DEPARTMENT OF PHYSICS

Course Structure & Syllabi for BTech [Engineering Physics] – (To be applicable for 2010-batch onwards)

BTech Course Structure –Engineering Physics

Course No.	Course Name	L	T	P	C		Course No.	Course Name	L	T	P	C
	Semester - 1							**Semester -2**				
CH101	Chemistry	3	1	0	8		BT101	Modern Biology	3	0	0	6
CH110	Chemistry Laboratory	0	0	3	3		CS 101	Introduction to Computing	3	0	0	6
EE101	Electrical Sciences	3	1	0	8		CS110	Computing Laboratory	0	0	3	3
MA101	Mathematics - I	3	1	0	8		EE102	Basic Electronics Laboratory	0	0	3	3
ME 110/ PH 110	Workshop / Physics Laboratory	0	0	3	3		MA102	Mathematics - II	3	1	0	8
ME 111	Engineering Drawing	0	0	3	3		ME101	Engineering Mechanics	3	1	0	8
PH101	Physics - I	2	1	0	6		PH102	Physics - II	2	1	0	6
SA 101	Physical Training - I	0	0	2	0		PH 110/ ME 110	Physics Laboratory/ Workshop	0	0	3	3
	NCC/NSO/NSS	0	0	2	0		SA 102	Physical Training - II	0	0	2	0
		11	**4**	**9**	**39**			NCC/NSO/NSS	0	0	2	0
									14	**3**	**9**	**43**
	Semester 3							**Semester 4**				
MA201	Mathematics - III	3	1	0	8		PH202	Electromagnetics	3	1	0	8
EE220	Signals, Systems and Networks	3	1	0	8		PH204	Quantum Mechanics	3	1	0	8
PH201	Advanced Classical Mechanics	3	1	0	8		PH206	Analog & Digital Electronics	3	0	0	6
PH203	Semiconductor Devices	3	0	0	6		BT205	Biophysics	2	1	0	6
PH205	Heat & Thermodynamics	2	1	0	6		HS2xx	HSS Elective - II	3	0	0	6
HS2xx	HSS elective - I	3	0	0	6		PH210	Electronics Lab-I	0	0	4	4
SA 201	Physical Training - III	0	0	2	0		SA 202	Physical Training -IV	0	0	2	0
	NCC/NSO/NSS	0	0	2	0			NCC/NSO/NSS	0	0	2	0
		17	**4**	**0**	**42**				**14**	**3**	**4**	**38**
	Semester 5							**Semester 6**				
PH301	Microprocessor architecture and Programming	3	0	0	6		PH302	Solid State Physics	2	1	0	6
PH303	Atomic and Molecular Spectroscopy	3	0	0	6		PH304	Engineering Optics	3	0	0	6
PH305	Computational Physics	2	0	2	6		PH306	Nuclear Science & Engineering	3	0	0	6
PH307	Statistical Mechanics	2	1	0	6		PH308	Measurement Techniques	2	0	2	6
HS3xx	HSS Elective - III	3	0	0	6		XXxxx	Open Elective - I	3	0	0	6
PH311	Electronics Lab-II	0	0	6	6		PH320	General Physics Lab	0	0	6	6
		13	**1**	**8**	**36**				**13**	**1**	**8**	**36**
	Semester 7							**Semester 8**				
PH413	Materials Science & Engineering	3	0	0	6		PH414	Nanoelectronics&Nanophotonics	3	0	0	6
PH415	Lasers & Photonics	3	0	0	6		PH4XX	Department Elective - II	3	0	0	6
PHxxx	Department Elective-I	3	0	0	6		PH4XX	Department Elective - III	3	0	0	6
XXxxx	Open Elective - II	3	0	0	6		XX4XX	Open Elective - III	3	0	0	6
PH417	Advanced Physics Lab	0	0	6	6		HS4XX	HSS Elective - IV	3	0	0	6
PH498	Project - I	0	0	6	6		PH499	Project - II	0	0	6	6
		12	**0**	**12**	**36**				**15**	**0**	**6**	**36**

SEMESTER-3

PH201: Advanced Classical Mechanics (3-1-0-8)

Generalized coordinates. Lagrangian formulation of dynamical systems. D'Alemberts Principle. calculus of variations; Principle of least action: Hamilton's principle, Symmetry and conservation theorems, Hamiltonian Formulation, Legendre transformation, Poisson brackets; Two body central force problem: conservation of angular momentum and energy, motion in gravitational potential, equation for the orbit, stability of orbits; Conserved quantities : angular momentum and Runge Lenz Vector; Orthogonal transformation: rigid body rotation about a fixed axis, moment of Inertia tensor, Eigen values and principal axis transformations; Euler angles, Euler equations of a rigid body, precession of heavy symmetrical top; Small oscillations: dynamical matrix, normal modes. Continuum mechanics: Transverse motion of a Taut String, the wave equation, boundary conditions, waves on a finite string, three-dimensional wave equation, volume and surface forces; Stress and Strain: the elastic moduli, the stress tensor, the strain tensor for a solid; Relation Between Stress and Strain: Hooke's law, the equation of motion for an elastic solid, longitudinal and transverse waves in a solid; Fluids: description of the motion, waves in a Fluid.

Texts:

1. N.C. Rana and P.S. Joag, *Classical Mechanics,* Tata McGraw-Hill, New Delhi, 1991.
2. H. Goldstein, *Classical Mechanics,* Narosa, New Delhi, 1998.

References:

1. J. R. Taylor, Classical Mechanics, University ScienceBooks, 2003.
2. L.D. Landau and E.M. Lifshitz, *The Classical Theory of Fields*, Elsevier, 2005.

PH203: 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.

Texts:

1. S. M. Sze, *Physics of Semiconductor devices*, 2nd Ed., John Wiley, 1982.
2. M. 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, 2008.
2. B. G. Streetman, *Solid State Electronic Devices*, 5th Ed., PHI, 2001.

PH205: Heat and Thermodynamics (2-1-0-6)

Kinetic theory and Transport phenomena: Equation of state of a perfect gas, Maxwell velocity distribution, real gases and Vander Wall's equation, Brownian motion, mean free path, viscosity and thermal conductivity. Laws of thermodynamics and applications: Review of thermodynamic systems, state variables, intensive and extensive parameters, thermodynamic processes, Zeroth and first law of thermodynamics; State functions, internal energy and enthalpy, Joule Thomson effect, Carnot process and entropy, second law of thermodynamics, refrigerators and thermodynamic engines; Otto and diesel engines, TdS equations, Third law of thermodynamics; Thermodynamic potentials: Entropy and internal energy as thermodynamic potentials, Legendre transformation, Helmholtz and Gibbs potentials, enthalpy, grand potential, transformation of variables Maxwell relations; Phase equilibria: Gibb's phase rule, Clausius-Clapeyron equation, phase equilibrium and Maxwell construction, first order phase transitions.

Texts:

1. W. Pauli, *Thermodynamics and kinetic theory of gases*, Dover Publications, 2010
2. M. W. Zeemansky and R. H. Dittman, *Heat and thermodynamics*, McGraw Hill, 1997

References:

1. F. W. Sears and G. L. Salinger, *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, Narosa, New Delhi, 1975.
2. C. Kittel and H. Kroemer, *Thermal Physics*, W. H. Freeman & Co., 1980.
3. F. Mandl,*Statistical Physics*, John Wiley, 1978.
4. W. Greiner, L. Neise and H. Stocker, *Thermodynamics and Statistical Mechanics*, Springer, 1995.

SEMESTER-4

PH202: 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, ClausiusMossotti 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 EM field. Wave guides & 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.

Texts:

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.

PH204: Quantum Mechanics (3-1-0-8)

Review of wave mechanics: Young's double slit, de Broglie relation, wave packets, Schrodinger equation; Observable, Eigen values and Eigen functions; Simple applications: particle in a box; potential well; potential barrier, delta function potential, linear harmonic oscillator; Matrix formulation: Dirac's bra and ket notation, matrix representation of vectors and operators, expectation values; Angular momentum: spherical harmonics, $\boldsymbol{L^2}$ and L_z operators, commutation relations, spin of electron; 3-dimensional problems: Hydrogen atom, energy levels, wave function; Time independent perturbation: non-degenerate and degenerate cases; applications to Zeeman effect.

Texts:

1. E. Merzbacher, *Quantum Mechanics*, 3rd Ed., John Wiley & Sons, 1998.
2. S. Gazierowicz, *Quantum Physics*,, John Wiley, 2000

References:

1. P. W. Mathews and K. Venkatesan, *A Textbook of Quantum Mechanics,* Tata McGraw Hill, 1995.
2. J.J. Sakurai, *Modern Quantum Mechanics*, Pearson Education, 2002.
3. R. Shankar, *Principle of Quantum Mechanics,* 2nd Ed., Springer, 2008.
4. B.H. Bransden and C.J. Joachain, *Quantum Mechanics,* 2nd Ed., Pearson Education, 2007.

PH206: Analog and Digital Electronics (3-0-0-6)

Physics of junction devices; BJT/FET amplifiers; Feedback: effect of negative and positive feedback, basic feedback topologies; Feedback amplifiers: sinusoidal oscillators. Different classes of power amplifiers; differential amplifiers; Operational amplifiers: arithmetic circuits, active filters, voltage controlled oscillators, A/D and D/A converters, sample and hold circuits and other applications of Op-amps; SE/NE 555 timer IC, multivibrators. Review of number systems and their inter conversion, logic gates and logic families; MOSFET as switch; CMOS inverter; Combinational logic modules; flip-flops; registers; counters; sequential circuits, decoders, encoders, multiplexers, de-multiplexers and their applications; comparators; Different types of semiconductor memories and their architectures; Programmable logic devices.

Texts:

1. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, Oxford University Press, 2008.
2. R. A. Gaykwad, *Op-Amps and Linear Integrated Circuits*, Prentice- Hall of India, 2002.
3. D. P. Leach, A. P. Malvino and G Saha, *Digital Principles and Applications*, Tata McGraw Hill, 2007.

References:

1. J. F. Wakerly, *Digital Design - Principles and Practices*, 3rd Ed., Prentice Hall of India, 2005.
2. J. Millman and C. C. Halkias, *Integrated Electronics*, Tata McGraw Hill, 1995.
3. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, Pearson Education, 2007.
4. P. Horowitz and W. Hill, *The Art of Electronics*, Cambridge University Press, 1995.
5. M. Mano, *Digital Design*, 2nd Ed., Prentice Hall of India, 1997.

PH210: Electronic Lab - I (0-0-4-4)

Amplifiers: single-stage 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.

SEMESTER – 5

PH301: 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, interfaces 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.

Texts:

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*, PHI, 2001.

PH303: Atomic and Molecular Spectroscopy (3-0-0-6)

Review of single electron systems; Multi-electron atoms: central-field and Hartree – Fock approximations, Thomas Fermi model, angular momentum, LS and jj coupling, Pauli exclusion principle, alkali spectra, Helium atom, complex atoms; Zeeman effect, Paschen-Back effect and Stark effect. Rotational spectra of diatomic molecules, infra-red spectra, diatomic vibrating rotator, vibration rotation spectra; electronic spectra of diatomic molecules, vibrational coarse structure, Franck- Condon principle, dissociation energy, rotational fine structure; Spectroscopic Techniques: Interferometers and spectrometers, FTIR, Raman, NMR and ESR spectroscopy.

Texts:

1. B H Bransden and C J Joachain, *Physics of atoms and molecules*, 2nd Ed., Pearson Education, 2007.
2. A N Banwell and E M McCash, *Fundamentals of molecular spectroscopy*, 4th Ed., Tata McGraw Hill, 1995.

References:

1. H E White, *Introduction to atomic spectra*, 1st Ed., McGraw Hill, 1934.
2. H. Haken and H. C. Wolf, *The Physics of Atoms and Quanta: Introduction to experiment and theory*, 7th Ed., Springer, 2010.
3. S. Svanberg, *Atomic and molecular spectroscopy: basic aspects and practical applications*,4th Ed., Springer, 2004.
4. W. Demtroder, *Laser Spectroscopy*, 4th Ed., Springer, 2008.

PH305: Computational Physics (2-0-2-6)

Matrices: System of linear equations, Gauss and Gauss-Jordan elimination, Matrix Inversion, LU decomposition, Eigen value and eigenvector problems, Power and Jacobi method, application to physics problems; Ordinary and Partial Differential Equations: Euler, Runge-Kutta and finite difference methods; solution to initial and boundary value problems, Finite difference solutions to hyperbolic, parabolic and elliptic partial differential equations, application to physics problems; Monte Carlo Simulation: Markov process and Markov chain, random numbers, simple and importance sampling, Metropolis algorithm, 2D-Ising model.

Texts:

1. S. S. M. Wong, *Computational Methods in Physics and Engineering*, World Scientific, 1997.
2. T. Pang, *An Introduction to Computational Physics*, Cambridge University Press, 1997.

References:

1. R. H. Landau, M. J. Paez and C. C. Bordeianu, *Computational Physics: Problem Solving with Computer*, Wiley VchVerlagGmbh& Co. KGaA, 2007.
2. D. Frenkel and B. Smit, *Understanding Molecular Simulation*, Academic Press, 1996.
3. M. E. J. Newman and G. T. Barkema, *Monte Carlo Methods in Statistical Physics*, Clarendon Press, Oxford, 2001.
4. M. P. Allen and D. J. Tildesley, *Computer Simulation of Liquids*, Clarendon Press, Oxford, 1991.
5. W. H. Press, S. A. Teukolsky, W. T. Verlling and B. P. Flannery, *Numerical Recipes in C/Fortran*, Cambridge, 1998.

PH307: Statistical Mechanics (2-1-0-6)

Ensemble theory: Phase space, Ergodic hypothesis, Liouville's theorem, micro-canonical, canonical and grand canonical ensembles, equipartition and virial theorems, formulation of quantum statistics, quantum mechanical ensemble theory. Quantum gases: Ideal Bose gas, Bose Einstein condensation, blackbody radiation, phonons; ideal Fermi gas, Pauli paramagnetism, thermionic emissions, white dwarfs. Non-equilibrium statistical mechanics: Boltzmann transport equation, master equations, Markov processes, diffusion and Brownian motion.

Texts:

1. R.K. Pathria, *Statistical Mechanics*, Butterworth Heinemann, 1996.
2. N. Pottier, *Nonequilibrium Statistical Physics*, Oxford University Press, 2010.

References:

1. K. Huang, *Statistical Mechanics*, John Wiley, Asia, 2000.
2. L.D. Landau and E.M. Lifshitz, *Statistical Physics-1*, Pergamon, 1980.
3. L. Couture and R. Zitoun, *Statistical Thermodynamics and Properties of Matter*, Gordon & Breach Science Publishers, 1998.

PH311: Electronics Lab - II (0-0-6-6)

Experiments using Small Scale Integration and Medium Scale Integration digital integrated circuits: logic gates, flip-flops, counters, multiplexers, de-multiplexers, shift registers, seven segment decoders, monostable multi-vibrators, 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

SEMESTER- 6

PH302: Solid State Physics (2-1-0-6)

Crystallography: crystal lattices and symmetry groups, reciprocal lattice, Brillouin zone, Miller indices, crystal structure by X-ray diffraction, crystal defects; Thermal properties: crystal potentials, harmonic theory of lattice vibrations, optical and acoustic modes, density of states, Einstein and Debye theory of specific heat; Electronic properties: free electron theory, electrons in a periodic potential, Bloch's theorem, Kronig-Penny model, formation of bands, effective mass, holes, classification of metal, insulator and semiconductor, intrinsic and extrinsic semiconductors, law of mass action, Hall effect; Magnetic properties: classical and quantum models of diamagnetism, quantum theory of Para-magnetism, Lande g factor, Hund's rule, electronic configurations, crystal field, Curie law, concepts of Ferro, ferri, and anti-ferro magnetism; Superconductivity: Meissner effect, London equations, BCS ground state, flux quantization in superconducting ring, type-II superconductors, Josephson tunnelling, high temperature superconductors.

Texts:

1. H. P. Myers, *Introduction to Solid State Physics*, CRC press, 1997.
2. C. Kittel, *Introduction to Solid State Physics*, John Wiley & Sons, 2005.

References:

1. N.W. Ashcroft and N.D. Mermin, *Solid State Physics*, HBC Publication, 1976.
2. J. R. Christman, *Fundamentals of Solid State Physics*, John Wiley & Sons, 1988.
3. A.J. Dekker, *Solid State Physics*, Mcmillan, 1986.

PH304: Engineering Optics (3-0-0-6)

Geometrical optics: Matrix formulation for lens and mirrors and combinations, Aberrations. Diffraction Theory: Kirchhoff integrals, Fraunhoffer 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.

Texts:

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.

References:

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

PH306: Nuclear Science and Engineering (3-0-0-6)

Review of nuclear physics: general nuclear properties, models of nuclear structure, nuclear reactions, nuclear decays and fundamental interactions; Nuclear radiation: radioactivity, radiation dosimetry, dosimetry units and measurement; radiation protection and control; applications of radiation: medical applications, industrial radiography, neutron activation analysis, instrument sterilization, nuclear dating; Nuclear fission: nuclear energy, fission products, fissile materials, chain reactions, moderators, neutron thermalization, reactor physics, criticality & design; nuclear power engineering; energy transport and conversion in reactor systems, nuclear reactor safety; nuclear fusion: controlled fusion, nuclear fusion reactions, fusion reactor concepts, magnetic confinement, tokamak, inertial confinement by lasers; Nuclear waste management: components and material flow sheets for nuclear fuel cycle, waste characteristics, sources of radioactive wastes, compositions, radioactivity and heat generation; waste treatment and disposal technologies; safety assessment of waste disposal; Particle accelerators and detectors: interactions of charged particles, gamma rays and neutrons with matter, electrostatic accelerators, cyclotron, synchrotron, linear accelerators, colliding beam accelerators, gas-filler counters, scintillation detectors, and semiconductor based particle detectors.

Texts:

1. K. S. Krane, *Introductory Nuclear Physics*, John Wiley, 1987.
2. R. J. Blin-Stoyle, *Nuclear and Particle Physics,*Springer, 1991.

References:

1. J. K. Shultis and R. E. Faw, *Fundamentals of Nuclear Science and Engineering*, Marcel Dekker, 2007.
2. J. E. Turner, *Atoms, Radiation, and Radiation Protection*, Wiley-VCH, 2007.
3. R. L. Murray, *Nuclear Energy,* 6th Ed., Butterworth-Heinemann, 2008.
4. J. J. Duderstadt and L. J. Hamilton, *Nuclear Reactor Analysis*, Wiley, 1976.
5. D. H. Perkins, *Introduction to High Energy Physics*, Cambridge University Press, 2000.
6. J. R. Lamarsh and A. J. Baratta, *Introduction to Nuclear Engineering*, Prentice Hall, (2001
7. G. Chmielewski, C. M. Kang, C. S. Kang, and J. L. Vujic, *Radiation Technology: Introduction to Industrial and Environmental Applications*, Seoul National University Press, 2006.

PH308: Measurement Techniques (2-0-2-6)

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.

Texts:

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.

References:

1. G. K. White, *Experimental Techniques in Low Temperature Physics*, Clarendon, 1993.
2. A. Roth, *Vacuum Technology*, Elsevier, 1990.
3. D. A. Skoog, F. J. Holler and T. A. Nieman, *Principles of Instrumental Analysis*, Saunders Coll. Publ., 1998.

PH320: General Physics Lab (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.

SEMESTER – 7

PH413: Materials Science & Engineering (3-0-0-6)

Classification of engineering materials; equilibrium and kinetics; 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 and 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 behaviors, 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, oxidation resistant materials, protection against corrosion; electrical and optical properties of the materials; ceramics, polymers and composites materials, selection and design consideration; environmental issues in material science.

Texts:

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. Watchman, *Characterization of Materials*, Butterworth-Heinenmann, 1992.
2. L.H. Van Valck, *Elements of Materials Science and Engineering*, 6th Ed., Addision-Wesley, 1998.

PH415: Lasers and Photonics (3-0-0-6)

Laser Physics: The Einstein coefficients, light amplification, the threshold condition, laser rate equations, line broadening mechanisms, cavity modes, optical resonator, quality factor, mode selection, Q-switching, mode locking in lasers; gas lasers, solid state lasers, semiconductor lasers and dye lasers.

Photonics: optical properties of anisotropic media, wave refractive index, optical activity and Faraday effect, liquid crystals; principles of electro-optics, magneto-optics, photo refractive materials, acousto-optics and related devices; Nonlinear optical susceptibilities, second harmonic generation, self-focussing and Kerr effect; basic principles and applications of holography; Step index and graded index optical fibers, attenuation and dispersion; fiber optic communications; optical detectors.

Texts:

1. W. T. Silfvast, *Laser Fundamentals*, 2nd Ed., Cambridge University Press, 2004.
2. B.E.A. Saleh and M.C.Teich, *Fundamentals of Photonics*, 2nd Ed., Wiley, 2007.

References:

1. A. Ghatak and K. Thyagarajan, *Optical Electronics*, Cambridge University Press, 2009.
2. A. Yariv and P. Yeh, *Photonics*, 6th Ed., Oxford University Press, 2007.
3. O. Svelto and D. C. Hanna, *Principles of Lasers*, Springer, 1998.
4. R.W. Boyd, *Nonlinear Optics*, 3rd Ed., Academic Press, 2007.
5. A. Yariv and P. Yeh, *Photonics: Optical Electronics in Modern Communications*, 6th Ed., Oxford University Press, 2006.

PH417: Advanced Physics Lab (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.

PH498: Project - I (0-0-6-6)

SEMESTER- 8

PH414: Nano Electronics and Nano photonics (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.

Texts:

1. Charles P. Poole and Frank J. Owens, *Introduction to Nanotechnology*, Wiley-Interscience, 2003.
2. P. N. Prasad, *Nanophotonics*, Wiley Interscience, 2004.

References:

1. A. S. Edelstein and R. C. Cammarata (eds.), *Nanomaterials: Synthesis, Properties and Applications*, IOP, UK, 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. Rainer Waser (ed.), *Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices*, Wiley-VCH, 2003.

PH499: Project - II (0-0-6-6)

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