Department of Physics:: Tezpur University
Course Structure for B.Sc-B.Ed (2019)

Minimum Credit Requirement: 180
Minimum Duration: 8 Semesters
Maximum Duration: 12 Semesters

SEM	Credit	SEM	Credit
I	21	V	25
II	24	VI	24
III	25	VII	19
IV	22	VIII	18

Semester I

Course Code	Course Name	L-T-P	CH	CR	Remark
PD 101	Physics-I	2-1-0	3	3	GE for Non-Major
PD 103	General Physics-I	2-1-0	3	3	CORE for Physics Major
CD 101	Chemistry-I	2-1-0	3	3	GE
MD101	Mathematics-I	2-1-0	3	3	GE
PD 197	Physics Lab-1	0-0-3	6	3	CORE for Physics Major GE for Non-Major (Chemistry & Biology)
ED 106	Education: An Evolutionary Perspective	2 -0 -1	4	3	
ED 104	Communicative English (Language Proficiency)	2-1-0	3	3	
ED 105	Basics in Computer Applications	2-0-1	4	3	
Total credits			26	**21**	

Semester II

Course Code	Course Name	L-T-P	CH	CR	Remark
PD 102	Physics-II	2-1-0	3	3	GE for Non-Major
PD 104	General Physics-II	2-1-0	3	3	CORE for Physics Major
CD 102	Chemistry-II	2-1-0	3	3	GE
MD 102	Mathematics-II	2-1-0	3	3	GE
PD 198	Physics Lab-II	0-0-3	6	3	CORE for Physics Major
CD 107	Chemistry Laboratory	0-0-3	6	3	GE
ES 103	Environmental Studies	4-0-0	4	4	GE
ED 102	Education and Development	2-0-1	4	3	
NS 106	National Service Scheme	0-0-2	4	2	
Total credits			32	**24**	

Semester III

Course Code	Course Name	L-T-P	CH	CR	Remarks
PD 201	Physics III	2-1-0	3	3	Non-Major

Course Code	Course Name	L-T-P	CH	CR	Remarks
PD 203	Classical Mechanics	2-1-0	3	3	CORE
PD 301	Mathematical Physics-I	2-1-0	3	3	CORE
CD 201	Chemistry-III	3-0-0	3	3	GE
ED 201	Environmental Education	2-0-1	4	3	
ED 202	Learner and Learning	2-0-1	4	3	
MD219	Mathematics-III	2-1-0	3	3	GE
PD 297	Physics Lab-III	0-0-4	8	4	CORE
	Open Elective-I	2-1-0	3	3	
Total credit			28	**25**	

Semester IV

Course Code	Course Name	L-T-P	CH	CR	Remarks
PD 205	Electromagnetism	2-1-0	3	3	CORE
PD 214	Electronics	2-1-0	3	3	CORE
PD 218	Modern Physics	2-1-0	3	3	CORE
PD 216	Thermodynamics and Statistical Physics	2-1-0	3	3	CORE
ED 203	Contemporary Issues in Education	2-0-1	4	3	
ED 204	Assessment and Evaluation	2-0-1	4	3	
PD 298	Physics Lab-IV	0-0-4	8	4	CORE
Total credit			28	**22**	

Semester V

Course Code	Course Name	L-T-P	CH	CR	Remarks
PD 303	Physical and Geometrical Optics	2-1-0	3	3	CORE
PD 202	Introductory QM	2-1-0	3	3	CORE
PD 315	Mathematical Physics II	2-1-0	3	3	CORE
PD 309	Analog Electronics and Communications	2-0-1	3	3	DSE
PD 204	Atomic and Nuclear Physics	0-0-4	8	4	CORE
PD 399	Physics Lab-V	0-0-3	6	3	CORE
ED 301	Teaching Approaches and Strategies	2-0-1	4	3	
ED 302	Classroom Organization and Management	2-0-1	4	3	
Total credits			**34**	**25**	

Semester VI

Course Code	Course Name	L-T-P	CH	CR	Remarks
PD 307	Basic Material Science	2-1-0	3	3	CORE
PD 317	Basic Computation Techniques	2-1-0	3	3	CORE
PD 311	Waves and Acoustics	2-1-0	3	3	CORE
ED 308	Pedagogy A: Physical Science I	2-0-1	4	3	
ED 307 or ED 309	Pedagogy B: Mathematics I Or Pedagogy B: Bio Science I	2-0-1	4	3	
ED 303	School Education in NE India	2-0-0	2	2	
PD 300	Physics Lab-VI	0-0-4	8	4	CORE
	Elective I	2-1-0	3	3	DSE
Total credits			**26**	**24**	

Semester VII

Course Code	Course Name	L-T-P	CH	CR	Remarks
ED 408	Pedagogy A: Physical Science II	2-0-1	4	3	
ED 407 or ED 409	Pedagogy B: Mathematics II or Pedagogy B: Bio Science II	2-0-1	4	3	
ED 404	Initial School Experience/School Internship-I	0-0-4	8	4	
PD 308	Laser Physics	2-1-0	3	3	
PD 400	Laboratory-VII	0-0-4	8	4	
	Open Elective-II		3	3	
Total credits			30	**20**	

List of elective papers

1. **PD 220 Renewable Energy**
2. **PD 221 Nanomaterial Fundamentals and application**
3. **PD 222 Earth Science**

Semester VIII

Course Code	Course Name	L-T-P	CH	CR	Remarks
PD 314	Measurement Physics	2-1-0	3	3	
ED 405	School Internship	0-0-15	30	16	
Total credits				**19**	

Total credit till 6th Sem: 141

Total credit of 7th and 8th Sem: 39

Grand total credit =180

Detailed Syllabi

Semester-I

PD 101: PHYSICS-I **(L2-T1-P0-CH3-CR3)**

Coordinates, Vectors and Matrices:

Coordinate systems, plane polar, cylindrical and spherical polar, line element, surface element and volume element, gradient, divergent and curl.

Line, surface and volume integrals.

Properties of matrices, complex conjugate matrix, transpose matrix, 5ermitian matrix, unit matrix, diagonal matrix, adjoint of a matrix, self-adjoint matrix, cofactor matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix, eigenvalue, diagonalization of matrices.

Mechanics:

Work-energy theorem, conservative forces and potential energy, energy diagram, non-conservative forces, motion in non-inertial frames, uniformly rotating frame, centrifugal and Coriolis forces.

Motion under a central force.

System of particles, centre of mass, equation of motion of the centre of mass, laboratory and centre of mass frame of references, elastic and inelastic collisions, linear and angular momentum and their conservation laws, fixed axis rotation, moment of inertia, theorem of parallel and perpendicular axes, compound pendulum, Kater's and bar pendulum.

Properties of Matter:

Elasticity, elastic constants, Hooke's law, torsional oscillation, bending of a beam, cantilever, surface tension, viscosity, kinematics of moving fluids.

Text Books:

1. Spiegel M., *Vector Analysis: Schaum's Outlines Series*, 2nd edition (McGraw Hill, 2017).
2. Potter M. C., Goldberg J., *Mathematical methods*, 2nd edition (Phi Learning Pvt. Ltd., 2008).
3. Mathur, D. S., *Mechanics*, (S. Chand & Co. Ltd., 2000).
4. Kleppner, D. and Kolenkow, R., *Introduction to Mechanics*, (McGraw-Hill, 1973).

Reference Books:

1. Harper C., *Introduction to Mathematical Physics*, 1st edition (Phi Learning Pvt. Ltd., 2008).
2. Chow, T. L., *Mathematical Methods for Physicists: A concise introduction*, 1st edition (Cambridge Univ. Press, 2000).
3. Takwale R., Puranik P., *Introduction to Classical Mechanics*, (McGraw Hill, 2017).
4. Young, H. D. and Freedman, R. A., *University Physics*, 12th edition (Pearson, 2009).

PD 197: Physics Lab –I **(L0-T0-P3-CH6-CR3)**

1. Laboratory related components:
    a. Laboratory safety measures, handling of chemical, electrical and electronics items and instruments, handling of laser and laser related instruments and experiments, handling of radioactive samples and related instruments, general safety measures etc.
2. Familiarization with equipment and components:
    a. Familiarization of different Electrical and Electronics components and hence identification & determination of values of unknown components.
    b. Familiarization of different optical and hence show different optical behavior & pattern by using different optical components and optical sources (white light, laser, sodium light etc.)
    c. Familiarization of Microsoft excel, Origin and other software for data analysis.
    d. Soldering and de-soldering of components in a circuit board.

3. Use of equipment:
    a. Multimeter and its uses.
    b. Function generator and its uses.
    c. CRO and its use to measure the wavelength, frequency, amplitude etc. of a given electrical signal.
4. Study the variation of time period with distance between center of gravity and center of suspension for a bar pendulum and,
    a. determine
        a) radius of gyration of the bar about its axis through its center of gravity and perpendicular to its length and,
        b) value of g
5. Determine the moment of a given magnet and horizontal component of Earth's magnetic field using magnetometers.
6. Determine g through Kater's Pendulum.
7. Find the refractive index of a given prism with the help of a spectrometer.
8. To determine the surface tension of the given liquid (water/CC14) by capillary tube method.
9. To measure the focal length of a given lens using (a) Bessel's method and (b)Magnification method.
10. To study elastic and inelastic collisions using suspended spherical balls of different materials.
11. Determination of Young's modulus of the given wire by torsional oscillation (Searl's method).

PD 103: General Physics I **(L2-T1-P0-CH3-CR3)**

Introductory Mechanics and Properties of Matter:
Work, Energy and Force: Work-energy theorem, conservative forces and potential energy, energy diagram, non-conservative forces, motion in non-inertial frames, uniformly rotating frame, centrifugal and introductory concept of Coriolis forces.

System of particles: Centre of mass, equation of motion of the centre of mass, laboratory and centre of mass frame of references, Elastic and inelastic collisions, linear and angular momentum and their conservation laws.

Rigid body dynamics: Fixed axis rotation, moment of inertia, theorem of parallel and perpendicular axes, calculation of moment of inertia for bodies of different shapes, compound pendulum, Kater's and bar pendulum, calculation of the acceleration due to gravity.

Properties of matter: Elasticity, elastic constants, Hooke's law, torsional oscillation, bending of a beam, cantilever, surface tension, viscosity, kinematics of moving fluids.

Introductory Mathematical Physics:

Coordinate systems: plane polar, cylindrical, spherical polar, line element, surface element and volume element in different coordinate systems, gradient, divergent and curl.

Integrals: Line, surface and volume integrals with physical examples.

Properties of matrices: complex conjugate matrix, transpose matrix, hermitian matrix, unit matrix, diagonal matrix, adjoint of a matrix, self-adjoint matrix, cofactor matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix, eigenvalue and diagonalization of matrices.

Differential equations: Ordinary differential equations and their solutions.

Text books:
1) Mathur, D. S., Mechanics, (S Chand & Co Ltd, 2000)
2) Kleppner, D. and Kolenkow, R., Introduction to Mechanics, (McGraw-Hill Book Co., Inc, 1973)
3) Spiegel M., *Vector Analysis: Schaum's Outlines Series*, 2nd edition (McGraw Hill Education, 2017)
4) Potter M. C., Goldberg J., *Mathematical methods*, 2nd edition (Phi Learning Pvt. Ltd-New Delhi, 2008)

Reference books:
1) Takwale R., Puranik P., *Introduction to Classical Mechanics*, (McGraw Hill Education 2017)
2) Young, H. D. and Freedman, R. A., University Physics, 12th edition (Pearson, 2009)
3) Harper C., *Introduction to Mathematical Physics*, 1st edition (Phi Learning Pvt. Ltd-New Delhi, 2008)
4) Chow, T. L., *Mathematical Methods for Physicists: A concise introduction*, 1st edition (Cambridge Univ. Press, 2000)

Semester-II

PD 102: PHYSICS-II **(L2-T1-P0-CH3-CR3)**

Special Theory of Relativity:

Frames of reference, relative velocity and accelerations, Concept of ether, Michelson-Morley experiment, elements of special theory of relativity, the postulates, Galilean and Lorentz transformations, equivalence of mass and energy, time dilation, length contraction, simultaneity, Doppler effect, twin paradox.

Electromagnetism:

Coulomb's law (electric), electric field due to a system of charges, Gauss's law in differential and integral forms, electric dipole, its electric field and potential, capacitance of parallel plates.

Coulomb's law (magnetic), Biot-Savart law, force on a current and on moving charges in a B-field.

Electronics:

Kirchhoff's law, network theorem, nodal analysis, mesh analysis, maximum power transfer theorem, series circuits, parallel circuits (DC analysis only), semiconductors; p-type, n-type semiconductors, p-n junction, diode, triode.

Text Books:

1. Beiser A., *Concepts of Modern Physics*, 6^{th} edition (Tata McGraw Hill, 2008).
2. Rakshit, P. C. and Chattopadhaya, D., *Electricity and Magnetism*, (New Central Book Agency, 2012).
3. Robbins, A. H. & Miller, W. C., *Circuit Analysis* (Delmar Cengage Learning, 2003).

Reference Books:

1. Resnick, R., *Introduction to Special Relativity*, 1^{st} edition (Wiley, 2007).
2. Griffith, D. J., *Introduction to Electrodynamics*, 3^{rd} edition (Prentice Hall of India, 1999).
3. Edminister, J. A., *Electrical Circuits- Schaum's Outline series*, 2^{nd} edition (McGraw Hill,1983).

PD 198: Physics Lab -II **(L0-T0-P3-CH6-CR3)**

1. Design LCR series and parallel circuits and to measure resonant frequencies.
2. To prove Thevenin's and Norton's theorem.
3. Determine the force between two current carrying conductors.
4. Study the I-V characteristics of a Diode.
5. Study of Lissajous Figure of two different waves using CRO and find out the unknown frequency of an electrical signal.
6. To determine the thickness of thin film using interferometric method.
7. Determine the mechanical/ Electrical equivalent of heat by Joule's Calorimeter.
8. Determine the coefficient of linear expansion of the given metal sample by optical lever method.
9. Determine of the co-efficient of viscosity of water by Poiseulle's method.
10. Determine the wavelength of the given source of light using Fresnels' Biprism.
11. Measurement of frequency of an unknown tuning fork using a sonometer.
12. To determine the coefficient of self-inductance of a coil by Rayleigh's D.C. Bridge method.

PD 104: General Physics II **(L2-T1-P0-CH3-CR3)**

Electrostatics:

Coulomb's law and Gauss's law with applications: Coulomb's law (electric), electric field due to a system of charges, Gauss's law in differential and integral forms with applications, electric dipole, its electric field and potential, capacitance of parallel plate.

Magnetostatics:

Coulomb's law and Biot-Savart law with applications: Coulomb's law (magnetic), the Biot-Savart law, current carrying conductors in a magnetic field.

Special Theory of Relativity:

Basic developments and concepts: Frames of reference, relative velocity and accelerations, concept of ether, Michelson Morley experiment and its result, elements of special theory of relativity, the postulates, Galilean and Lorentz transformations, time dilation, length contraction, Doppler effect, twin paradox.

Mass-energy equivalence: Equivalence of mass and energy, concept of the electronvolt unit and relevant examples with fundamental particles.

Electronics:

Circuit analysis: Network theorem, nodal analysis, mesh analysis, maximum power transfer theorem, series circuits, parallel circuits (DC analysis only).

Semiconductors: p-type and n-type, p-n junction, diode, triode, LED, solar cell.

Text books:

1) Griffith, D. J., *Introduction to Electrodynamics*, 3rd edition, (Prentice-Hall of India, 1999)
2) Purcell E.M., Electricity and Magnetism, 3rd edition , Cambridge University Press; 3 edition
3) Beiser A., *Concepts of Modern Physics*, 6th Edition (Tata McGraw-Hill 2008)
4) Robbins, A. H. & Miller, W. C., *Circuit Analysis*, (Delmar Cengage Learning., 2003).

Reference books:

1) Rakshit, P. C. and Chattopadhaya, D., *Electricity and Magnetism*, (New Central Book Agency, 2012)
2) Resnick, R., *Introduction to Special Relativity*, 1st edition (Wiley 2007)
3) Edminister, J.A., *Electrical Circuits- Schaum's Outline series*, 2nd edition (McGraw Hill, 1983)

Semester-III

PD 201: Physics-III **(L2-T1-P0-CH3-CR3)**

Particle properties of waves: Wave particle duality, Photoelectric effect, Black body radiation, Plank radiation law, Rayleigh-Jeans law, Stefan's law.

Atomic physics: Rutherford model, Bohr model, hydrogen atom (quantum numbers and spectral series, qualitative), X-ray, Moseley's law, Basics of Lasers. Basics particle physics: elementary forces and particles.

Limitations of classical physics: Qualitative discussions of the problem of the stability of the nuclear atom. The photo-electric effect. Franck-Hertz experiment and the existence of energy levels. Experimental evidence for wave-particle duality, X-ray diffraction and Bragg law. Compton scattering. Electron and neutron diffraction. Einstein and de Broglie's relations ($E = h\gamma$, $p = h/\lambda$).

Schrodinger equation: The concept of the wave function as probability amplitude and its probabilistic interpretation. Plane wave solutions of the one-dimensional time-dependent Schrodinger equation for a particle in free space and elementary derivation of the phase and group velocities (quantitative discussion of wave packets is not required).

Uncertainty relation: The position-momentum uncertainty relation and simple consequences. Solutions of the one-dimensional Schrodinger's equation for an infinite square well potential, qualitative treatment of the finite well (derivation not required). Linear harmonic oscillator.

Text Books:

1. Beiser, A., *Concepts of Modern Physics* (McGraw-Hill, 2002).
2. Krane, K. S., *Modern Physics* (Wiley).

Reference Books:

1. Beiser, A., Perspectives *of Modern Physics* (McGraw-Hill Inc.,US).
2. Thornton, S. T. and Rex, A., *Modern Physics for Scientists and Engineers* (Cengage Learning; 4 edition).
3. Gautreau, R. Schaum's *Outline of Modern Physics*, (McGraw-Hill; 2 edition).
4. Young, H.D. and Freedman, R.A., *University Physics*, 12^{th} edition, (Pearson, 2009).

PD 203: Classical Mechanics **(L2-T1-P0-CH3-CR3)**

Mechanics of a particle: Conservation theorems for a particle, motion of a particle under damping forces, motion of a particle under central force, motion of a body in a resisting medium, Kepler's laws of planetary motion, moving co-ordinate systems, Galilean transformation, Coriolis force, Foucault's pendulum.

Mechanics of a System of Particles: Centre of mass and its motion, conservation theorems for a system of particles, collision problems, constraints, generalised co-ordinates, configuration space, principle of virtual work, D'Alembert's principle.

Lagrangian Formulation: Lagrange's equation, the rules of forming Lagrange's equation, Lagrange's equations for non-conservative forces, spherical and cylindrical co-ordinates, Hamilton's principle and Lagrange's equation, application of Lagrange's equation, motion of charged particle in an electromagnetic field, superiority of Lagrange's approach over Newtonian approach.
Hamiltonian Formulation: Phase space, Hamiltonian function and Hamiltonian equation, Application of Hamiltonian equation, Harmonic oscillator, compound pendulum, cyclic co-ordinates, Liouville's theorem, Routh's procedure.

Text Books:

1. Upadhyaya, J. C., *Classical Mechanics*, (Himalayan Publishing House).
2. Gupta, S. L., Kumar, V. and Sarma, H. V., *Classical Mechanics*, (Pragati Prakashan).

Reference Books:

1. Goldstein, H., *Classical Mechanics*, (Narosa, 2001).
2. Rana N. C., and Joag, P. S., *Classical Mechanics*, (Tata McGraw-Hill, 1991).
3. Takwale, R. G. and Puranik, P. S., *Introduction to Classical Mechanics,* (Tata McGraw-Hill, 1978).
4. Panat, P. V., *Classical Mechanics*, (Narosa Publishing House).

PD 301:Mathematical Physics-I **(L2-T0-P1-CH4-CR3)**

Scalar and vector fields, differentiations, divergence and curl, integrations, Greens, Gauss's and Stokes theorems and their applications, transformations of coordinate systems and vector components, metric coefficients, curvilinear coordinates, expressions for grad., div., and curl, Helmholtz equation in three-dimensions and separable variables in various coordinate systems, matrices and determinants.
Beta, gamma and error functions, relationship between the beta and gamma functions, reduction of some classes of integrals to gamma functions, Sterling's formula, derivation of values of gamma functions.
Fourier series: Evaluation of coefficients, graphical representations, even and odd functions, properties of Fourier series, Fourier integrals.
Elements of probability: Mathematical probability, compound probability, total probability, sample space, random variables, expectation value, averages, mean, standard deviation, binomial distribution, normal distribution; variance, covariance and correlation; theory of errors, central limit,
Random Process: Random variables to random process, statistical averages, stationary processes.

Text Books:

1. Harper, C., *Introduction to Mathematical Physics, (*Prentice Hall, 2009).
2. Arfken, G. B., and Weber, H. J., *Mathematical Methods for Physicists*, (Elsevier Ltd, Oxford, 2005).
3. Spiegel, M. R., *Vector Analysis,* Schaum's outline series, (Tata McGraw-Hill 1979).

Reference Books:

1. Morganeau, H. and Purphy, C. M., *The Mathematics of Physics and Chemistry,* (Young Press, 2009).

PD 297: Physics Lab-III **(L0-T0-P4-CH8-CR4)**

1. To observe the rotation of the plane of polarization of monochromatic light by a given solution and to determine the specific rotation of sugar solution using a Polarimeter.
2. Determine the wavelength (λ) of the given monochromatic light by using Lloyd's mirror.
3. To measure thermo e.m.f. of a thermocouple as a function of temperature and find inversion temperature.
4. To measure the radius of curvature of a given concave mirror and to measure the refractive index of a liquid by this method.
5. To measure the inductance of a given inductor using Anderson bridge.
6. To measure the capacitance of a capacitor by de-Sauty method and to find permittivity of air.
7. To study Op-Amp. characteristics:
    a. To get data for different input bias current,
    b. To measure and null the output offset voltage.
8. Determine the efficiency of the given solar cell for different intensity and different frequency of light sources.
9. Measure the elasticity of the given sample by Newton's ring method.

Semester-IV

PD 205: Electromagnetism **(L2-T1-P0-CH3-CR3)**

Electrostatics in vacuum: Coulomb's law, Electric field due to a system of charges, Field lines, flux and Gauss's law, Gauss's law in differential form, the electric dipole and its electric field and potential, the couple and force on, and the energy of, a dipole in an external electric field, Gauss's law in integral form, field and potential due to surface and volume distributions of charge, force on a conductor, the capacitance of parallel plate, cylindrical and spherical capacitors, electrostatics in the presence of dielectric media, Modification to Gauss's law, polarisation, the electric displacement, relative permittivity, capacitance and energy in the presence of dielectric media.
Magnetic effects in the absence of magnetic media: the B-field, steady currents: the B-field set up by a current, the Biot-Savart law, the force on a current carrying conductor and on moving charges in a B-field, the magnetic dipole and its B-field, the force and couple on, and the energy of, a dipole in an external B-field, energy stored in a B-field.
Gauss's law in integral form, simple cases of the motion of charged particles in electric and magnetic fields.

Text Books:

1. Griffith, D. J., *Introduction to Electrodynamics*, 3rd edition, (Prentice-Hall of India, 1999).
2. Purcell, E. M., *Electricity and Magnetism*, Berkely Physics Course, Vol. 2 (McGraw-Hill, 1965).
3. Matveev, A.N., *Electricity and Magnetism*, (Mir Publishers, 1986).

PD 214: Electronics **(L2-T1-P0-CH3-CR3)**

Series and Parallel Resonant circuits (Detailed AC analysis).
Introduction to Three Phase Circuits. Two port n/w, Z-parameter, Y-parameter, Transmission.
Semiconductors: p and n Type Semiconductors. Energy Level Diagram, Mobility and conductivity, transport phenomenon due to donor and acceptor impurities, Fermi level, Hall Effect, conductivity measurement Conductivity and Mobility.
Diodes: Barrier Formation in pn Junction Diode (Simple Idea). Current Flow Mechanism in Forward and Reverse Biased Diode (Recombination, Drift and Saturation of Drift Velocity). Derivation of Mathematical Equations for Barrier Potential, Barrier Width and Current for Step Junction. pn junction and its characteristics. Static and Dynamic Resistance. Diode Equivalent Circuit. Ideal Diode. Load Line Analysis of Diodes and Q-point.
Two-terminal Devices and their Applications: (1) Rectifier Diode. Half-wave Rectifiers.
Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification.
Efficiency. Qualitative idea of C, L and π - Filters. (2) Wave shaping circuits (3) Zener Diode and Voltage Regulation. (4) Photo Diode, (5) Varactor Diode.

Bipolar Junction Transistors, n-p-n and p-n-p transistors. Characteristics of CB, CE and CC Configurations. Current gains α, β and γ and Relations between them. Load Line Analysis of transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff, and saturation Regions. Transistor in Active Region and Equivalent Circuit.

Fundamental of Digital Circuits, Combinational Circuits.

Text Books:

1. Robbins, A. H. & Miller, W.C., *Circuit Analysis*, (Delmar Cengage Learning., 2003).
2. Hayt, W. H. & Kemmerly, J. E., *Engineering Circuit Analysis*, (McGraw Hill, New York, 1993).
3. Millman, J., Halkias, C.C. and Jit, S., *Electronic Devices and Circuits*, (McGraw Hill Education,India, 2016).
4. Kumar, A., *Fundamentals of Digital Electronics* (PHI Learning Pvt. Ltd., 2003).

Reference Books:

1. Toro,V. Del, *Electrical Engineering Fundamentals*, (Prentice Hall, 1994).
2. Edminister, J.A., *Electrical Circuits- Schaum's Outline series*, 2nd edition (McGraw Hill,1983).
3. Smith, R.J. and Dorf, R.C., *Circuits, Devices and Systems*, (John Wiley & Sons, 1992).
4. Morris, J. *Analog Electronics*, (Arnold Publishers, 1991).
5. Mottershead, A. *Electronic Circuits and Devices*, (Prentice Hall, 1997).
6. Streetman, B.G. & Banerjee, S., *Solid State Electronic Devices*, (Pearson Prentice Hall, 2006).
7. Bhargava, N. N., Kulshreshtha D.C. & Gupta S.C., *Basic Electronics & Linear Circuits*, (Tata McGraw Hill, 2006).
8. Boylestad, R. & Nashelsky, L. *Electronic Devices and Circuit Theory*, 8th edition, (Pearson Education, India, 2004).
9. Malvino A. P., *Electronic Principals*, (Glencoe, 1993).

PD 218: Modern Physics **(L2-T0-P1-CH4-CR3)**

Particle-like properties of electromagnetic radiation: Electromagnetic spectrum, electromagnetic waves, blackbody radiation, the photoelectric effect, the Compton effect, Bremsstrahlung and X-ray production.

Wave-like properties of particles: deBroglie hypothesis, uncertainty relationships for classical waves, Heisenberg uncertainty relationships, wave packets.

One-dimensional time independent Schroedinger equation, probabilities and normalization, applications to the free particle, particle in a box (1-D and 2-D), the simple harmonic oscillator.

Models of the atom: Thompson model, Rutherford model, line spectra, Bohr model, Franck-Hertz experiment, the correspondence principle, deficiencies of Bohr atomic model, vector model, intrinsic spin, Stern-Gerlach experiment, hydrogen atom energy levels, Zeeman effect, fine structure, electronic states in many-electron atoms, X-rays.

Expansion of universe, background radiation, big bang cosmology, the future of the universe.

Text Books:

1. Krane, K. S., *Modern Physics*, (John Wiley & Sons, 1983).
2. Bernstein, J., Fishbane, P. M. and Gasiorowicz, S. G., *Modern Physics*, 1st edition, (Prentice-Hall, 2000).

PD 216: Thermodynamics and Statistical Physics (L2-T1-P0-CH3-CR3)

Macroscopic description of the state, extensive and intensive variables, temperature, thermodynamic variables (pressure, temperature, etc.), thermal equilibrium, equation of state.
Thermal conductivity, zeroth law of thermodynamics**,** temperature scales, work, heat and internal energy, the Gibbs-Duhem relation.
Thermodynamic processes: reversible, irreversible, quasi-static, adiabatic, isothermal.
First law of thermodynamics**,** specific heat capacity, enthalpy, kinetic theory of gases and Maxwell-Boltzmann statistics, calculation of pressure, kinetic interpretation of temperature, mean free path, Maxwell's distribution, equi-partition of energy, heat engines.
The second law of thermodynamics, Carnot cycle and Kelvin temperature scale, Clausius' theorem, entropy and its physical interpretation, entropy change for simple processes.
Free energies: Helmholtz free energy, Gibbs free energy, Legendre transformations, conditions of equilibrium, Maxwell's relations, phases and phase transitions, equilibrium between two-phases, general equilibrium conditions, the Clausius-Clapeyron equation, phase transformation of substances, Van der Walls gas and the liquid gas transition, thermodynamics of magnetic systems, The third law of thermodynamics.
Microscopic versus macroscopic points of view, kinetic theory of gases, concept of ensembles, micro-canonical, canonical, grand-canonical ensembles, partition function, postulates of classical statistical mechanics, derivation of thermodynamics from statistical mechanics principles, equation of state for ideal and real gases, Gibbs paradox.

Text Books:

1. Callen, H. B., *Thermodynamics and Introduction to Thermostatistics,* 2nd edition, (Wiley Student Edition).
2. Reif, F., *Fundamentals of Statistical and Thermal Physics,* (Tata McGraw-Hill, 1985).
3. Zemansky, M. W. and Dittman, R. H., *Heat and Thermodynamics,* 7th edition, (Tata McGraw-Hill International, 2007).

PD 298: Physics Lab-IV (L0-T0-P4-CH8-CR4)

1. To determine the resistivity of the given semiconductor sample by Four Probe method.
2. To determine the susceptibility of the given sample by Quince tube method.
3. To determine the Planck constant using different wavelength of light using Planck constant kit.
4. To study interference and diffraction with a laser beam at a single slit, double slit, three slits and four slits, and measure the slit separations.
5. To measure the spot size of a beam from a He-Ne laser and a diode laser and to calculate the M parameter.
6. To study the p-n junction characteristics and obtain output voltage at different frequencies.
7. To study connector losses in optical fibers:
    a. loss due to diameter mis-match,
    b. loss due to lateral off-set,
    c. loss due to angular misalignment
8. To measure the refractive index of a sample with a Michelson interferometer.
9. Determination of the focal length and hence the power of a convex lens by displacement method on an optical bench.
10. To find out the velocity of ultrasonic waves in a medium using ultrasonic interferometer.

Semester-V

PD 303: Physical and Geometrical Optics (L2-T1-P0-CH3-CR3)

Basic Geometric Optics: law of reflection, reflection from planar and curved surfaces, Snell's law, refraction at the planar and curved surfaces, thin lens, prisms.

Matrix methods: matrix optics concepts and basic matrices, cascading matrices: thin lens, thick lens, principal planes and imaging, study of a compound lens.

Aberrations: monochromatic and chromatic aberrations, Seidel aberrations: spherical aberration, coma, astigmatism, field curvature and distortion, chromatic aberrations, examples.

Polarization: light as a transverse wave, linear and circular polarizations, methods of producing and analyzing polarized light, linear polarizers and wave plates, Fresnel reflection and transmission coefficients, total internal reflection, Jones vectors and matrices for the ploarizer and wave plate, Stokes vectors and Muller matrices.

Interference: division of wavefront and amplitude, intensity distribution in an interference pattern, visibility of fringes, Young's double-slit interferometer, Michelson interferometer, Rayleigh interferometer, multiple beam interference: Fabry-Perot etalon and interferometer, resolving power.

Diffraction: Fresnel-Huygens theory of diffraction, Fresnel and Fraunhofer regions of diffraction, diffraction at a straight edge, Fraunhofer diffraction at the slit, circular and rectangular apertures, resolving power of a telescope, diffraction at multiple slits, grating, resolving power of a grating.

Holography: recording and reconstruction of a wave, characteristics of the diffracted waves from the hologram, diffraction efficiency, types of the holograms, zone plate analogy of the hologram.

Fourier Optics: simple concepts.

Text Books:

1. Subrahmanyam, N., Lal, B. and Avadhanulu, M. N., *A Textbook of Optics*, (S. Chand & Co. Ltd., 2012).
2. Mathur, B. K. and Pandya, T. P., *Principles of Optics*, (Tata McGraw-Hill International, 1981).
3. Chakraborty, P. K., *Geometrical and Physical Optics*, 3rd edition, (New Central Book Agency(P) Ltd., 2005).

Reference Books:

1. Hecht, E., *Optics*, 4th Edition, (Addison-Wesley Pub. Co., 2001).
2. Born, M. and Wolf, E., *Principles of Optics*, 7th edition, (Pergamon Press Ltd, 2000).
3. Jenkins, F. A. and White, H. E., *Fundamentals of Optics*, 4th edition, (Tata McGraw-Hill International, 1981).
4. Sirohi, R. S., *Wave Optics and Applications*, (Orient Longman, 1993).

PD 202: Introductory Quantum Mechanics **(L2-T1-P0-CH4-CR3)**

Origin of quantum theory, inadequacy of classical ideas, Planck's quantum hypothesis, photoelectric effect, Compton scattering.

Wave-particle duality, deBroglie's hypothesis, experimental evidence for deBroglie's hypothesis, Davisson-Germer experiment, Thompson experiment.

Simple consequences of uncertainty relation, wave function and its probabilistic interpretation, wave packet and uncertainty relation.

Schrodinger equation, solution of one-dimensional Schrodinger equation for an infinite square well potential, reflection and transmission at potential steps, qualitative treatment of barrier penetration for simple rectangular barriers.
The quantum harmonic oscillator.

Text Books:

1. Schiff, L. I., *Quantum Mechanics,* 3rd edition, (McGraw-Hill, New Delhi, 1968).
2. Ghatak, A. and Lokanathan, S., *Quantum Mechanics*, 5th edition, (Macmillan, 2004).

Reference Books:

1. Merzbacher, E., *Quantum Mechanics,* 2nd edition, (John Wiley, New York, 2005).
2. Richtmyer, F. K., Kennard E. H. and Lauritsen, T., *Introduction to Modern Physics,* 5th edition, (McGraw-Hill, 1976).
3. Waghmare, Y. R., *Fundamentals of Quantum Mechanics*, 1st edition, (Wheeler publishing, 1996).
4. Mathews, P. M. and Venkatesan, K., *A Textbook of Quantum Mechanics*, 2nd edition, (Tata McGraw-Hill, 1976).

PD 315: Mathematical Physics-II **(L2-T1-P0-CH3-CR3)**

Ordinary differential equations, second-order homogeneous and inhomogeneous equations, Wronskian, general solutions, adjoint of a differential equation, ordinary and singular points, series solution; Legendre, Hermite, Laguerre and the associated polynomials, their differential equations, generating functions, Bessel functions, spherical Bessel equations, integral representation of special functions.
Generating functions, Recurrence relations, Rodrigue's formulae and orthogonality of the special functions, Sturm Liouville problem, elements of hyper-geometric functions, Gauss hyper-geometric and confluent hyper-geometric equations, Dirac delta function, Green function.
Partial differential equations in physical problems: Laplace's equation, Poisson's equation, Heat flow equations, Wave equations, Helmholtz equations, solutions of these equations, eigenvalue problems, boundary value problems, method of separation of variables.
Integral transforms: Laplace transform, Hankel transform, Mellin transform, Fourier transform.
Properties of Laplace and Fourier transforms, application of Laplace and Fourier transforms.

Text Books:

1. Harper, C., *Introduction to Mathematical Physics, (*Prentice Hall, 2009).
2. Arfken, G. B., and Weber, H. J., *Mathematical Methods for Physicists*, (Elsevier Ltd, Oxford, 2005).
3. Spiegel, M. R., *Vector Analysis*, Schaum's outline series, (Tata McGraw-Hill 1979).

Reference Book:

1. Morganeau, H. and Purphy, C. M., *The Mathematics of Physics and Chemistry*, (Young Press, 2009).

PD 309: Analog Electronics & Communications (L2-T1-P0-CH3-CR3)

Op-Amp with and without feedback: Open loop considerations-inverting, non-inverting, differential, feedback-voltage follower, Practical op-amps: Offset considerations-input offset voltage, input bias current, input offset current, thermal drift, effect of power supply voltage, other temperature sensitive parameters, noise, CMRR, maximum common mode input voltages, op-amp instrumentation circuits.
Linear Applications: Op-amp as ac amplifiers, summing and averaging circuits, integrators, differentiators, voltage-current converter, current-to voltage converter, analog computers, voltage regulators.
Introduction to communication systems: Elements of a Communication System, terminologies in Communication systems, basics of signal representation and analysis. Noise: external, internal, noise calculations, noise figure. Amplitude modulation techniques: Theory and generation of AM, DSBSC, SSB, VSB.
Angle modulation techniques: theory, practical issues and generation of Frequency Modulation (FM) and Phase.
Radio transmitters and receivers: Introduction to – AM, SSB, FM Transmitters. Receiver Types: tuned radio-frequency (TRF) and superheterodyne receiver, AM and FM Receivers.
Radiation and propagation of waves -Electromagnetic Radiation, Effects of the Environment, Propagation of Waves - Ground (Surface) Waves, Sky Waves and Space Waves.

Text Books:

1. Gayakward, R.A., *Op-Amps and Linear Integrated Circuits*, 3rd Edition, (PHI, 2001).
2. Kennedy, G., Bernard D. and Prasanna, S. R. M., *Electronic Communication Systems*, (McGraw-Hill Global Education India, 5th edition, 2011).

Reference Books:

1. Hambley, A. R., *Electronics*, 2nd Edition, (Prentice Hall, 2000).
2. Horowitz, P. and Hill, W. *The Art of Electronics*, 2nd Edition, (Cambridge University Press, 1995).

PD 204: Atomic and Nuclear Physics (L2-T1-P0-CH3-CR3)

Atomic Physics: The Bohr model of the hydrogen-like atom, brief account of the Sommerfeld model, electron spin, Stern-Gerlach experiment, space and spin quantization, the vector model of the atom, spin-orbit interaction, fine structure of spectral lines, LS and jj coupling, the Zeeman effect, Paschen-Back effect, Stark effect, scattering of light: Rayleigh scattering formula, colour of the sky, polarisation of the scattered light.
Nuclear Physics: General properties of nuclei, concept of nuclear size, spin, parity, magnetic dipole moment and electric quadropole moment of nuclei, nuclear forces and stability of nuclei, concept of packing fraction and binding energy, binding energy curve and its significance.
Natural radioactivity and radioactive decay: Type of radioactive decays, theory of radioactive disintegration, radioactive constants, mean-life of a radio element, radioactive equilibrium, half-life of a radio element, determination of decay constant and half-life.

Nuclear reactions: Types of nuclear reactions, conserved quantities of nuclear reaction, energies of nuclear reaction, Q-value, exoergic & endoergic reactions, nuclear fusion and fission reactions.
Detectors: Principles of detection of charge particles, construction and working principle of gas-filled detectors, ionization chamber, its construction and working principle, interaction of γ-particle with matter, construction and working principles of a scintillating detector.

Text Books:

1. Krane, K. S., *Introductory Nuclear Physics*, (John Wiley, New York, 1987).
2. White, W. H., *Introduction to Atomic Spectra*, (McGraw-Hill, 1934).

Reference Books:

1. Green, A. E. S., *Nuclear Physics*, (McGraw-Hill Book Company, Inc., New York, 1955).
2. Srivastava, B.N., *Basic Nuclear Physics and Cosmic Rays*, (Pragati Prakashan, Meerut, 2011).

PD 399: Physics Lab-V **(L0-T0-P4-CH8-CR4)**

1. To find out the magneto-resistance of the semiconductor sample as a function of magnetic field and to plot the graph between magnetic field vs. potential developed using magneto-resistance set-up.
2. To plot the gain – bandwidth relation for a negative feed back amplifier using IC 741.
3. To find out the Curie temperature of the given ferromagnetic material ($BaTiO_3$) using Curie temperature kit.
4. To study Malus' law of polarization.
5. To measure optical nonlinearity using z-scan method.
6. To find out the value of Boltzmann constant using Boltzmann Constant kit.
7. To find out the Rydberg constant by observing the Balmer series of Hydrogen using spectrophotometer.
8. To study diffraction at a circular aperture and find the resolving power of a given lens used as an objective of a telescope.
9. a. Develop a clipping and a clamping circuit and determine the output voltage with different DC bias voltage applied.
   b. Design and develop a full wave and a half wave rectifier circuits and find out the ripple factor of the circuits.
10. To study the temperature dependence of Hall coefficient of a semiconductor sample using Hall effect set-up.

Semester-VI

PD 307: Basic Material Science **(L2-T1-P0-CH3-CR3)**

Fundamentals of crystallography: Bravais lattice, unit cell, crystal systems, Miller indices of crystal planes and directions, point groups.

Typical crystal structures: Simple (sc) cubic, body centered (bcc) cubic and face centered (fcc), cubic and structures, Hexagonal closed packed (hcp), Diamond and Zinc blende (ZnS) closed packed structures, packing factors, NaCl, CsCl and cubic perovskite and wurtzite structures.

Structure of solids: linear and planar density, ligancy, packing efficiency, closed pack planes and directions, voids.

Crystal imperfections: point imperfections (vacancies and interstitials), Frenkel and Schottky defects, dislocations, grain boundary, grain growth and surface energy calculation.

Crystal binding: Primary and secondary bondings, bond length and bond energy, van der Waals bonding, inert gas crystals, ionic, covalent and metallic bondings, Madelung constant, Madelung energy.

Phase and phase transformation: Melting point of crystalline and amorphous solids, degrees of freedom, phase rule, binary alloys, nucleation and phase transformation.

Elastic properties, Young, bulk and rigidity moduli, yield stress, Poisson's ratio, compressibility, creep and fatigue, plasticity.

Diffusion*:* Fick's first and second laws, thermal diffusion.

Text Books:

1. Callister, W. D., *Materials Science and Engineering*, 5th edition (John Wiley, 2000).
2. Raghavan, V., *Materials Science and Engineering*, 4th edition (Prentice Hall India, 1991).
3. Kittel, C., *Introduction to Solid State physics*, 7th edition, (Wiley Eastern Ltd.,1996).
4. Burns, G., *Solid State Physics*, (Academic press, 1995).
5. Dekker, A. J., *Solid State Physics*, (Macmillan India Ltd., 2003).
6. Ashcroft, N. W. and Mermin, N. D., *Solid State Physics*, (Saunders, 1976).

Reference Books:

1. Smith, W. F., *Principles and Materials Science and Engineering*, 2nd edition (Tata McGraw-Hill Inc., 1990).
2. Patterson, J. D. and Bernard, B., *Introduction to the Theory of Solid State Physics*, 2nd edition, (Springer, 2007).
3. Ghatak, A. K. and Kothari, L.S., *Introduction to Lattice Dynamics*, (Addison-Wesley, 1972).
4. Hall, H. E. and Hook J. R., *Solid State Physics*, 2nd edition, (Wiley, 1991).
5. Azaroff, L. V., *Introduction to Solids*, (Tata McGraw-Hill, 1977).
6. Mathur, D. S., *Properties of Matter*, (S. Chand & Co., 2010).

PD 317: Basic Computation Techniques **(L2-T1-P0-CH3-CR3)**

Introduction to computers.
Programming using FORTRAN; programming using C and C^{++}
Simple programming examples from calculus; solution of simple algebraic equations, solution of simple differential equations.
Examples of least squares curve fitting, matrix eigenvalue problems.

Text Books:

1. Gottfried**,** B. S**.,** *Schaum's outline of theory and problems of programming with C***,** (McGraw-Hill Professional, 1996).
2. Kanetkar, Y., *Let us C*, (BPB *Publications*, 2012).
3. Mayo, W. E. and Cwiakala, M., *Schaum's Outline of Programming With Fortran 77*, Schaum's Outline series, (McGraw-Hill, 1995).
4. Scheid, F., *Schaum's outline of theory and problems of numerical analysis*, 2^{nd} edition, Schaum's outline series, (McGraw-Hill, 1989).

Reference Books:

1. Mathews, J. H., *Numerical Methods for Mathematics, Science and Engineering*, (Prentice Hall, 1997).
2. Narsingh Deo, *System Simulation with Digital Computers*, (Prentice Hall, 1979).

PD 311: Waves and Acoustics **(L2-T1-P0-CH3-CR3)**

Vibrations: Potential energy vs. displacement relation, concept of equilibrium, development of simple harmonic oscillation (SHO) and other anharmonic terms from force equations, damped oscillation, critical damping, Q-factor of an oscillator, forced vibration, resonance, low and high frequency responses, eigen frequency and normal modes, energy transfers between modes, coupled pendulum, Lissajous figures, anharmonic oscillator, Fourier series and Fourier coefficients, Fourier analysis in some simple cases.
Waves: Progressive wave in one-dimension and in three-dimensions, wave equation, plane wave and spherical wave, intensity, dispersion, group velocity, phase velocity, speed of transverse waves in a uniform string, eigen frequencies and eigen modes for plucked and struck strings, speed of longitudinal waves in a field, energy density and intensity of waves.
Superposition of waves: Superposition principle, interference in space and energy distribution, beats, combinational tones, production, detection and applications of ultrasonic waves, Doppler effect, shock waves.
Acoustics: Vibrations in bounded system, normal modes of a bounded system, harmonics, quality of sound, noise and music, intensity and loudness, bel and phon, principle of sonar system, acoustic transducers and their characteristics, recording and reproduction of sound, measurement of velocity, frequency and intensity, acoustics of halls, reverberation and Sabines formula.

Text Books:

1. Chattopadhyay, D., *Vibration*, *Waves and Acoustics*, (New Central Book Agency, 2010).
2. Main, I. G., *Vibrations and Waves in Physics,* 2nd edition (Cambridge University Press, 1984).

Reference Books:

1. Randall, R. H., *An Introduction to Acoustics*, Sect. 7-21, 7-22, (Addison-Wesley, 1951).
2. Wood, A. B., *A Textbook of Sound*, 3rd Edition, (Bell & Sons, 1955).
3. Crawford, F. S., *Waves*, *Berkeley Physics Course*, Vol. 3, (Tata McGraw-Hill, 1968).
4. Pain, H. I., *The Physics of Vibrations and Waves*, 6th edition (John Wiley & Sons Ltd., 2005).

PD 300: Project cum Physics Lab-VI **(L0-T0-P4-CH8-CR4)**

Semester-VII

PD 308: Laser Physics **(L2-T1-P0-CH3-CR3)**

Planck's Law, Absorption, spontaneous emission and stimulated emission, Einstein's A & B coefficients, two-level atomic systems, light amplification, threshold condition.
Line broadening mechanism, pumping methods and laser rate equations, variation of laser power around threshold. optimum output coupling.
Modes of a rectangular cavity and open planar resonator, the quality factor (Q-factor), the ultimate bandwidth of laser, mode selection, Q-switching, mode locking, modes of a confocal resonator, general spherical resonator.
Properties of laser beam, propagation of Gaussian beam and ABCD matrix.
Some laser systems like He-Ne laser, ruby laser, neodymium-based lasers, CO_2 laser, dye laser, fiber laser, semiconductor laser, DFB lasers, DH lasers.
Generation of ultra-fast optical pulses, pulse compression, femto-second laser and its characteristics
Some applications of lasers like laser cooling, laser tweezers, material processing.

Text Books:

1. Ghatak, A. K. and Thyagarajan, K., *Optical Electronics*, (Cambridge University Press, 2009).
2. Svelto, O., *Principles of Lasers*, 3rd edition, (Springer, 2007).
3. Milonni, P. W. and Eberly, J. H., *Laser Physics*, (John Wiley & Sons, 2010).

Reference Books:

1. Yariv, A., *Quantum Electronics*, 3rd edition, (Wiley Eastern Ltd.).
2. Davis, J. H., *Introduction to Low Dimension Physics*, (Cambridge University Press, 1997).
3. Siegman, A. E., *Lasers*, (University Science Books, 1986).

PD 400: Laboratory-VII **(L0-T0-P4-CH8-CR4)**

1. To design and fabricate a phase shift oscillator for the given frequency and to study the output using Op-Amp. 741/ 324 / 325.
2. Determination of thermal conductivity of a substance by Lee's method.
3. Scintillation counter:
   a. Find out the resolution and the FWHM of the given Scintillation counter.
   b. Find out the gamma ray energy of the given radioactive sources.
4. Determination of the Young's modulus of a beam by four-point bending.
5. To determine the velocity of sound in (a) dry air, and (b) rods by Kundt's tube method.
6. Calculate the difference in wavelength between atomic transition lines and Zeeman lines using Zeeman effect set-up. (SES instruments Pvt. Ltd).
7. To study Talbot imaging and to obtain Talbot distances with moiré interferometry and to measure the focal length of a lens.
8. Determination of the boiling point of a liquid by platinum resistance thermometer and metre-bridge.
9. To measure the diameter of a thin wire using (a) interference, and (b) diffraction and compare the results.
10. To measure the dielectric constant and loss using microwave bench.

Semester-VIII

PD 314: Measurement Physics **(L2-T1-P0-CH3-CR3)**

Data interpretation and analysis, precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and nonlinear curve fitting, chi-square test, Measurement of energy and time using electronic signals from the detectors and associated instrumentation, signal processing, multi-channel analyzer, Time of flight technique, coincidence measurements, true-to-chance ratio.
Transducers (temperature, pressure/vacuum, magnetic field, vibration, optical), measurement and control, ionization chamber, proportional counter, GM counters, spark chambers, cloud chamber, semiconductor detectors for charged particles and γ-ray detectors, scintillation counters, photodiodes and charge coupled device (CCD) and CMoS cameras for detection of electromagnetic radiation.
Production of low temperature below 1K, adiabatic 25emagnetization and magnetic refrigerator, special properties of liquid helium, temperature below 10^{-6}K, nuclear 25 emagnetization, measurement of low temperatures.
Op-amp based, instrumentation amp, feedback, filtering and noise reduction, shielding and grounding, Fourier transforms, lock-in detector, box-car integrator, modulation techniques.

Text Books:

1. Sayer, M. and Mansingh, A., *Measurement, Instrumentation and Experiment Design in Physics and Engineering*, (Prentice-Hall India, 2000).
2. Nakra, B. C. and Chaudhry, K. K., *Instrumentation Measurement and Analysis* (Tata McGraw-Hill, 1985).

Reference Books:

1. Knoll, G. F., *Radiation, Detection and Measurement*, 3rd edition, (John Wiley & Sons, 2000).
2. Jones, B. E., *Instrumentation measurement and feedback* (Tata McGraw-Hill, 1978).

List of elective papers

1. PD 220:Renewable Energy
2. PD 221:Nanomaterial Fundamentals and application
3. PD 222:Earth Science

PD 220: Renewable Energy (L2-T1-P0-CH3-CR3)

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Electromagnetic and Piezoelectric Energy Harvesting, Energy storage and conversion devices: fuel cells, batteries, supercapacitors.

Environmental issues and Renewable sources of energy, sustainability.

Text Books:

1. H. P. Garg and Jai Praksh, *Solar Energy Fundamentals and Applications*, TMH, 2000.
2. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon, 1986.
3. G. Boyle, (Ed.), *Renewable Energy, Power for a Sustainable Future*, The Open University/Oxford University Press, 1996.
4. R. O. Hayre, S. W. Cha, W. Colella and F. B. Prinz, *Fuel Cell Fundamentals*, Wiley, 2008.
5. B. E. Logan, Microbial Fuel Cells, Wiley, 2007.
6. G.D Rai, *Non-conventional energy sources*, Khanna Publishers, New Delhi, 2011.
7. M P Agarwal, *Solar energy*, S Chand and Co. Ltd., 1983.
8. Suhas P Sukhative, *Solar energy: principles of thermal collection and storage,* Tata McGraw - Hill Publishing Company Ltd, 3rd Ed. 2008.

Reference Books:

1. A. Luque and S. Hegedus (Eds.), *Hand book of Photovoltaic Science and Engineering*, 2nd Edn., John Wiley, 2011.
2. P Jayakumar, *Solar Energy: Resource Assessment Handbook*, 2009.
3. P. Takahashi and A. Trenka, *Ocean Thermal Energy Conversion*, John Wiley, 1994.
4. C. Y. Wereko-Brobby and E. B. Hagan, *Biomass Conversion and Technology*, John Wiley, 1997.
5. J. F. Walker and N. Jenkins, *Wind Energy Technology*, John Wiley and Sons, 1997.
6. D. D. Hall and R. P. Grover, *Biomass Regenerable Energy*, John Wiley, 1987.
7. T. Jiandong, Z. Naibo, W. Xianhaun, H. Jing, and D. Huishen, *Mini Hydropower*, John Wiley, 1996.

PD 221: Nanomaterial Fundamentals and Applications (L2-T1-P0-CH3-CR3)

Nanoscale systems: Length scales, 1D, 2D and 3D nanostructures (nanodots, nanowires, nanorods, thin films), Band structure and density of states of materials at nanoscale, Size effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.
Synthesis of nanostructured materials: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.
Characterization: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy.
Properties of nanomaterials: Dielectric constant for nanostructures. Excitons in direct and indirect band gap semiconductor nanocrystals, absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. Electron transport in nanostrcutures, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. Mechanical and thermal properties of nanomaterials.
Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices. CNT based transistors. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Text Books:

1. C.P. Poole, Jr. Frank J. Owens, *Introduction to Nanotechnology* (Wiley-Interscience, May 2003).
2. S.K. Kulkarni, *Nanotechnology: Principles & Practices* (Capital Publishing Company, 2007).
3. K.K. Chattopadhyay and A. N. Banerjee, *Introduction to Nanoscience and Technology* (PHI Learning Private Limited, 2009).
4. Richard D. Booker, *Earl Boysen, Nanotechnology* (John Wiley and Sons, 2005).

Reference Books:

1. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, *Nanoparticle Technology Handbook* (Elsevier, 2007).
2. Bharat Bhushan, *Handbook of Nanotechnology* (Springer-Verlag, Berlin, 2004).
3. Cao Guozhong and Wang Ying, *Nanostructures and Nanomaterials –Sysnthesis, Properties and Applications*, World Scientific Publishing, 2^{nd} edition, 2011.
4. Dieter Vollath, *Nanomaterials: An Introduction to Synthesis, Properties and Applications*, Wiley, 2008.
5. *Nanoscale Materials in Chemistry*, edited by Kenneth J. Klabunde & Ryan Richards, John Wiley & Sons, 2^{nd} edition, 2009.
6. *Nanomaterials: Synthesis, properties and Applications*, Ed. A. S. Edelstein and R.C.Cammarata, IOP (UK, 1996). Characterization of nanophase materials: Ed. Z.L.Wang, Willey-VCH (New York, 2002).
7. *Naostructured Materials*, Ed. Jackie Yi-Ru Ying (Academic Press, Dec 2001).
8. *Nanotechnology: Basic Science and emerging technologies*, Ed. Michael Wilson, K.Kannangara, G. Smith, M. Simmons, and C. Crane (CRC Press, June 2002).

PD 222: Earth Science **(L2-T1-P0-CH3-CR3)**

1. Structure:

(a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, Magnetic field, Gravity field, Thermal structure and Heat Flow. Earth's Interior.
(b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems. I The Atmosphere: variation of temperature, density and composition with altitude, clouds.
(d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers.

2. Dynamical Processes:

(a) Concept of plate tectonics; sea-floor spreading and continental drift. Earthquake and earthquake belts, Seismic waves, Volcanoes and Tsunamis.
(b) The Atmosphere: Atmospheric circulation. Weather and climatic changes and. Cyclones.
I Climate: (i) Earth's temperature and greenhouse effect. (ii) The Indian monsoon system.

3. Geophysical Exploration:

Basic principles of Gravity, Magnetic, Electrical and Seismic Explorations.

Reference Books:

1. *Planetary Surface Processes*, H. Jay Melosh, Cambridge University Press, 2011.
2. *Consider a Spherical Cow: A course in environmental problem solving*, John Harte.University Science Books.
3. *Holme's Principles of Physical Geology*. 1992. Chapman & Hall.
4. Emiliani, C, 1992. *Planet Earth, Cosmology, Geology and the Evolution of Life and Environment*. Cambridge University Press.

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