform of derivatives. Physical significance along with examples of Fourier and Laplace transforms. Special functions, Hermite, Laguerre, Legendre and associate Legendre polynomial. Bessel function, Neumann function, and spherical Bessel function, Gamma function. Nonhomogeneous equations- Green's function, Green's function in terms of Eigen-function, the Sturm-Liouville problem, Green's function for Dirac Delta functions,

Recommended Books:


1. Dass H.K, R. Verma, 2011, 6th Edition, Mathematical Physics, S. Chand & Company Ltd. New Delhi.
2. Kreyszig E. 2011, 10th Edition, Advanced Engineering Mathematics. Wiley, New York.
3. Riley K F, M P Hobson and S J Bence. 2006, 3rd Edition, Mathematical Methods for Physics and Engineering, Cambridge University Press, Cambridge.
4. Arfken G.B and H.J Weber, F.E Harris, 2012, 7th Edition, Mathematical Methods for Physicists, A. Press, New York.
5. Spiegel M.R 2009, 1st Edition Advanced Mathematics for Engineers and Scientists, Schaum's outlines series, McGraw Hill.
6. Collins R.E, 2011, 2nd Edition, Mathematical Methods for Physicists and Engineers, Dover Publications.
7. Tang K.T, 2010, 2nd Edition, Mathematical Methods for Engineers and Scientists 2, Springer.


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| PHY-554 | Quantum Mechanics-I | 3 (3 – 0) |

Review of concepts of classical mechanics, The state of a system, Dynamical variables and operators, Linear vector space, orthogonal systems, linear transformations, matrices, change of basis, Hilbert space, Commuting and non commuting operators, Heisenberg uncertainty relations, Functions and expectation values, Dirac notation, Hermitian operators, Symmetry principles and conservation laws, Orbital angular momentum, Spin, The eigenvalues and eigen functions of L2 and Lx, Matrix representation of angular momentum operators, Addition of angular momenta. Properties of one dimensional potential functions, Solutions of Schrödinger equation for free particles, the potential barrier problems, The linear harmonic oscillator, Particle in a box. Schrödinger Equation in Three Dimensions, Separation of Schrodinger equation in Cartesian coordinates, Central potentials, The free particle, Three dimensional square well potential, The hydrogen atom, Three dimensional isotopic oscillator.

Recommended Books:


1. Zettli N. 2009 "Quantum Mechanics Concepts and applications" J Willy.
2. Bransden B.H. & Joachain C.J. 1990 "Introductory Quantum mechanics", Longman Scientific & Technical London.
3. Liboff, R.L. 1980. "Introductory quantum Mechanics", by Addison Wesley Publishing Company, Reading Massachusetts,
4. W.Greiner 1980 "An Introduction Quantum Mechanics", Addison Wesley Publishing Company, Reading Massachusetts.


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| PHY-556 | Nuclear Physics-I | 3 (3 – 0) |

Nuclear mass, size, nuclear spin, Nuclear Binding energy, magnetic dipole moments, electric quadruple moments, parity and statistics. Observed phenomenon of radio activity, explanation of α-decay:

Absorption, Range, Ionization and Stopping power of alpha particles, theory of alpha decay, Fermi theory of β-decay, theory of γ-decay, energetic of γ-decay, Nuclear isomerism, Internal conversion, Mossbauer Effect, Yukawa meson theory of nuclear forces, properties of nuclear forces, n-p and p-p scattering at low energies. Passage of charged particles through matter, Ionization chamber, proportional counter, GM counter, scintillation counter, semi-conductor detector, bubble chamber. Linear accelerator, van de Graff generator, Synchrocyclotron, proton synchrotron, betatron, photographic emulsion.

Recommended Books:


1. Zhang, Z..M, B.K. Tsai and G. Machin. 2010. Experimental Methods in Physical Science Vol. 2, Academic Press, USA.
2. Alejandro Garcia and Ernest M. Henley, (2007). Subatomic Physics, by publisher: World Scientific Publishing.
3. B R Martin, 2006. Nuclear and Particle Physics, publisher: New York: Wiley
4. David, W.I.F., K. Shankland, L.B McK usker and C. Baerloche. 2006. Structure Determination from Powder Diffraction Data. Oxford University Press, New York.
5. Povh B, Rith K, Scholz C and Zetsche F, 2006, Particles and Nuclei: an Introduction to the Physical Concepts, 5th Edition, publisher: Berlin Springer,.
6. Hanlon, J. F. 2003. A User Guide to Vacuum Technology. John Wiley and sons, USA.
7. Kaplan Irving Nuclear Physics, latest edition.
8. lilley John 2001 Nuclear physics: Basic concepts and applications,
9. Kenneth S. K. 1995. “Introducing Nuclear Physics,


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| PHY-558 | Electrodynamics-II | 3 (3 – 0) |

*Maxwell’s equations*, Differential form of Faraday law of electromagnetic induction, Maxwell correction of Amper’s law and displacement current, Electromagnetic energy vector (Poynting vector), Wave equations for scalar and vector potential, Gauge transformations, Lorentz gauge and Coulombs gauge, Retarded scalar and vector potentials, Wave equations for *E* and *H*, Time dependent wave equation, Plane electromagnetic waves in a conducting and non-conducting media, Linear and circular polarization. *Electromagnetic wave in matter*: Propagation in linear media, Reflection and Transmission at the boundary of non-conducting media (Normal and Oblique incidence), Reflection at conducting surface, Frequency dependence of permittivity, *Radiation:* Electric and Magnetic dipole, Power radiated by a point charge, Radiation reaction, *Electrodynamics and Relativity:* Einstein’s Postulates, Geometry of Relativity, Lorentz Transformations, Proper time and velocity, Relativistic energy, momentum, kinematics, and electrodynamics, Magnetism as a relativistic phenomenon.

Recommended Books:


1. Griffiths D.J. 1999, Introduction to Electrodynamics, 3rd Edition
2. John R. Reitz, 1992, Foundations of Electromagnetic Theory, 4th Edition


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| PHY-560 | Electronics-II | 3 (3 – 0) |

An overview of operational amplifiers (op-amp), the differential amplifier, the inverting and non-inverting amplifiers, op-amp frequency response, negative feedback, comparators, integrators and differentiators, Instrumentation amplifier, Log and Antilog amplifiers, Constant current source, Current to Voltage and Voltage to Current converters, phase shift oscillators, the Wienbridge oscillator, the Colpitts & Hartley oscillators, the crystal oscillator, Schmitt triggers, the 555 timer, monostable, bistable, and astable multi vibrators, switching circuits, introduction to thyristors, silicon-controlled rectifiers, diacs and triacs, Number systems, digital circuits, Logic gates and Boolean algebra, arithmetic circuits, flip flops and latches, binary counters, Analog to Digital and Digital to analog conversion circuits.

Recommended Books:


1. Floyd, T. L. 2010. Digital Fundamentals 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
2. Floyd, T. L. 2010. Electronic Devices 9TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
3. Malvino, A. P. 2008. Electronic Principles. 7TH Ed. Glencoe-McGraw-Hill Book Co.
4. Nashelsky, L. & Robert, L. B. 2009. Electronic Devices and Circuit Theory 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
5. Tocci, R. J. 2010. Digital Systems: Principles and Applications 11TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).


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| PHY-562 | Lab Course-III (Atomic & Nuclear Physics) | 3 (0 – 3) |

The candidate must perform at least Eight experiments from the list given below. 50% weightage must be given to viva-voce about apparatus, theory of experiments and estimation of errors.

1. To Expose the students to advance level experimentation in Physics
2. To make them familiar to such experiments where out come can be used in developing future research capabilities and teaching skills
3. To make the students confident in their studies by showing and measuring parameters mostly used in their theoretical work.
1. To study the characteristics curves of GM counter.
2. To determine the absorption coefficient of lead for Gamma Rays using GM counter assembly.
3. To determine the maximum energy of Beta Particles using GM counter assembly.
4. To determine the range of an Alpha Particle and guess its energy using empirical relations using GM counter assembly.
5. To measure the half life of a radioactive nuclide.
6. To study of Random processes and fluctuations in Random processes (Gaussian distribution curve) using GM counter assembly.
7. To study radioactive equilibrium using $Cs^{137}/Ba^{137}$ mini generator using GM counter assembly.
8. Demonstration of Interaction of Radiations with matter using absorber kit using GM counter assembly.
9. Verification of inverse square law using GM counter assembly.
10. To study the wave characteristics of an electron. (electron diffraction experiment.)
11. Determination of Planck's constant using He-Neon laser, and compare its results with Photo cell method.
12. Determination of velocity of light using He-Neon laser and compare it with other standard methods.

**Recommended Books:**


1. Gray T S. Applied Electronics (John-willey and Sons)
2. Higgings R J. Experimental Electronics (Mc Graw Hill)
3. Mark H and N.T Olson. Experiments in Modern Physics (Mc Graw Hill)
4. Melissienson A C. Experiments in Modern Physics (Academic)
5. Squares G L. Practical Physics 3rd Ed. Cambridge University Press.


## 3rd Semester

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| PHY-651 | Quantum Mechanics-II | 3 (3 – 0) |

Matrix representation of operators, digitalization, Identical Particles, Second Quantization, Indistinguishability of identical particles, Systems of identical particles, Quantum dynamics of identical particle systems, statistics, Symmetry of states, Fermions, Bosons. Time evolution of a system, Schrödinger and Heisenberg pictures, Time independent perturbation theory for non-degenerate and degenerate levels, Time dependent perturbation theory, Variational method, The WKB approximation

and its applications. Theory of Scattering, Scattering experiments and cross sections, Potential scattering, the method of partial waves, The Born's approximation

Recommended Books:


1. Zettli N. 2009 "Quantum Mechanics Concepts and applications" J Willy.
2. Bransden B.H. & Joachain C.J. 1990 "Introductory Quantum mechanics", Longman Scientific & Technical London.
3. Liboff, R.L. 1980. "Introductory quantum Mechanics", by Addison Wesley Publishing Company, Reading Massachusetts,
4. W.Greiner 1980 "An Introduction Quantum Mechanics", Addison Wesley Publishing Company, Reading Massachusetts.


| PHY-653 | Nuclear Physics-II | 3 (3 – 0) |
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Types of nuclear reaction, Conservation laws of nuclear reaction, Q-values of nuclear reaction, threshold energy, transmutation by photons, protons, deuterons and α-particles, direct reactions, compound nuclear theory of nuclear reactions, limitation of compound nucleus, excited states of nucleus, bound and virtual energy levels, level width, cross-section for nuclear reactions, Breit-wigner formula. Liquid drop model, Semi-empirical mass formula, volume and surface energies, Shell model: magic numbers and closed shells, spin – orbit interaction, Collective nuclear model, nuclear deformations. The production and detection of neutrons, Fission and Fusion Reactions, discovery of nuclear fission, fission products, Bohr-wheeler theory of nuclear fission, mass and energy distribution of fission fragments, Description of nuclear fusion process, D-D and D-T reactions, Fusion processes in sun and stars, Nuclear fission and fusion as a source of energy, Basic of nuclear reactors, controlled nuclear fusion.

**Recommended Books:**


1. Henley E M and A Garcia.2007, *Subatomic.* World Scientific Publishing.
2. Povh B, K Rith, C Scholz and F Zetsche, 2006, *Particles and Nuclei: an Introduction to the Physical Concepts* 5th Edition. Berlin Springer.
3. Martin B R. 2006, *Nuclear and Particle Physics.* New York: Wiley.
4. David, W.I.F., K. Shankland, L.B McK usker and C. Baerloche. 2006. Structure Determination from Powder Diffraction Data. Oxford University Press, New York.
5. Hanlon, J. F. 2003. A User Guide to Vacuum Technology. John Wiley and sons, USA.
6. Lilley J. 2001, *Nuclear physics: Basic concepts and applications.*
7. Krane K S, 1995, *Introducing Nuclear Physics.*.
8. *Nuclear Physics,* by Irving Kaplan latest edition.
9. Zhang, Z..M, B.K. Tsai and G. Machin.


| PHY-655 | Statistical Mechanics | 3 (3 – 0) |
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Laws of thermodynamics, thermodynamic variables, reversible adiabatic changes. Entropy, Microstates and macrostates, ensembles and ensemble averaging, approach to equilibrium. Classical probability, Statistical probability, binomial and Gaussian probability distributions, central limit theorem. Microcanonical systems, quantum state, entropy and equilibrium in a microcanonical system, Canonical ensemble, partition function, entropy in canonical system, Boltzmann distribution, thermodynamical averages, applications to single particle, factorization of partition function. Equipartition theorem, free energy and its minimization, Gibbs and Helmholtz free energy and applications. Maxwell distribution of molecular speeds, classical probability of a state, Maxwell-Boltzmann probability distribution, density of states in k-space, distribution of speeds in a classical gas. Black body radiation, Rayleigh-Jeans theory, Planck distribution, free energy of a photon gas, Stefan-Boltzmann formula, phonons. Systems with variable number of particles, chemical potential, grand canonical ensemble, relation to thermodynamic variables. Identical particles, fermions and bosons, partition function for identical particles, semi-classical

approximations, identical particles localized on a lattice, thermodynamic properties of a Fermi gas, Bose condensation

Recommended Books

1. Gould H and J Tobochnik.2010, Thermal and Statistical Physics, Princeton University Press.
2. Bowley R and M. Sanchez. 2000, Introductory Statistical Mechanics, 2nd Ed. Clarenden Press, Oxford,
3. Huang K.2001, Introductory Statistical Physics, 1st Ed. CRC.
4. Kittel C and H. Kroemer, 1980, Thermal Physics, second edition, W. H. Freeman.

| PHY-657 | Solid State Physics-I | 3 (3 – 0) |
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Crystal structure in 2D and 3D, fundamental types of lattices, index system for crystal planes, simple crystal structures, X-ray diffraction, Braggs law, Ewald Construction, 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. Brief Introduction to Defects in Solids, Color Center, 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.

Recommended Books:

1. M. Ali Omer, 2009 “Elementary Solid State Physics”, 6th Edition. D. Kindersley Pvt. Ltd.
2. H. Ibach, H. Luth, 2009 “ Solid State Physics: An introduction to the principles of material science” 4th Edition by Springer.
3. C. Kittle, 2004 “Introduction to Solid State Physics”, 8th Edition by John Wiley and Sons Inc.

| PHY-659 | Particle Physics-I* | 3 (3 – 0) |
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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, isospin charge conjugation, time reversal, G parity, CPT theorem. The Electromagnetic Filed: Gauge invariance and Maxwell’s equations, polarization ad photon spin, angular momentum, parity and C parity of the photon. The Klein-Gordan Equation: Non relativistic quantum mechanics, Lorentz covariance and 4 vector notation, the Klein Gordon equation, the Feynman-Stuckelberg interpretation of E < O solutions, non relativistic perturbation theory (brief review), rules for scattering amplitudes in the Feynman-Stukelberg approach. The Dirac Equation: Covariant form of the Dirac Equation, Dirac γ-matrices, conserved current and the adjoint equation, free particle spinors, anti particles, normalization of spinors and the completeness relations, bilinear covariant, zero mass fermion, the two-component neutrino.

Books Recommended:

1. Burcham, E.E. and Jobes, M., J. (1995) "Nuclear and Particle Physics", Longman.
2. Das, A. and Ferbel, T. , (1994) "Introduction to Nuclear and Particle Physics", Johan Wiley and Sons.
3. Williams", W.S.C. (1993) "Nuclear and Particle Physics, Oxford University Press.
4. Gottfired, K. and Weisskopt, F. (1986) "Concepts of Particle Physics", vol. 1, Oxford University Press.
5. Griffiths, D. (1987). "Introduction of elementary Particles", , John Wiley and Sons.

| PHY-661 | Advanced Electronics* | 3 (3 – 0) |
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Number Systems and codes, Logic Gates and Boolean algebra, Combinational logic, Sum of products form, Karnaugh maps method, Digital arithmetic operations and circuits, multiplexer and demultiplexers, decoders encoders, Sequential logic, Flip Flops, Synchronous Logic, basic binary ripple counter, modulus counters, BCD counter, synchronous/asynchronous counter, counter, parallel counters, up-down counter application as digital time (clock) shift registers, semi conductor, memory elements (simple concept), Digital Computer, Concept of computer system (CPU, input & output devices, computer networking, software system and simulation software) and micro-processor, Communication systems, Modulation and Demodulation, Classification of signals, Analysis and transmission of signals, Amplitude modulation, Angle/Phase and Frequency modulations, Pulse code modulation.

Recommended Books:

1. Floyd, T. L. 2010. Digital Fundamentals $10^{TH}$ Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
2. Tocci, R. J. 2010. Digital Systems: Principles and Applications $11^{TH}$ Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
3. Lathi, B. P. 2009. Modern Digital and Analog Communication Systems $4^{TH}$ Ed. Oxford University Press.
4. Mano, M. M. 2002. Digital Design $4^{TH}$ Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

| PHY-663 | Environmental Physics-I* | 3 (3 – 0) |
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The economic system, living in green house, enjoying the sun, Transport of matter, Energy and momentum, the social and political context. Black body radiation, The emission spectrum of sun, The transition electric dipole moment, The Einstein Coefficients, Lambert – Beer's law, The spectroscopy of bio-molecules, Solar UV and life, The ozone filter. The energy Balance, (Zero-dimensional Greenhouse Model), elements of weather and climate, climate variations and modeling. Diffusion, flow in rivers, ground water. Flow equations of fluid Dynamics, Turbulence, Turbulence Diffusion, Gaussian plumes in air, Turbulent jets and planes the concept of sound, sound pressure level, frequency & propagation, sound level, measuring transient noise, the acoustic environment, Hazardous effects of noise, noise control., Radioactive decay law, sources of radiation, Interaction of Radiation with matter, Measuring Radiation, Nuclear Fuel Cycle, Sources of Radioactive waste, Health Hazards, Radioactive waste management.

Recommended Books:

1. Booker E and R V G Belle. 1999, Environmental Physics. 2nd ed. John Wiley and sons. 1999.
2. Grasseur G P. 1999, Atmospheric Chemistry & Global Change. $1^{st}$ Ed. Publisher: Oxford).
3. John M.Wallace. 1997, Atmospheric Science. 1st Ed. Publisher: Academic Press.
4. Physics of Environmental and Climate, Guyot Praxis Publication, 1998.

| PHY-665 | Health and Medical Physics-I* | 3 (3 – 0) |
|---|---|---|

Interactions of lionizing Radiation with Matter: Introduction; Beta-rays, range-energy relationship, mechanism of energy loss, Ionization and excitation, Bremsstrahlung, Alpha, rays, Rang-energy relation – ship, Energy transfer, Gamma-rays, exponential absorption, interaction mechanism, Pair production. Compton scattering, photoelectric absorption, photodisintegration, Combined effect, Neutrons,

Production classification, interaction, Scattering, Absorption. Radiotherapy: Introduction, The development of radiotherapy, Radio therapeutic aims, External beam therapy, Brach therapy, unsealed source therapy, Requirements for accuracy and precision, Quality assurance, The role of medical physics. Medical Imaging: Diagnostic X-rays, Production of X-rays, Absorption of x-ray to other planes, Partial volume effect, Artifacts, Contrast agent in conventional radiography and CT, Diagnostic Ultrasound, Doppler effect, radionuclide imagine, positron emission tomography (PET), Magnetic resonance imagining (MRI), Contrast agents for MRI.

Recommended Books:


1. Armstrong P and L Martin. Diagnostic Imaging 4th Ed. Blackwell Science Ltd.
2. Bushong S C. 1993, Radiologic Science of Technologists. 5th Ed. Mosby.
3. Cember H. 1996, Introduction to Health Physics. 3rd Ed. McGraw Hill, New York.
4. Forty R. 2010, ICFA, Instrumentation School.
5. Greening J R. 1985, Fundamentals of Radiation Dosimetry. 2nd Ed. Adam Hilger Ltd., Bristol.
6. Joran C. 2003, CERN, summer student lecturers
7. RIEGLER W. 2008,CERN, Academic Training Course.
8. Williams J R and D I Thwaits, 1993, Radiotherapy Physics. Oxford University Press, New York.


| PHY-667 | Climatology and Metrology-I* | 3 (3 – 0) |
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Synoptic Meteorology: Composition & structure of atmosphere, ICAO standard atmosphere, weather elements, Air mass classification, Thermodynamic characteristics, General Circulation.Atmospheric thermodynamics, First law of thermodynamics and enthalpy; adiabatic processes and potential temperature. The second law of thermodynamics; entropy' thermodynamics of water vapour and moist air' thermodynamic properties of the water substance' phase transition of water' water vapour and most air' Clausious- Clapaeyron's equation; Aerological diagram' selection of coordinates' choice of diagrm; analysis of tephigram. Methods of surface observations & codes: Reading of routine observation, barometric corrections & reduction, reading, setting * maintenance of thermometers, surface codes, aeronautical codes (Speci & Metar). Dynamic Meteorology: Circulation & vorticity, stokes theorem, vorticity equation, Rossby waves. Meteorological Instruments: Meterorological instruments used in thermometry, barometry, hygrometery, rainfall & snowfall measurement, wind measurement, cloud measurement, evaporation measurement, visibility measurement, sunshine measurement. Introduction to weather radar system, introduction to radiosonde equipment.

Recommended Books.


1. Vonstorch H. 2001, Statistical Analysis in Climate Research. 1st Ed. Publisher: Cambridge. Morgan M, 1991, Meteorology 3rd Ed. (Publisher: MacMillion),
2. Brasseur G P, 1999, Atmospheric Chemistry & Global Change (Publisher: Oxford), 1st Edition.
3. Hougton, 1985, Hand Book of applied Meterology, 1st Ed. Publisher: Wiley
4. Hidore O. 1984, Climatology 1st ed. (Publisher: Merrill).
5. Carlson. 1981, Tropical Meterology, 1st Ed. Publisher: The Pennsylvania State University.
6. Haltiner and Martin. 1957, Dynamical & Physical Meteorlogy 1st Ed. (Publisher: McGraw Hill).


| PHY-669 | Lab Course-III (Electronics) | 3 (0 – 3) |
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1. Design and measure the equivalent resistance and capacitance of parallel series resistive and capacitive circuits respectively.
2. Design a full-wave rectifier and study its output without and with a capacitor filter.
3. Design a full-wave rectifier and study its output with a π filter.
4. Design a regulated power supply using Zener diode and study its regulation.
5. Design clipper and clamping circuits and study the output wave shapes.
6. Design circuits for logic gates (NOT, OR, NOR, AND, NAND, XOR) using discrete components.
7. Design a CE amplifier and study its frequency response. Determine its low- and upper-limit frequencies and also the bandwidth.
8. Design a common source FET amplifier and determine its input and output impedance.
9. Design an RC phase-shift oscillator and determine its frequency by Lissajous figures.

10. Design an astable multi vibrator and determine its frequency.
11. Design a transformer-coupled class A power amplifier and determine its ac power delivered to the load and percent efficiency.
12. Design inverting and non-inverting amplifiers using operational amplifiers using 741 IC's.
13. Design differentiator and integrator circuits and study output wave shapes using 741 IC's.
14. Design Half adder and full adder circuits
15. Design half subtractor and Full Subtractor circuits.

**Recommended Books:**


1. Floyd, T. L. 2010. Electronic Devices 9TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
2. Nashelsky, L. & Robert, L. B. 2009. Electronic Devices and Circuit Theory 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
3. Malvino, A. P. 2008. Electronic Principles. 7TH Ed. Glencoe-McGraw-Hill Book Co.
4. Grob, B. 2003. Basic Electronics 9TH Ed. McGraw-Hill.


## 4th Semester

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| PHY-652 | Plasma Physics | 3 (3 – 0) |

Introduction. Occurrence of plasmas in nature. Definition of plasma. Concept of temperature. Debye shielding. The plasma parameter. Criteria for plasma. Applications of plasma physics. Single-particle motions in electromagnetic field. Uniform and nonuniform E and B fields. Time-varying E and B fields. Fluid description of plasma. Wave propagation in plasma. Derivation of dispertion relations for simple electrostatic and electromagnetic modes. Introduction to Controlled Fusion: Basic nuclear fusion reactions, reaction rates and power density, radiation losses from plasmas, operational conditions.

Recommended Books:


1. Bittencourt J A, 2004 Fundamentals of Plasma Physics" (second Edition) INPE.
2. Krall N A and A W Trivelpiece, 1986 Principles of Plasma Physics" by (McGraw-Hill).
3. Glasstone S and R H.Lovberg, 1975 Controlled Thermonuclear Reactions (D.Van Nestrand).
4. CHEN F F, 1974 Introduction to Plasma Physics and control fusion, (Plenum).


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| PHY-654 | Computational Physics | 3 (3 – 0) |

Introduction, Scientific programming methodology, Scientific programming languages, Numerical solutions of ODEs, Euler Method, Numerical errors and instabilities, Euler Improved Method, Runge Kutta 4th order Method, Adaptive integration technique, Runge Kutta Fehlberg Method. Numerical quadrature, Riemann's Sum, Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule. Random number, Random walk, introduction to Monte Carlo techniques, Monte Carlo Integration and Cubatures. Numerical Solution of Nonlinear Equations f(x) = 0. Numerical Solution of Linear System of equations, Gauss Jordan Method, Jacobi Method, Gauss Seidel iterative Method. Numerical solutions of PDEs, Finite elements method, Laplace equation, Heat Equation, Explicit and Implicit methods, Crank-Nicholson Scheme, Wave equation. Interpolation and data fitting, Polynomial interpolation, Newton's Polynomial, Newton-Gregory Forwards Polynomial, Lagrange Interpolating polynomial, Chi square fitting, Linear Fit. Computer algebra and Introduction to MATHEMATICA, Introduction to MATLAB. Algorithm development using C++. Simulation techniques and computer graphics, computational techniques in investigating and visualizing fundamental physics.

Recommended Books:


1. Harvey M. Deitel and Paul J. Deitel, 2012, *C++ How to Program, 8/e, Early Objects Version*, Prentice Hall
2. Richard Fitzpatrick, 2011*, Introduction to Computational Physics*, University of Texas.
3. William H. Press, Brian P. Flannery, Saul A.
4. Paul L. Devries and Javier E. Hasbun, 2010, *A First Course in Computational Physics*, John Willey and Sons. N.Y..
5. Andi Klein and Alexander Godunov, 2006, *Introductory Computational Physics*, Cambridge

University Press.
6. R. H. Landau, M. J. Paez and C. C. Bordieanu , 2007, *Computational Physics: Problem solving with Computers*, Ed. 2nd, Wiley VCHVerlag GmbH & Co KgaA.
7. Teukolsky, and William T, 1998, *Numerical Recipes: The Art of Scientific Computing*, Vetterling Cambridge University Press.

| PHY-656 | Solid State Physics-II | 3 (3 – 0) |
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Solid state problem, Born-Oppenheimer approximation, free electron approximation, density of states, Fermi Dirac distribution, k-space, concept of Fermi energy and the Fermi surface, free electron description of Heat capacity, electrical conductivity of metals, Hall effect, Nearly free electron model, origin of the energy gap, , Bloch functions, motion of electrons in electron in a periodic potential, crystal momentum, effective mass, physical interpretation of the effective mass, Augmented Plane Wave method, Semiconductors, intrinsic and extrinsic semiconductors, intrinsic carrier concentration, mobility, impurity conductivity donor states, acceptor states, thermal ionization of donors and acceptors, simple description pf pn-junction and rectification, Transistors, Semiconductors heterostructure and outline of solid state lasers, Diamagnetism and Paramagnetism, Larmor Diamagnetism, Adiabatic Diamagnetism, Pauli Paramagnetism, Conduction electrons Diamagnetism, introduction to superconductivity. Qualitative aspects of BCS Theory.

Recommended Books:

1. M. Ali Omer, 2009 “Elementary Solid State Physics”, 6th Edition. D. Kindersley Pvt. Ltd.
2. H. Ibach, H. Luth, 2009 “ Solid State Physics: An introduction to the principles of material science” 4th Edition by Springer.
3. C. Kittle, 2004 “Introduction to Solid State Physics”, 8th Edition by John Wiley and Sons Inc.

| PHY-658 | Laser and Optics | 3 (3 – 0) |
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Review of quantum mechanics, interaction of radiation with matter, Spontaneous and stimulated emission, absorption, cavity, gain medium, population inversion, threshold condition, Three and four level laser, pumping mechanisms, properties of a laser beam, Modes of a rectangular cavity, Raleigh-Jeans and Planck radiation formula, mode density, homogeneous and inhomogeneous broadening of atomic transitions, amplitude fluctuations and spiking, Rate equation approach to Laser theory, stationary solution, time-dependent solution, lasing condition, hole burning effect, Matrix formulation of Geometrical optics , optical resonators, Q-switching and mode locking, active and passive mode-locking, fresnal number, types of laser, laser applications

Recommended Books

1. Svelto O. 2010, Principles of Lasers. 5th Ed. Springer New York Dordrecht Heidelberg London
2. Hooker S and C Webb. 2010, Laser Physics Oxford University Press, Inc. New York
3. Abramczyk H. 2005, .Introduction to laser spectroscopy. Elsevier.
4. Silfvast W T. 2004, Laser Fundamentals. Cambridge University Press.

| PHY-660 | Particle Physics-II* | 3 (3 – 0) |
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Hadrons Spectroscopy: Formation experiments, particle wave formalism and the optical theorem, the Breit-Winger 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. Electrodynamics

of spinless particles: An "electron" in an electromagnetic field A", "spinless" electron – muon scattering, the cross section in terms of the invariant amplitude M, the decay rate in terms of M, "spinless" electron – electron scattering, electron – positron scattering: and application of crossing, invariant variables, the origin of the propagator. Electrodynamics of Spin ½ Particles: An electron interacting with an electromagnetic field A" , Moller scattering e- e- → e-e- the process e- μ- → e- μ- trace theorems and properties of y matrices., e- μ- scattering and the process e- e- → μ+ μ- helicity conservation at high energies, survey of e- e+ → e- e+ , μ- μ+ , e- μ- → e- μ- in the laboratory frame; kinematics relevant to the parton model, photons, polarization vectors, more on propagators, the electron propagator, the photon propagator, massive vector particles, real and virtual photons, Compton scattering γ e- → γ e- pair, annihilation e+ e- → γγ, the + ive prescription for propagators, Eeynman rules QED.

Books Recommended:


1. Burcham, E.E. and Jobes, M., J. (1995) "Nuclear and Particle Physics", Longman.
2. Das, A. and Ferbel, T. , (1994) "Introduction to Nuclear and Particle Physics", Johan Wiley and Sons.
3. Williams", W.S.C. (1993) "Nuclear and Particle Physics, Oxford University Press.
4. Gottfired, K. and Weisskopt, F. (1986) "Concepts of Particle Physics", vol. 1, Oxford University Press.
5. Griffiths, D. (1987). "Introduction of elementary Particles", John Wiley and Sons.


| PHY-662 | Advanced Electronics Lab Course* | 3 (0 – 3) |
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1. Design of UJT relaxation oscillator of a variable frequency, measure frequency and amplitude of the out put.
2. Design RF transistor oscillator, Convert into a transmitter, detect the transmitted wave by a radio receiver (Both for AM & FM).
3. Design and study the application of operational amplifier, (current to voltage converter instrumentation amplifier, buffer, voltage clamp, low and high pass filter, half wave rectifier etc.).
4. Design and study the Low/High pass active filters using 741 IC.
5. Design and study the application of 555 timers IC (mono-stable, astable and bi-stable multi-vibrators).
6. Design a fixed and self bias transistor binary and triggering of binary, using IC's construct and study RS, JK (Master stave), T and D flip-flops.
7. Design and study of a half and full adder with different Boolean expression using IC's.
8. Synchronous and asynchronous BCD counters, Memory shift register with IC's.
9. Frequency counter and optional digital clock.
10. Design and construct and analog to digital and digital to analog converters using IC's.
11. Design and study of decoder, encoder, multiplexer and de-multiplexer circuits and compare the input out put waveforms.
12. To construct and understand an operation of arithmetic logic unit and study of different arithmetic logic operations.
13. To construct and study of data storage and retrieved using semiconductor memory and understand the process of fetching an instruction and its operand with ALU.
14. Using microprocessor trainer's study of microprocessor application working form host personal computers.
15. Design of Digital Clock.

**Recommended Books:**


1. Floyd, T. L. 2010. Digital Fundamentals $10^{TH}$ Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
2. Tocci, R. J. 2010. Digital Systems: Principles and Applications $11^{TH}$ Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
3. Lathi, B. P. 2009. Modern Digital and Analog Communication Systems $4^{TH}$ Ed. Oxford University Press.
4. Mano, M. M. 2002. Digital Design $4^{TH}$ Ed. Prentice-Hall Intern. Inc., Englewood Cliffs

(USA).

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| PHY-664 | Environmental* Physics Lab Course | 3 (0 – 3) |

Students are required to study the functioning and data analysis obtained from various machines used in Atmospheric & Environmental Physics. The students have to work in some agencies where these facilities are available. The details of the activities performed in this lab are as under.

1. Solid Aerosols / soils sample collections
2. Physio chemical & mechanical properties of solid aerosols / soils samples.
3. Qualitative & Quantitative analysis solid aerosols / soils samples.
4. Morphological & texture analysis of solid aerosols / soils samples.
5. Climatological data analysis with respect to global warming & global cooling (whether trends)

Recommended Books:


1. Zhang, Z..M, B.K. Tsai and G. Machin. 2010. Experimental Methods in Physical Science Vol. 2, Academic Press, USA..
2. "The status of Climate Variation in Pakistan & Its Impact", by SMRC. No. 10 SAARC Met. Research Centre, 1st Edition 2004.
3. Hanlon, J. F. 2003. A User Guide to Vacuum Technology. John Wiley and sons, USA.
4. Vonstorch H. 2001, Statistical Analysis in Climate Research. 1st Ed. Publisher: Cambridge.
5. David W I F, K Shankland, L.B McK usker.
6. Grasseur G P, 1999, Atmospheric Chemistry & Global Change (Publisher: Oxford), 1st Edition.
7. Hougton, 1985, Hand Book of applied Meterology, 1st Ed. Publisher: Wiley
8. Thompson R D. 1997, Applied Climatology. 1st Ed. Publisher: Routledge.


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| PHY-666 | Health and Medical Physics -II* | 3 (3 – 0) |

Radiation Dosimetry: History of Absorbed Dose, Stochastic and Non-stochastic quantities, units for absorbed Dose, Absorbed Dose Calorimeters, Exposure and its measurements. The free-air chamber, Exposure measurement with calibrated cavity chamber. The concept of Kerma, absorbed Dose in air, Absorbed dose in other Materials, Factors converting Exposure to Absorbed Dose to wake, High energy calibrations. The Bragg-Gray Cavity theory. Methods of Dosimetry: Calorimeters, Ionization chambers, chemical Dosimetry, Thermo luminescence Dosimetry (TLD), Photographic Dosimeter, Scintillation Detectors, other Dosimetric Systems. Health Physics: Cardinal principles of radiation protection, minimize time, Maximize distance, Maximize shielding, Time, Distance and shielding, Maximum permissible dose, whole-body occupational exposure, whole-body non-occupational exposure, partial body occupational exposure, X-ray and pregnancy, Basic radiation safety criteria, effective dose-equivalent, allowable limit on intake (ALI), inhaled radioactivity, derived air concentration, Gastrointestinal tract, Basis of radiation safety regulations

Recommended Books:


1. Cember H. 1996, Introduction to Health Physics. 3rd Ed. McGraw Hill, New York.
2. Williams J R and D I Thwaits, 1993, Radiotherapy Physics. Oxford University Press, New York.
3. Armstrong P and L Martin. Diagnostic Imaging 4th Ed. Blackwell Science Ltd.
4. Bushong S C. 1993, Radiologic Science of Technologists. 5th Ed. Mosby.
5. Greening J R. 1985, Fundamentals of Radiation Dosimetry. 2nd Ed. Adam Hilger Ltd., Bristol.
6. Joran C. 2003, CERN, summer student lecturers
7. RIEGLER W. 2008, CERN, Academic Training Course.
8. Forty R. 2010, ICFA, Instrumentation School.


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| PHY-668 | Climatology and Metrology-II* | 3 (3 – 0) |

Climatology: Climatic elements; principles of climate classification; world climate classification; climates of Asia; climates of the sub-continent; the climate of Pakistan. Climate Change: Meteorological factors affecting climate; greenhouse gases; El-Nino, La-Nina. Tropical Meteorology: Tropical general

circulation, Diurnal variations of meteorological elements in the tropics, A survey of low-latitude weather disturbances easterly waves' intertropical convergence zone. Monsoons, Tropical cyclones, structure and formation of cyclones. Aviation Meteorology: meteorological aspects of flight planning's, aviation hazards and their association with synoptic patterns, aircraft icing, turbulence, fog, thunderstorms, dust storms, low-level vertical wind shear, jet stream formation & structure.

Recommended Books.


1. Brasseur G P, 1999, Atmospheric Chemistry & Global Chang (Publisher: Oxford), 1st Edition.
2. Vonstorch H. 2001, Statistical Analysis in Climate Research. 1st Ed. Publisher: Cambridge.
3. Morgan M, 1991, Meteorology 3rd Ed. (Publisher: MacMillion),
4. Hidore O. 1984, Climatology 1st ed. (Publisher: Merrill).
5. Haltiner and Martin. 1957, Dynamical & Physical Meteorlogy 1st Ed. (Publisher: McGraw Hill).
6. Carlson. 1981, Tropical Meterology, 1st Ed. Publisher: The Pennsylvania State University.
7. Hougton, 1985, Hand Book of applied Meterology, 1st Ed. Publisher: Wiley


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| PHY-679 | Seminar | 1 (1 – 0) |
| PHY-680 | Thesis** | 6 (0 – 6) |
| PHY-681 | Project*** | 3 (0 –3) |

Note:

*One optional subject to be chosen in 3rd and 4th semester.

**Projects may be opted in lieu of option-II of the subject already taken by the student in 3rd semester.

*** Thesis will be allotted in the 3rd semester. However, the credit hours for thesis will only count towards the 4th semester.

+ Internship will be offered to students during summer vacations as an optional activity.

**The End**