B. Tech. (Engineering Physics) Course Structure at IIT Guwahati

(As per approval by the Senate on May 06 and August 10, 2007)

Semester – I

Course#	*Course Title*	*L-T-P*	*C*
MA101	Mathematics I	3-1-0	8
CH101	Chemistry	3-1-0	8
CH110	Chemistry Lab	0-0-3	3
PH101	Physics I	2-1-0	6
ME110	Workshop I	0-0-3	3
EC101	Electrical Science	3-1-0	8
ME111	Engineering Drawing	2-0-3	7
HS1xx	HSS Elective	3-0-0	6
Contact hours = 29		16-4-9	49

Semester – II

Course#	*Course Title*	*L-T-P*	*C*
MA102	Mathematics II	3-1-0	8
ME101	Engineering Mechanics	3-1-0	8
EC102	Basic Electronics Lab	0-0-4	4
CS101	Introduction to Computing	3-0-0	6
CS110	Computing Lab	0-0-3	3
PH102	Physics II	2-1-0	6
BT101	Modern Biology	3-1-0	8
PH110	Physics Lab	0-0-3	3
	NCC/NSO/NSS	-------	-
Contact hours = 28		14-4-10	46

Semester – III

Course#	*Course Title*	*L-T-P*	*C*
HS2xx	HSS Elective	3-0-0	6
CS201	Object Oriented Programming and Data Structure	3-0-3	9
MA201	Mathematics III	3-1-0	8
EC220	Signals and Systems	3-0-0	6
PH211	Classical Mechanics	3-1-0	8
PH213	Quantum Mechanics I	3-1-0	8
Contact hours = 24		18-3-3	45

Semester – IV

Course#	*Course Title*	*L-T-P*	*C*
XX 2xx	Science Elective	3-0-0	6
HS2xx	HSS Elective	3-0-0	6
PH212	**Heat and Thermodynamics**	**3-1-0**	**8**
PH214	Quantum Mechanics II	3-1-0	8
PH218	**Analog and Digital Electronics**	**3-1-0**	**8**
PH210	**Electronic Lab I**	**0-0-4**	**4**
Contact hours = 22		15-3-4	40

Semester – V

Course#	*Course Title*	*L-T-P*	*C*
BT205	Biophysics	2-1-0	6
PH301	**Electromagnetics**	**3-1-0**	**8**
PH303	**Microprocessor Architecture and Programming**	**3-0-0**	**6**
PH305	**Atomic and Nuclear Physics**	3-1-0	8
CH431	Group Theory and Spectroscopy	3-1-0	8
PH310	**General Physics Lab**	**0-0-6**	**6**
Ph320	**Electronics Lab II**	**0-0-3**	**3**
Contact hours = 27		14-4-9	45

Semester – VI

Course#	*Course Title*	*L-T-P*	*C*
HS3xx	HSS Elective	3-0-0	6
PH302	**Engineering Optics**	**3-0-0**	**6**
PH304	**Materials Science**	**3-0-0**	**6**
PH306	Statistical Mechanics	3-1-0	8
PH308	Numerical Methods and Computational Physics	2-0-2	6
PH312	Measurement Techniques	2-0-3	7
PH330	**Advanced Physics Lab**	**0-0-6**	**6**
Contact hours = 28		16-1-11	45

Semester – VII

Course#	*Course Title*	*L-T-P*	*C*
XX 4xx	Open Elective I	3-0-0	6
XX 4xx	Department Elective I	3-0-0	6
PH413	**Lasers and Photonics**	**3-1-0**	**8**
PH415	Solid State Physics	3-1-0	8
PH417	**Semiconductor Devices**	**3-0-0**	**6**
PH419	Project – Part I	0-0-8	8
Contact hours = 25		15-2-8	42

Semester – VIII

Course#	*Course Title*	*L-T-P*	*C*
XX4xx	Open Elective II	3-0-0	6
HS4xx	HSS Elective	3-0-0	6
PH414	**Nanoelectronics and Nanophotonics**	**3-0-0**	**6**
PH4xx	Department Elective II	3-0-0	6
PH4xx	Department Elective III	3-0-0	6
PH421	Project – Part II	0-0-12	12
Contact hours = 27		15-0-12	42

N.B.1:Courses given in **bold** are new and the syllabi for these courses are attached. Other courses are common/existing M.Sc. courses (with numbers changed but titles and syllabi unchanged).

N.B.2:The students may also opt for M.Sc. PH5xx elective courses in the VIII semester.

Syllabi for B.Tech. Engineering Physics Courses at IIT Guwahati

(The syllabi for Physics compulsory courses only are given below)

PH-101 Physics I (2-1-0-6)

Classical Mechanics: Review of Newtonian Mechanics in rectilinear coordinate system. Motion in plane polar coordinates. Conservation principles . Collision problem in laboratory and centre of mass frame. Rotation about fixed axis . Non-inertial frames and pseudo forces . Rigid body dynamics .

Special Theory of Relativity: Postulates of STR. Galilean transformation. Lorentz transformation. Simultaneity. Length Contraction. Time dilation. Relativistic addition of velocities. Energy-momentum relationships.

Quantum Mechanics: Two-slit experiment. De Broglie's hypothesis. Uncertainty Principle, wave function and wave packets, phase and group velocities. Schrödinger Equation. Probabilities and Normalization. Expectation values. Eigenvalues and eigenfunctions. Applications in one dimension: Particle in a box, Finite Potential well, Harmonic oscillator.

Text Books:

1. D. Kleppner and R. J. Kolenkow, *An Introduction to Mechanics*, Tata McGraw-Hill (2000).
2. R.Eisberg and R. Resnick, *Quantum Physics of Atoms,Molecules,Solids,Nuclei and Particles*, John-Wiley, 2nd Edition (1985).

References:

1. R. P. Feynman, R. B. Leighton, and M. Sands, *The Feynman Lectures on Physics*, Vol.I, Norosa Publishing House (1998).
2. J.M. Knudsen and P.G. Hjorth, *Elements of Newtonian Mechanics*, Springer (1995).
3. R. Resnick, *Introduction to Special Relativity*, John Wiley, Singapore (2000).
4. A. Beiser, *Concepts of Modern Physics*, Tata McGraw-Hill, New Delhi (1995).
5. S. Gasiorowicz, *Quantum Physics*, John Wiley (Asia) (2000).

PH-102 Physics 2: (2-1-0-6)

Vector Calculus: Gradient, Divergence and Curl, Line, Surface, and Volume integrals, Gauss's divergence theorem and Stokes' theorem in Cartesian, Spherical polar, and Cylindrical polar coordinates, Dirac Delta function.

Electrostatics: Gauss's law and its applications, Divergence and Curl of Electrostatic fields, Electrostatic Potential, Boundary conditions, Work and Energy, Conductors, Capacitors, Laplace's equation, Method of images, Boundary value problems in Cartesian Coordinate Systems, Dielectrics, Polarization, Bound Charges, Electric displacement, Boundary conditions in dielectrics, Energy in dielectrics, Forces on dielectrics.

Magnetostatics: Lorentz force, Biot-Savart and Ampere's laws and their applications, Divergence and Curl of Magnetostatic fields, Magnetic vector Potential, Force and torque on a magnetic dipole, Magnetic materials, Magnetization, Bound currents, Boundary conditions.

Electrodynamics: Ohm's law, Motional EMF, Faraday's law, Lenz's law, Self and Mutual inductance, Energy stored in magnetic field, Maxwell's equations, Continuity Equation, Poynting Theorem, Wave solution of Maxwell Equations.

Electromagnetic waves: Polarization, reflection & transmission at oblique incidences.

Texts:

1. D. J. Griffiths, *Introduction to Electrodynamics*,3rd edition, Prentice-Hall of India(2005).
2. A.K.Ghatak, *Optics*, Tata Mcgraw Hill (2007).

References:

1. Engineering Electromagnetics, Nathan Ida, Springer, 2005.
2. M. N. O. Sadiku, *Elements of Electromagnetics*, Oxford (2006).
3. R. P. Feynman, R. B. Leighton, and M. Sands, The Feynman Lectures on Physics, Vol.II, Norosa Publishing House (1998).
4. I. S. Grant and W. R. Phillips, Electromagnetism, John Wiley, (1990).

PH110: Physics Laboratory: (0-0-3-3)

Typical Experiments: Rotational inertia of a rigid body, Small oscillation, Black body radiation: Stefan-Boltzmann law, Velocity of sound in air, Fraunhofer diffraction: single slit, multiple slits, Diffraction by plane grating, Interference of light: Newton's ring, Polarization of light, Decay of current in a RC circuit, LCR circuit: forced damped oscillation, Electrical properties of Materials, Hall effect, Magnetic field along the axis of a coils, Photovoltic effect: Solar Cell, etc.

1. D. Halliday, R. Resnick and J. Walker, Fundamentals of Physics, John Wiley, Singapore (2001).
2. D. Kleppner and R. J. Kolenkow, An Introduction to Mechanics, Tata McGraw-Hill(2002).
3. D. J. Griffiths, Introduction to Electrodynamics, Prentice-Hall (1995).
4. F. A. Jenkins and H. E. White, Fundamental of Optics, McGraw-Hill, (1981).
5. S. M. Sze, Physsics of Semiconductor Devices, Wiley Eastern (1981).

PH-211 Classical Mechanics (3-1-0-8)

Review: Application of Newton's Laws and Conservation Laws.

Lagrangian Dynamics: Mechanics of a system of particles, constraints and generalized coordinates, Lagrange's equations, applications. Variational calculus and Least Action principle.

Central force problem: Equations of motion, orbits, Virial theorem, Kepler problem, scattering in a central force field.
Rigid body motion: Orthogonal transformations, Euler angles, Coriolis effect, angular momentum and kinetic energy, tensors and dyadic, inertia tensor, Euler equations, applications, heavy symmetrical top.

Hamiltonian formulation: Legendre transformations, Hamilton equations, cyclic coordinates and conservation theorems, principle of least action, canonical transformations, Poisson brackets, Hamilton-Jacobi theory, Action-angle variables.

Small oscillations: Eigenvalue problem, frequencies of free vibrations and normal modes, forced vibrations, dissipation.

Classical field theory: Lagrangian and Hamiltonian formulation of continuous systems.

Text Book:

1. H. Goldstein, *Classical Mechanics*, 2nd ed., Narosa (1985).

References:

1. L. Landau and E. Lifshitz, *Mechanics*, Oxford (1981).
2. F. Scheck, *Mechanics*, Springer (1994).

PH-213 Quantum Mechanics I (3-1-0-8)

Introduction to Quantum Theory: Wave-Particle duality, matter waves, group velocity, phase velocity, uncertainty principle, wave packets.

Basic postulates of quantum mechanics, concept of probability and probability current density, Schrödinger equation. Operators, eigenvalues and eigenfunctions.

Simple potential problems: Particle in a box, steps, barriers, wells, bound states, delta-function potential, linear harmonic oscillator, Hermite polynomials.

Matrix formulation of Quantum Mechanics: Linear and matrix algebra, Dirac's bra and ket notation, matrix representations of vectors and operators, expectation values, different representations in quantum mechanics, parity operation. Matrix theory of harmonic oscillator.

Theory of Angular Momentum: Spherical harmonics, eigenvalues for $\mathbf{L}^2$ and L_z, commutation relations, quantum numbers, degeneracies.

Schrödinger Equation for Central Potential: Hydrogen atom, power series solution for the radial part, energy quantization, quantum numbers, Laguerre polynomials, 3-dimensional harmonic oscillator.

Text Book:

1. S. Gasiorowicz, *Quantum Physics*, John Wiley, Asia (2000).

References:

1. P. W. Mathews and K. Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw Hill (1995).
2. F. Schwabl, *Quantum Mechanics*, Narosa (1998).
3. L. I. Schiff, *Quantum Mechanics*, McGraw-Hill (1968).
4. E. Merzbacher, *Quantum Mechanics*, John Wiley, Asia (1999).
5. B. H. Bransden and C. J. Joachain, *Introduction to Quantum Mechanics*, Longman (1993).

PH-212 Heat and Thermodynamics (3-1-0-8)

Thermodynamic system and state variables, Zeroth law. Equation of state, law of corresponding states. First law, enthalpy, relations between partial derivatives, Joule expansion and Joule-Thomson effect. Second law: exact differential, Carnot cycle, entropy, entropy increase principle, Gibbs paradox. TdS equations and properties of systems. Helmoltz and Gibbs potentials, Legendre transformations, Maxwell relations, Clausius-Clapeyron equation, introduction to second order phase transition, Third law, Nernst heat theorem. Chemical potential, phase equlibria and phase rule, surface tension, magnetism, voltaic cells, black-body radiation. Applications: Rankine's cycle, Mollier's diagram. IC engines: Otto cycle, Diesel cycle, two and four stroke engines. Reaction and impulse turbines, velocity diagrams, jet propulsion and turbo jet.

Kinetic Theory and Transport Phenomena: Equation of state of an ideal gas, equipartition of energy, specific heat. Real gases and Van der Walls equation. Mean free path, collision cross section. Viscosity, thermal conductivity, and diffusion. Non-equilibrium Thermodynamics: Linear law, Onsager reciprocity relations, entropy production, thermodiffusion, thermoelectric effect. Heat transfer: Equation of conduction, solution in simple geometries, introduction to convective and radiative heat transfer.

Text Books:

1. M. W. Zemansky, R. H. Dittman, *Heat and Thermodynamics*, McGraw Hill (1987).
2. F. W. Sears, G. L. Salinger, *Thermodynamics, Kinetic Theroy, and Statistical Thermodynamics*, Narosa, New Delhi (1995).
3. R. C. Srivastava, S. K. Saha and A. K. Jain, *Thermodynamics: A Core Course*, 2nd ed., Prentice-Hall of India (2004).

References:

1. F. Mandl, *Statistical Physics*, ELBS/John Wiley (1978).
2. M. N. Saha and B. N. Srivastava, *A Treatise on Heat*, Indian Press (1980).

3. W. Greiner, L. Neise, and H. Stöcker, *Thermodynamics and Statistical Mechanics*, Springer (1995).

4. B. N. Roy, *Fundamentals of Classical and Statistical Thermodynamics*, John Wiley (2002).

5. Y. A. Cengel and M. A. Boles, *Thermodynamics: An Engineering Approach*, Tata McGraw-Hill (2003).

6. F. P. Incropera and D. P. Dewitt, *Introduction to Heat Transfer*, 3rd ed., John Wiley (1996).

PH-214 Quantum Mechanics II (3-1-0-8)

Perturbation Theory: Non-degenerate and Degenerate Cases. applications: Zeeman and Stark effects. Induced electric dipole moment of Hydrogen

Real Hydrogen Atom: Relativistic correction, spin-orbit coupling, hyperfine interaction, Helium atom, exclusion principle, exchange interaction.

Schrödinger equation for a slowly varying potential, WKB approximation, turning points, connection formulae, derivation of Bohr-Sommerfeld quantization condition, applications of WKB.

Time Dependent Perturbation Theory: Sinusoidal perturbation, Fermi's Golden Rule, special topics in radiation theory, semi-classical treatment of interaction of radiation with matter, Einstein's coefficients, spontaneous and stimulated emission and absorption, application to lasers.

Scattering Theory: Born Approximation, scattering cross section, Greens functions. scattering for different kinds of potentials, applications.

Relativistic Invariance, Dirac equation, solution of free field Dirac equation, Klein-Gordon equation.

Text Books:

1. S. Gasiorowicz, *Quantum Physics*, John Wiley, Asia (2000).

2. E. Merzbacher, *Quantum Mechanics*, John Wiley, Asia (1999).

References:

1. P. W. Mathews and K. Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw Hill (1995).

2. F. Schwabl, *Quantum Mechanics*, Narosa (1998).

3. L. I. Schiff, *Quantum Mechanics*, McGraw-Hill (1968).

4. B. H. Bransden and C. J. Joachain, *Introduction to Quantum Mechanics*, Longman (1993).

PH-218 Analog and Digital Electronics (3-1-0-8)

Physics of junction devices. BJT/FET amplifiers and oscillators: Multistage amplifiers, frequency response of basic and compound configurations, Feedback: Effect of negative and positive feedback, basic feedback topologies and their properties, analysis of practical feedback amplifiers; sinusoidal oscillators (RC, LC, and crystal), multivibrators. Power amplifiers: Class A, B, AB, C, D stages; IC output stages. Operational amplifier circuits: Differential and cascade amplifiers and applications, SE/NE 555 timer IC, active filters, voltage controlled oscillator, A/D and D/A converters, sample-and hold- circuit.

Logic families: Different logic families, MOSFET as switch, TTL inverter – circuit description and operation; CMOS inverter–circuit description and operation; other TTL and CMOS gates, electrical behaviour of logic circuits. Combinational logic modules: Decoders, encoders, multiplexers, de-multiplexers and their applications; three state devices, comparators, programmable logic devices. Sequential logic circuits: design and analysis of synchronous and asynchronous sequential circuits. Memory: Read-only memory (ROM), EPROM, Flash, static and dynamic random access memories.

Text Books:

1. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, Oxford University Press (1997).
2. R. A. Gayakwad, *Op-Amps and Linear Integrated Circuit*, Prentice-Hall of India (2002).
3. J. F. Wakerly, *Digital Design – Principles and Practices*, 3/e, Prentice-Hall of India (2005).

References:

1. J. Millman and C.C. Halkias, *Integrated Electronics*, Tata McGraw Hill (1995).
2. B. G. Streetman, *Solid State Electronics Devices*, 5e, Prentice-Hall of India (2001).
3. P. Horowitz and W. Hill, *The Art of Electronics*, Cambridge University Press (1995).
4. F. J. Hill and G. R. Peterson, *Computer-aided Logical Design*, 4th ed., John Wiley (1993).
5. M. Mano, *Digital Design*, 2nd ed., Prentice-Hall of India (1997).
6. V.P. Nelson, H.T. Nagle, B.D. Carroll & J.D. Irwin, *Digital Logic Circuit Analysis and Design*, Prentice-Hall (1995).

PH-210 Electronics Laboratory I (0-0-4-4)

Amplifiers: single- and multi-stage amplifiers, frequency response, Fourier transform, various classes of amplifiers and their frequency response, various modulation schemes. Multivibrators and wave function generators, filters. Measurement of depletion layer capacitance and effect of temperature. Controller circuits.

References:

1. P. B. Zbar and A. P. Malvino, *Basic electronics: A text-lab manual*, Tata McGraw Hill (1983).
2. P. Horowitz and W. Hill, *The Art of Electronics*, Cambridge University Press (1995).
3. R. A. Gayakwad, *Op-Amps and Linear Integrated Circuits*, Prentice-Hall of India (2002).

PH-301 Electromagnetics (3-1-0-8)

Electrostatics: Green function, Dirichlet and Neumann boundary conditions, Green function for the sphere. Laplace Equation: Separation of variables in spherical and cylindrical coordinates and general solution (Legendre polynomials, Spherical harmonics, Bessel function, etc.). Expansion of Green function in spherical and cylindrical coordinates. Multipole expansion. Dielectrics: Boundary value problem, Clausius Mossotti equation. Electrostatic energy. Anisotropy and susceptibility tensor. Magnetism: Green function method for vector potential, Magnetic materials, Boundary value problems. Magenetic field in conductors.

Maxwell Equations: Time varying fields, conservation laws, Plane waves, propagation in nonconducting and conducting media. Reflection and refraction, Fresnel relations. Kramers-Kronig relations. Gauge transformation and gauge conditions. Green function method for wave equation. Retarded potentials. Poynting theorem – for harmonic fields – in dispersive medium. Transformation properties of the electromagnetic field. Wave guides and Cavities: Fields within a conductor. Rectangular and cylindrical geometries. Orthonormal modes. Energy flow and attenuation. Power loss and Q-value. Schumann resonances. Radiation: Oscillating source. Electric dipole, magnetic dipole, and electric quadrupole fields. Centre-fed linear antenna. Multipole expansion and multipole radiation. Scattering of electromagnetic waves.

Text Books:

1. J. D. Jackson, *Classical Electrodynamics*, 3rd ed., John Wiley (2005).
2. W. Greiner, *Classical Electrodynamics*, Springer (2006).

References:

1. E. C. Jordan and K. G. Balmain, *Electromagnetic Waves and Radiating Systems*, 2nd ed., Prentice-Hall of India (1995).
2. J. D. Kraus, *Antennas*, 2nd ed., McGraw-Hill (1988).

PH-303 Microprocessor Architecture and Programming (3-0-0-6)

Introduction to Microprocessors. The 8085 Architecture, Bus organization, Registers, Memory, I/O devices. Control signals, Machine cycles and Bus timings. Memory Interfacing: Memory Read cycle, Address decoding, Interfacing the 8155 memory section. I/O Interfacing: I/O Instructions and executions, Device selection, Interfacing with input and output devices. Memory mapped I/O. 8085 Instructions and Assembly Language: Arithmetic operations, Logic operations, Branch operations. Controls and time delays.

Flowchart and Programming techniques, Stack and Subroutines, Restart, Conditional Call, and Return instructions. Nesting. Code Conversions: BCD-Binary, BCD-seven segment LED, Binary-ASCII. BCD Arithmetic and 16-bit data operations. Operating System: Assembler and programming using an Assembler. Interrupts: Instructions, Restart, Trap. Programmable interrupt controller 8259A. Interfacing: with D/A and A/D converter. Interfacing I/O ports using 8155. The 8279 keyboard/display interfacing. The 8255 programmable peripheral interface. Serial I/O and Data communication. Microprocessor applications.

Text Books:

1. R. S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*,

5th ed., Penram International/Prentice-Hall (1999).

2. N. K. Srinath, 8085 *Microprocessor Programming and Interfacing*, Prentice-Hall of India (2005).

References:

1. D. V. Hall, *Microprocessors and Interfacing*, Tata McGraw-Hill (1995).

2. W. Kleitz, *Microprocessor and Microcontroller Fundamentals: the 8085 and 8051 Hardware and Software*, Prentice-Hall (1997).

3. J. Uffenbeck, *Microcomputers and Microprocessors: the 8080, 8085, and Z80 Programming, Interfacing, and Troubleshooting*, Prentice-Hall (1999).

4. J. Uffenbeck, *8086 Family, Programming and Interfacing*, Prentice-Hall of India (2001).

PH-305 Atomic and Nuclear Physics (3-1-0-8)

Review of the Hydrogen atom problem, Stark Effect, Zeeman effect, Paschen-Back effect. Interaction with electromagnetic field, Dipole approximation, Selection rules. Line width of spectral lines. Relativistic correction, Fine and Hyperfine structure. Helium Atom, Consequence of the Pauli exclusion principle, Approximate methods for ground and excited states, Auger effect. Many electron atoms: Central field approximation. Antisymmetrization of wave function. Thomas-Fermi method. Hartree and Hartee-Fock method of self-consistent field. *LS* coupling and *jj* coupling. Density functional theory.

Two-Nucleon Problem: Ground and excited states of Deuteron. n-p scattering and its spin dependence. Coherent and incoherent scattering. Tensor forces and the Deuteron problem. Magnetic and Quadrupole moments of the Deuteron. Photo disintegration of the Deuteron. Many-Nucleon Phenomenology: Binding energy and Weizsacker mass formula. Liquid drop model. Spontaneous fission. Mass distribution of fission products. Nuclear reactions: Cross section. Partial wave analysis. Resonance. Breit-Wigner dispersion formula. Shell model. Independent particle model. *LS* coupling and *jj* coupling schemes. Collective model. Many body treatment of the nucleus.

Text Books:

1. B. H. Bransden and C. J. Joachain, *Physics of Atoms and Molecules*, Pearson Education (2003).

2. H. Haken and H. C. Wolf, *The Physics of Atoms and Quanta*, Springer (2004).

3. R. R. Roy and B. P. Nigam, *Nuclear Physics, Theory and Experiment*, New Age (1995).

References:

1. H. E. White, *Introduction to Atomic Spectra*, McGraw-Hill (1934).

2. N. Levine, *Quantum Chemistry*, 4th ed., Prentice-Hall of India (2000).

3. E. U. Condon and G. H. Shortley, *The Theory of Atomic Spectra*, Cambridge (1935).

4. J. M. Blatt and V. F. Weisskopf, *Theoretical Nuclear Physics*, John Wiley (1952).

PH-310 General Physics Laboratory (0-0-6-6)

Experiments based on general physics, optics, and condensed matter physics.

References:

1. R. A. Dunlop, *Experimental Physics*, Oxford University Press (1988).

2. A. C. Melissinos, *Experiments in Modern Physics*, Academic Press (1996).

PH-320 Electronics Laboratory II (0-0-3-3)

Experiments using Small Scale Integration and Medium Scale Integration digital integrated circuits: logic gates, flip-flops, counters, multiplexers, demultiplexers, shift registers, seven-segment decoders, monostable multivibrators, latches, memories, etc. Assembly language programming for 8085 microprocessor, interfacing 8085 microprocessor with memory and I/O devices, 8085 microprocessor kit based interfacing experiments using peripheral programmable interface such as LED and 7-segment display, Temperature controller, stepper motor control, A/D and D/A converters, etc.

References:

1. P. B. Zbar and A. P. Malvino, *Basic electronics: A text-lab manual*, Tata McGraw Hill (1983).
2. A. P. Malvino and D. P Leach, *Digital Principles and Applications*, McGraw-Hill (1996).
3. R. S. Gaonkar: *Microprocessor Architecture, programming & application with 8085/8080A*, 2nd ed., New Age, 1995.

PH-302 Engineering Optics (3-0-0-6)

Geometrical optics: Matrix formulation for lens and mirrors and combinations, Aberrations. Diffraction Theory: Kirchoff integrals, Fraunhofer and Fresnel diffraction, Propagation of Gaussian beam, derivation of lens making formula, Fourier optics, Spatial frequency filtering, image processing, Holography.

Interference Phenomena: Two and Multiple beam interference, effect of line width, fringe contrast, coherence, Optical properties of single and multilayer thin films, matrix formulation, applications of interferometer. Polarization: Polarization of radiation, polarization calculus (matrix formulation and Poincare representation, Pancharatnam phase), birefringence, crystal optics, Ellipsometry and application of polarization based devices. Optical designing and testing, optical devices and their applications.

Text Books:

1. M. Born and E. Wolf, *Principles of Optics*, 6th ed., Cambridge University Press (1997).
2. B. H. Walker, *Optical Engineering Fundamentals*, SPIE Optical Engineering Press (1998).
3. R. M. A. Azzam and N. M. Bashara, *Ellipsometry and Polarized light*, Elsevier (1996).

4. W. J. Smith, *Modern Optical Engineering*, McGraw-Hill (1991).

References:

1. R. D. Gunther, *Modern Optics*, John Wiley (1990).
2. K. Iizuka, *Elements of Photonics*, John Wiley (2002).

PH-304 Materials Science (3-0-0-6)

Classification of Engineering Materials, Equilibrium and Kinetics, Atomic Structure and Chemical Bonding, Structure of Crystalline and Non-crystalline solids, Imperfections in Solids. Phase Diagrams: Phase rule, Phases, Binary phase diagram and Eutectic, Eutectoid and Peritectic systems, Microstructural changes, The Lever Rule, Examples of Phase diagram, Application of Phase diagram. Phase Transformation: Time scale of phase changes, nucleation and growth, transformation in steel, precipitation processes, solidification and crystallization, re-crystallization and grain growth. Diffusion in Solids: Fick's laws and their applications, Kirkendall effect, atomistic model of diffusion.

Mechanical properties of metals: Elastic, Anelastic and Viscoelastic behavior, Plastic deformation and Creep in Crystalline Materials, Hardness, Mechanical testing of metals. Failure: Fracture, fatigue and creep. Thermal processing of metal alloys: Annealing processes, heat treatment of steels, precipitation hardening. Oxidation and Corrosion: Mechanism of oxidation, Oxidation resistant materials, corrosion, Protection against corrosion. Materials: Ceramics, Polymers and Composites Materials Selection and Design consideration, Environmental issues in material science.

Text Books:

1. V. Raghavan, *Material Science and Engineering: A First Course*, 5th ed., Prentice-Hall of India (2004).

2. W. D. Callister Jr., *Materials Science and Engineering: An Introduction*, 6th ed. (2003).

References:

1. J. B. Wachtman, *Characterization of Materials*, Butterworth-Heinemann (1992).

2. L. H. Van Valck, *Elements of Materials Science and Engineering*, 6th ed., Addison-Wesley (1998).

PH-306 Statistical Mechanics (3-1-0-8)

Review of Thermodynamics: Laws of thermodynamics, entropy, potentials. Statistical Thermodynamics: Macroscopic and microscopic states, connection between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.

Ensemble Theory: Phase space, Liouville's theorem, microcanonical ensemble, examples, quantum states and phase space. Canonical Ensemble: Equilibrium, partition function, energy fluctuation, equipartition and Virial theorem, harmonic oscillators, statistics of paramagnetism. Grand

Canonical Ensemble: Equilibrium, partition function, density and energy fluctuation, correspondence with other ensembles, examples. Formulation of Quantum Statistics: Quantum mechanical ensemble theory, density Matrix, statistics of various ensembles, examples.

Theory of Simple Gases: Ideal gas in different quantum mechanical ensembles. Systems of: monatomic, diatomic and polyatomic molecules. Ideal Bose Gas: Thermodynamics, Bose-Einstein condensation, blackbody radiation, phonons, Helium II. Ideal Fermi Gas: Thermodynamics, Pauli paramagnetism, Landau diamagnetism, DeHass-Van Alphen Effect, thermionic and photoelectric emissions, white dwarfs. Interacting Systems: Cluster expansion, Virial Expansion, evaluation of Virial coefficients.

Text Book:

1. R. K. Pathria, *Statistical Mechanics*, Butterworth-Heinemann (1996).

References:

1. F. Reif, *Statistical and Thermal Physics*, McGraw-Hill (1985).
2. W. Greiner, L Neise, and H. Stöcker, *Thermodynamics and Statistical Mechanics*, Springer (1994).
3. K. Huang, *Statistical Mechanics*, John Wiley Asia (2000).
4. L. D. Landau and E. M. Lifshitz, *Statistical Physics*-I, Pergamon (1980).

PH-308 Numerical Methods and Computational Physics (2-0-2-6)

Errors: Its sources, propagation and analysis, computer representation of numbers.

Roots of Nonlinear Equations: Bisection, Newton-Raphson, secant method. System of Nonlinear equations, Newton's method for Nonlinear systems. Applications in Physics problems.

Solution of linear systems: Gauss, Gauss-Jordan elimination, matrix inversion and LU decomposition. Eigenvalues and Eigenvectors. Applications.

Interpolation and Curve fitting: Introduction to interpolation, Lagrange approximation, Newton and Chebyshev polynomials. Least square fitting, linear and nonlinear. Application in Physics problems.

Numerical Differentiation and Integration: Approximating the derivative, numerical differentiation formulas, introduction to quadrature, trapezoidal and Simpson's rule, Gauss-Legendre integration. Applications.

Solution of ODE: Initial value and boundary value problems, Euler's and Runge-Kutta methods, Finite difference method. Applications in Chaotic dynamics, Schrödinger equations.

Solution of PDE: Hyperbolic, Parabolic, and Elliptic Equations by finite difference. Application to 2-dimensional Electrostatic Field problems.

Text Books:

1. K. E. Atkinson, *Numerical Analysis*, John Wiley, Asia (2004).

2. S. C. Chapra and R. P. Canale, *Numerical Methods for Engineers*, Tata McGraw-Hill (2002).

References:

1. J. H. Mathews, *Numerical Methods for Mathematics, Science, and Engineering*, Prentice-Hall of India (1998).
2. S. S. M. Wong, *Computational Methods in Physics*, World Scientific (1992).
3. W. H. Press, S. A. Teukolsky, W. T. Verlling and B. P. Flannery, *Numerical Recipes in C*, Cambridge (1998).

PH-312 Measurement Techniques (2-0-3-7)

Sensors: Resistive, capacitative, inductive, electromagnetic, thermoelectric, elastic, piezoelectric, piezoresistive, photosensitive and electrochemical sensors; interfacing sensors and data acquisition using serial and parallel ports.
Low Pressure: Rotary, sorption, oil diffusion, turbo molecular, getter and cryo pumps; Mcleod, thermoelectric (thermocouple, thermister and pirani), penning, hot cathode and Bayard Alpert gauges; partial pressure measurement; leak detection; gas flow through pipes and apertures; effective pump speed; vacuum components.

Low Temperature: Gas liquifiers; Cryo-fluid baths; liquid He cryostat design; closed cycle He refrigerator; low temperature measurement.

Analytical Instruments: X-ray diffractometer; Spectrophotometers; FT-IR; DSC; lock-in amplifier; spectrum analyzer, fluorescence and Raman spectrometer, scanning electron microscope, atomic force microscope, interferometers.

Laboratory Component: physical parameter measurement using different sensors; low pressure generation and measurement; calibration of secondary gauges; cryostat design; CCR operation; data collection from analytical instruments in the department.

References:

1. A. D. Helfrick and W. D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*,

Prentice-Hall of India (1996).
2. J. P. Bentley, *Principles of Measurement Systems*, Longman (2000).
3. G. K. White, *Experimental Techniques in Low Temperature Physics*, Clarendon (1993).
4. A. Roth, *Vacuum Technology*, Elsevier (1990).
5. D. A. Skoog, F. J. Holler and T. A. Nieman, *Principles of Instrumental Analysis*, Saunders Coll. Publ. (1998).

PH-330 Advanced Physics Laboratory (0-0-6-6)

Experiments based on modern optics, lasers, solid state physics, microwave, nuclear physics and advanced measurement techniques.

References:

1. C. Isenberg and S. Chomet (eds.), *Physics Experiment and Projects for Students*, vols. I, II and III, Hemisphere Publishing Corporation (1998).
2. G. L. Squires, *Practical Physics*, Cambridge University Press (1999).

PH-413 Lasers and Photonics (3-1-0-8)

Laser Physics: Basic principle of laser, optical amplification, laser rate equations, gain coefficient, threshold condition, line broadening, optical resonators, longitudinal and transverse modes, optimum output coupling, Properties of Laser, Q-switching, mode locking and pulse compression, Various common laser systems and applications. Laser modulators: Electro-optics, Accousto-optics modulators, deflectors, tunable filters.
Nonlinear Optics: Nonlinear optical susceptibilities, Harmonic generation, frequency conversion, phase matching, bistable devices, optical switching. Photonic Devices: Optical detectors, Optical waveguides, integrated optics, Fiber-Optic communication systems, Optical computing.

Text Books:

1. O. Svelto, *Principles of Lasers*, Plenum Press (1998).
2. R. W. Boyd, *Non Linear Optics*, 2nd ed., Academic Press (2003).
3. K. Iizuka, *Elements of Photonics*, John Wiley & Sons (2002).
4. B. E. Saleh and M.C. Teich, *Photonics*, John Wiley (2002).

References:

1. A. E. Seigmen, *Lasers*, University Science Books (1986).
2. A. Yariv, *Optical Electronics*, 4th ed., Saunders College Publishing (1991).
3. Y. R. Shen, *The principle of Non Linear Optics*, John Wiley (1984).
4. G. Keisser, *Optical Fiber Communication*, McGraw-Hill (1991).

PH-505 Solid State Physics (3-1-0-8)

Crystal physics: Symmetry operations; Bravais lattices; Point and space groups; Miller indices and reciprocal lattice; Structure determination; diffraction; X-ray, electron and neutron; Crystal binding; Defects in crystals; Point and line defects.

Lattice vibration and thermal properties: Einstein and Debye models; continuous solid; linear lattice; acoustic and optical modes; dispersion relation; attenuation; density of states; phonons and quantization; Brillouin zones; thermal conductivity of metals and insulators.
Electronic properties: Free electron theory of metals; electrons in a periodic potential; Bloch equation; Kronig-Penny model; band theory; metal, semiconductor and insulators; bandgap; intrinsic and extrinsic semiconductors, Hall Effect, p-n junction.

Dielectrics: Polarizability; Clausius-Mossotti formula; Dielectric constant; ferroelectrics.
Magnetism: Diamagnetism, paramagnetism, ferromagnetism, antiferro magnetism and ferrimagnaetism.
Superconductivity: Meissner effect; London equations; coherence length; type-I and type-II superconductors.

Text Books:

1. H. P. Myers, *Introduction to Solid State Physics*, Viva books (1998).
2. M. A. Omar, *Elementary Solid State Physics*, Addison-Wesley (1975).

References:

1. C. Kittel, *Introduction to Solid State Physics*, John Wiley (1996).
2. A. J. Dekker, *Solid State Physics*, Macmillan (1986).
3. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, HBC Publ. (1976).

PH-417 Semiconductor Devices (3-0-0-6)

Energy bands in solids and Charge carriers. Semiconductors: Elemental and compound semiconductors, intrinsic and extrinsic materials, Direct and indirect band-gap semiconductors, Heavily doped semiconductors. Charge carrier in semiconductors: mobility, impurity band conduction, nonlinear conductivity, excess carriers in semiconductors. Semiconductor Bloch equation, transport properties.

P-N Junctions: fabrication, static and dynamic behavior of p-n junction diodes, Junction breakdown in p-n junctions, tunnel diode, Schottky diode. Bipolar Junction Transistor: fundamentals of BJT operation, BJT fabrication, carrier distribution and terminal current, generalized biasing, switches, frequency limitations of transistors. Field Effect Transistors: JFET, MOSFET. Metal Semiconductor junctions: Schottky effect, rectifying and Ohmic contacts. Integrated circuits, fabrication methods. Power devices: p-n-p-n diode, Silicon controlled rectifiers. Optoelectronic Devices: photodiodes, light emitting diodes, semiconductor lasers, photovoltaic cells.

Text Books:

1. S. M. Sze, *Physics of Semiconductor Devices*, 2nd ed., John Wiley (1982).
2. Michael Shur, *Introduction to Electronic Devices*, John Wiley (2000).
3. J. Singh, *Semiconductor Devices--Basic Principles*; John Wiley (2001).

References:

1. M. S. Tyagi, *Introduction to Semiconductor Materials and Devices*, John Wiley (1991).
4. Ben G. Streetman, *Solid State Electronic Devices*, 5th ed., Prentice-Hall of India (2001).

PH-414 Nanoelectronics and Nanophotonics (3-0-0-6)

Nanoelectronics: Energy levels, Density of states. Bond structure, coulomb blockade, quantum wire, electron phase correlation, single electron tunneling, quantum dot, molecular motors, nano-transistors and FET and NEMS and sensors.
Nanophotonics: nano scale field interaction, nanoconfinement, near field microscopy, plasmonics, nonlinear optical phenomena, nano-scale dynamics, quantum well laser, photonic crystal and wave guide. Growth method and characterization of material, nanolithography, nanphotonics for biotechnology.

Text Books:

1. Rainer Waser (ed.), *Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices*, Wiley-VCH (2003).
2. P. N. Prasad, *Nanophotonics*, Wiley Interscience (2004).

References:

1. A. S. Edelstein and R. C. Cammarata (eds.), *Nanomaterials: Synthesis, Properties and Applications*, Institute of Physics Publishing (1996).

2. Z. L. Wang (ed.), *Characterization of Nanophase Materials*, Wiley-VCH (2001).

3. T. Heinzel, *Mesoscopic Electronics in Solid State Nanostructures*, Wiley-VCH (2003).

4. Charles P. Poole and Frank J. Owens, *Introduction to Nanotechnology*, Wiley-Interscience (2003).