DEPARTMENT OF PHYSICS

INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD

COURSE STRUCTURE & SYLLABUS FOR

4-YEARS B. Tech.

IN

ENGINEERING PHYSICS

Effective from 2014-15

Second Year (Semester III)

Sl. No	Course Code	Name of the Course	L	T	P	Credit hours	Contact hours
1.	APC13101	Waves and Acoustics	3	1	0	7	4
2.	EIC 13103	Signals and Networks	3	1	0	7	4
3.	MMC13102	Engineering Thermodynamics	3	1	0	7	4
4.	AMR13101	Methods of Applied Mathematics-I	3	1	0	7	4
5.	CSR13101	Data Structures	3	0	0	6	3
6.	APC13201	Physics Lab-I	0	0	3	3	3
7.	MMC13202	Engineering Thermodynamics Lab	0	0	2/2	2/2	1
		Total	**15**	**4**	**4**	**38**	**23**

Second Year (Semester IV)

Sl. No	Course Code	Name of the Course	L	T	P	Credit hours	Contact hours
1.	APC14101	Classical Mechanics	3	1	0	7	4
2.	APC14102	Mathematical Physics	3	1	0	7	4
3.	APC14103	Applied Optics	3	1	0	7	4
4.	AMR14101	Numerical and Statistical Methods	3	1	0	7	4
5.	EER 14101	Applied Electrical Engineering	3	0	0	6	3
6.	APC14201	Physics Lab-II	0	0	3	3	3
7.	APC14202	Physics Lab-III	0	0	3	3	3
8.	APC14901	Summer Training-I (marks to be added in next semester)					
9.	SWC14701	Co-Curricular Activity-II	0	0	0	3	0
		Total	**15**	**4**	**6**	**43**	**25**

Third Year (Semester V)

Sl. No	Course Code	Name of the Course	L	T	P	Credit hours	Contact hours
1.	APC15101	Quantum Mechanics	3	0	0	6	3
2.	APC 15102	Analog and Digital Electronics	3	0	0	6	3
3.	APC15103	Electrodynamics	3	0	0	6	3
4.	APC15104	Sensors and Transducers	3	0	0	6	3
5.	MSC15152	Industrial Engineering and Management	3	0	0	6	3
6.	APC15201	Physics Lab-IV	0	0	3	3	3
7.	APC15901	Summer Training-I	0	0	0	5	0
		Total	**15**	0	**3**	**38**	**18**

Third Year (Semester VI)

Sl. No	Course Code	Name of the Course	L	T	P	Credit hours	Contact hours
1.	APC16101	Nuclear Science and Engineering	3	0	0	6	3
2.	APC16102	Atomic and Molecular Physics	3	0	0	6	3
3.	APC16103	Solid State Physics	3	0	0	6	3
4.	EIC16103	Digital Signal Processing	3	0	0	6	3
5.	APC16104	Low Temperature Physics and Superconductivity	3	0	0	6	3
6.	APC16201	Physics Lab-V	0	0	3	3	3
7.	APC16901	Summer Training-II (marks to be added in next semester)					
		Total	**15**	**0**	**3**	**33**	**18**

Fourth Year (Semester VII)

Sl. No	Course Code	Name of the Course	L	T	P	Credit hours	Contact hours
1.	APC17101	Statistical Mechanics	3	0	0	6	3
2.	APC17102	Physics of Nanomaterials	3	0	0	6	3
3.	APC17103	Thin Film Technology	3	0	0	6	3
4	APC17104	Optical Communication	3	0	0	6	3
5.	APC17105	Astrophysics and Cosmology	3	0	0	6	3
6.	APC17801	Project	0	0	6	6	6
7.	APC17901	Summer Training-II	0	0	0	5	0
8.	APC17401	Seminar	0	0	0	6	0
		Total	**15**	**0**	**6**	**47**	**21**

Fourth Year (Semester VIII)

Sl. No	Course Code	Name of the Course	L	T	P	Credit hours	Contact hours
1.	APC18101	Photonics and Optoelectronics	3	0	0	6	3
2.	APC18102	Characterization Techniques	3	0	0	6	3
3.	APC18103	Laser Physics and Technology	3	0	0	6	3
4.	APC18104	Computational Physics	3	0	0	6	3
5.	APC18105	Nanotechnology	3	0	0	6	3
6.	APC18801	Project	0	0	6	6	6
7.	APC18501	Grand Viva-Voce	0	0	0	4	0
		Total	**15**	**0**	**6**	**40**	**21**

SEMESTER-III

APC13101 WAVES AND ACOUSTICS (3-1-0)

Critical review on Oscillations: Lissajous' figures; Small oscillations, linear and transverse oscillations of a mass between two springs; Two dimensional oscillator, Normal modes, Longitudinal and transverse oscillations of coupled masses, Energy transfer between modes, Coupled pendulum; Damped and forced oscillations, Amplitude and velocity resonances, Quality factor.

Waves: Wave motion; Wave velocity, Boundary conditions and normal modes, Dispersion relations, Dispersive waves, Acoustic and optical modes. Waves in continuous media, Waves in absorptive media; Energy density and energy transmission in waves, Normal and anomalous dispersions in waves, Group velocity and phase velocity; Bandwidth theorem. Superposition of waves: Linear homogeneous equations and the superposition principle, Interference in space and energy distribution; beats and combination tones, Fog-signalling and Zones of silence; Ultrasonics: Production, detection, properties and applications of ultrasonic waves; Acoustic grating.

Acoustics: Reflection and transmission of sound wave at a boundary between two media; Acoustic filters; Modulation and demodulation; Radio transmitter; Architectural acoustics: Reverberation, Sabine's and Eyring's formula, Absorption of sound, Acoustical designs of rooms and auditorium, Presence of echoes, Focussing of sound, Echelon effect, Noise reduction and sound insulations; Acoustical measurements, Recording of sound on disc and film and its reproduction, Musical sound and scale; Helmholtz's theory of consonance and disonance; Tracking of artificial satellites; Shock waves, propagation of explosive sound, seismic waves.

Textbooks:

1. Oscillations, Waves and Acoustics: by Mittal; I. K. International, 2010
2. Acoustics, Waves and Oscillations: By S. N. Sen; New Age International, 1990

Reference Books:

1. The Physics of Waves and Oscillations; Bajaj N K; Tata Mcgraw Hill; 2000
2. Waves and Oscillations; N Subrahmanyam; Vikas Publication House Pvt Ltd; 1994
3. Waves and Oscillations; B K Mukherjee; Campus Books International; 2009
4. Oscillations and Waves; Satya Prakash; Pragati Prakashan; 2010
5. Waves and Oscillations: By R. N. Chaudhuri; New Age International, 2010
6. A Text Book on Oscillations, Waves and Acoustics: By M. Ghosh and D. Bhattacharya; S. Chand Publisher, 2006

EIC 13103 SIGNALS AND NETWORKS (3-1-0)

Definitions and concepts of different types of signals and systems, Convolution, Differential and Difference equation, LTI systems, Fourier Series, Fourier Transforms, Laplace Transform and Z-transforms.

Graph Theory and Network Equations: Introduction, Incidence Matrix, Loop Matrix and the Cut Set Matrix, Interrelation among Various Matrices.Mesh Equations, Node Equations, Network with Mutual Inductance.
Two Port Networks: Short Circuit Admittances, Open Circuit Impedances, Hybrid Parameters, Chain Parameters, Inverse Transmission Parameters, and Interrelation between Parameters. Transient response in Circuit Analysis.

Reference Books:

1. Signals and Linear Systems: Gabel R.A. and Robert R.A; John Wiley and Sons, New York.
2. Signals and Systems: Oppenheim, Wilsky and Nawab; Prentice Hall, New Delhi.
3. Probabilistic Methods of Signals and System Analysis: Cooper G.R and McGillem C.D; 3rd Edition, Oxford University Press, Cambridge.
4. Network Analysis: Van Valkenburg; 3rd Edition, Prentice Hall, New Delhi.

MMC13102 ENGINEERING THERMODYNAMICS (3-1-0)

Basic Thermodynamics:

Introduction, thermodynamic system, control volume, properties, processes and cycles, thermodynamic equilibrium, concept of continuum, Quasi-static process; Zeroth law of thermodynamics, Work and heat transfer, First Law of Thermodynamics for a closed systems, Steady flow energy equation; Second Law of Thermodynamics: Kelvin-Planck and Clausius statements; Causes of irreversibility; Carnot's theorem; Absolute temperature scale; Inequality of Clausius; Entropy principle; Entropy transfer and entropy generation; Quality of energy; Energy principle; Guoy-Stodale theorem; Properties of a pure substance; p-v, p-T, T-s and h-s diagrams

Applied Thermodynamics:

Steam generators: Classification, construction, mountings, accessories, its functions and performance; Air standard cycles; Otto, Diesel, Dual, Stirling and Ericsson cycles; Vapour power cycles, Rankine cycle; Reheat and regenerative cycles; Vapour compression Refrigeration cycle and Gas turbine cycle. Principle of working of 2-S and 4-S internal combustion engines.

Reference Books:

1. Engineering Thermodynamics: P. K. Nag, Tata McGraw Hill
2. Thermodynamics: An Engg. Approach: Y.A. Cengela & M. A. Boles; Tata McGraw Hill
3. Engineering Thermodynamics: Van Wylen
4. Fundamental of Thermodynamics: Sonntag, Borgnakke and Van Wylen; John Wiley & Sons.
5. A textbook of Engg. Thermodynamics: R.K. Rajput; Luxmi Publications
6. Fundamentals of Engg. Thermodynamics: E. Ratankrishnan; Prentice-Hall of India.
7. Engineering Thermodynamics: C P Arora; Tata McGraw Hill.
8. A course in Internal Combustion Engines: M. L. Mathur & R. P. Sharma; Dhanpati Rai

AMR 13101 METHODS OF APPLIED MATHEMATICS-I (3-1-0)

Part – I

Complex Variables: Limit, continuity and differentiability of function of complex variables. Analytic functions. Cauchy-Riemann's equations, Cauchy's integral theorem, Morera's theorem, Cauchy's integral formula, Taylor's and Laurent's series, singularities, Residue theorem, contour integration.

Special Functions: Solution of Bessel equation, recurrence relations and generating function for Jn (x) orthogonal property and integral representation of Jn (x). Solution for Legendre equation, Legendre polynomial, Rodrigue's formula, orthogonality property and generating function for Pn(x).

Part – II

Laplace Transform: Laplace transform of simple functions, properties of Laplace transform, t-multiplication and t-division theorems, Laplace Transform of derivatives, integrals and periodic functions. Inverse Laplace transform and its properties, convolution theorem. Use of Laplace transform in evaluating complicated and improper integrals and solution of ordinary differential equations related to engineering problems.

Partial Differential Equations: Classification of partial differential equations, solutions of one dimensional wave equation, one dimensional unsteady heat flow equation and two dimensional steady heat flow equation by variable separable method with reference to Fourier trigonometric series.

Textbooks:

1. Advanced Engineering Mathematics by R.K. Jain and S.R.K. Iyenger.
2. Higher Engineering Mathematics by B.S. Grewal.

Reference Books:

1. Complex Variables (Schaum's Series) by Speigel.
2. Laplace Trasforms (Schaum's Series) by M.R. Speigel
3. Special Functions for Scientsts & Engineers by W.W. Bell

CSR 13101 DATA STRUCTURE (3-0-0)

Data structure overview, Data types, Creation and analysis of programs, Algorithm analysis; Different data structures: Arrays, Stacks, Queues, Circular queues, Priority queues, Linked lists together with algorithms for their implementation and uses; Sorting algorithms: Insertion, Selection, Bubble, Quick, Merge, Heap etc;

Searching algorithms: Linear searching, Binary searching, Hashing strategy, Hashing functions and hash search;

Trees: Binary tree representation, Traversal, binary search tree, AVL trees, balancing rotations, Applications: Graphs: Representation, traversals, Shortest-path problems, Applications; Recursive: Divide-and-conquer, tower of Hanoi, etc.

Reference Books:

1. An Introduction to Data Structures with Applications, by Jean-Paul Tremblay, Paul G. Sorenson (TMH)
2. Theory and Problems of Data Structures, by Seymour Lipschutz (SCHAUM'S OUTLINE SERIES)

3. Data Structures using C and C++, by Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum (PHI)
4. Classic Data Structures, by D. Samanta (PHI)
5. Fundamentals of Data Structures in C++, by Ellis Horowitz, Sartaj Sahni, Dinesh Mehta (GALGOTIA)

APC13201 PHYSICS LAB-I (0-0-3)

Experiments based on:

Calculation of acceleration due to gravity, Study of resonance in forced vibrations, Determination of damping constant of damped oscillator, Determination of wavelength of stationary wave and velocity of sound in air, Determination of Young's modulus of steel wire, Determination of modulus of rigidity of hollow and solid metallic rods, Determination of coefficient of viscosity of liquid, Determination of coefficient of static and dynamic friction between wooden block and wooden surface, Charging and discharging of a Capacitor.

Textbooks:

1. An Advanced Course in Practical Physics by D. Chattopadhyay, P. C. Rakshit; New Central Book Agency (P) Ltd., 2007 (8e)
2. A Textbook of Advanced Practical Physics by S. K. Ghosh; New Central, 2000 (4e)

Reference Books:

1. Advanced practical physics for students, by B. L. Worsnop and H. T. Flint; Littlehampton Book Services Ltd., 1951 (9e)
2. Advanced Practical Physics, V-I & II by Chauhan and Singh; Pragati Prakashan
3. Physical Methods, Instruments and Measurements, Vol. 1-4, Edited by Yuri M. Tsipenyuk; Russian Academy of Sciences, Russia
4. Handbook of Physical Measurements, by Judith Hall, Judith Allanson, Karen Gripp, Anne Slavotinek; Oxford, 2e (2006)
5. Encyclopedia of Physical Science and Technology: Measurements Techniques and Instrumentation, by Robert Allen Meyers; Academic Press (2007)

MMC 13202 ENGINEERING THERMODYNAMICS LAB (0-0-2/2)

1. To study construction and operation of 2-stroke SI engine model.
2. To study construction and operation of 4-stroke SI engine model.
3. To study construction and operation of 4-stroke CI engine model.
4. To study construction and operation of various boiler models.
5. Performance testing of a 4-stroke Diesel engine.
6. Performance testing of a 4-stroke Petrol engine.
7. Performance testing of a steam boiler.
8. Performance testing of a steam power plant cycle.

SEMESTER-IV

APC14101 CLASSICAL MECHANICS (3-1-0)

Motion under central force: Equivalent one body problem, Differential equation of an orbit, Kepler's law, Center of mass and laboratory coordinates, Scattering in center of mass and laboratory frames, Scattering cross-section, Rutherford scattering, Elastic and inelastic collisions.

Motion in a non-inertial frame: Motion of a point particle in a general (rigid) non-inertial frame of reference, centripetal acceleration, Pseudo force, Coriolis force and its applications, Galilean Relativity.

Rigid body dynamics: Degrees of freedom of a rigid body, Moment of inertia and their products, principal moments and axes, Orthogonal transformations, Euler angles, Euler's equations, Precessional motion, heavy symmetrical top.

Lagrangian Formulation: Constraints and generalized Coordinates, degrees of freedom, D'Alembert's principle, Lagrange's equations from D'Alembert's principle, Hamilton's principle, Calculus of Variation and Lagrange's equations from Hamilton's principle. Conservation Theorems and Symmetry Properties, Simple applications of the Lagrangian formulation.

Hamiltonian Formulation: Definition of Hamiltonian, Legendre transformations, Hamilton equations and its application to simple cases, cyclic coordinates and conservation theorems, Canonical transformations, Poisson theorem, Poisson brackets.

Special theory of relativity: Minkowski world and Lorentz transformations, world lines, Relativistic Mechanics of Mass Points, Lorentz covariance of the new conservation laws, Relativistic analytical mechanics, Relativistic force.

Textbooks:

1. Classical Mechanics; Goldstein, Safko & Poole; Pearson; 2002
2. Classical Mechanics; Rana & Joag; Tata Mcgraw Hill; 1991
3. Classical Mechanics of Particles and Rigid Bodies; Gupta; John Wiley & Sons; 1988
4. Classical Mechanics; Systems of Particles & Hamiltonian Dynamics; Greiner; Springer-Verlag; 2009

Reference Books:

1. The General Properties of Matter; Newman and Searle; Edward Arnold; 1961
2. Elements of Properties of Matter; D.S. Mathur; S. Chand & Co. Ltd; 2010
3. Mechanics and General Properties of Matter; P.K. Chakraborti, Kolkata Books and Allied; 2009
4. Classical Mechanics; J. C. Upadhyay; Himalaya Publication House; 2008.

APC14102 Mathematical Physics (3-1-0)

Beta, Gamma and Error functions: Symmetry properties, evaluation and transformation, relation between above functions, evaluation of miscellaneous integrals.

Differential Equations and Special Functions: Second order linear ODEs with variable coefficients; Solution by series expansion; Legendre, Bessel, Hermite and Laguerre equations

and their solutions; Physical applications; Generating functions; recurrence relation; Green's function and its applications.

Fourier transform: Sine, Cosine and complex transforms with examples, definition, properties and representations of dirac delta function, properties of Fourier transforms, transforms of derivatives, Parseval's theorem, Convolution theorem, Momentum representation, Application of Fourier transformation to partial differential equations, discrete Fourier transforms, introduction to Fast Fourier Transforms.

Group theory: Concept of group, examples of group, abelian group, generators of finite group, cyclic group, group multiplication table, subgroup, conjugate elements and classes, isomorphism and homomorphism.

Tensors: Transformation properties, Metric tensor, Raising and lowering of indices, Contraction, Symmetric and anti-symmetric tensors, Christofell's symbols, transformation laws.

Textbooks:

1. Mathematical Methods for Physicists; Arfken & Weber; Academic Press; 2010
2. Introduction To Mathematical Physics; Harper; PHI Learning; 2009
3. Mathematical Physics; B.D. Gupta, Vikas Publishing House, 1986
4. Mathematical Physics; Advanced Topics; Joglekar; Universities Press; 2006

Reference Books:

1. Mathematical Methods in Physical Sciences; Boas; Wiley India Pvt Ltd; 2006
2. Mathematical Physics; Satya Prakash, S. Chand and Sons 1992.

APC14103 APPLIED OPTICS (3-1-0)

Geometrical Optics: Fermat's principle, General Theory of Image formation, The Matrix Method in paraxial optics.

Physical Optics: Interference of light: The principle of superposition, two-slit interference, coherence requirement for the sources, optical path retardations, lateral shift of fringes, Localised fringes; thin films. Diffraction: Fresnel diffraction: Fresnel half-period zone plates, straight edge, rectilinear propagation; Fraunhoffer diffraction: Diffraction at a slit, half-period zones, phasor diagram and integral calculus methods, the intensity distribution, diffraction at a circular aperture and a circular disc, Rayleigh criterion, Diffraction gratings: Diffraction at N parallel slits, intensity distribution, plane diffraction grating, Resolving power of a grating. Double refraction and optical rotation: Refraction in uniaxial crystals, its electromagnetic theory. Phase retardation plates, double image prism, polarization and transfer function, Rotation of plane of polarization, origin of optical rotation in liquids and in crystals.

Applications: Rayleigh refractometer, Michelson interferometer, its application for precision determination of wavelength, wavelength difference and the width of spectral lines. Intensity distribution in multiple beam interference, Fabry-Perot interferometer and etalon.

Optical systems: Characteristics of objectives, eyepieces, condensers for different applications. Human eye. Image manipulation by prism systems.

Textbooks:

1. Fundamental of Optics: Jenkins and White; McGraw-Hill; 2001
2. Optics: Ajoy Ghatak; Tata McGraw-Hill;2005
3. Optics: Eugene Hecht; Addison-Wesley;, 2001
4. Principles of Optics; M. Born and E. Wolf; Cambridge University Press; 1999

Reference Books:

1. Geometrical and Physical Optics: P. K. Chakrabarti; New Central Book Agency; 2010
2. Applied Optics and Optical Design; A.E Conrady; Dover Publications; 2011
3. Introduction to Applied Optics; Banerjee and Poon; CRC Press; 1991
4. Optics and Optical Instruments; Johnson; Dover Publications; 2011
5. Modern Optical Engineering, Warren Smith, McGraw-Hill Professional; 2007
6. Optics: Brij Lal and Subrahmanyam , S. Chand; 2010

AMR 14101 NUMERICAL AND STATISTICAL METHODS (3-1-0)

Part – I

Numerical Methods: Solution of algebraic and transcendental equation by bisection, iteration, false position and Newton-Raphson methods.

Solution of a system of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularisation, Jacobi and Gauss-Seidel methods.

Finite difference, Symbolic relations, Interpolation and Extrapolation, Newton-Gregory forward and backward, Gauss forward and backward, Stirling, Bessel and Lagrange's formulae, Inverse interpolation by Lagrange and iterative methods, Numerical differentiation and integration: Trapezoidal, Simpson's 1/3rd, Simpson's 3/8th and Weddle quadrature formulae.

Numerical solution of first order ordinary differential equations by Taylor's series, Picard's, Euler's, Modified Euler's, Runge-Kutta and Milne's methods. Solution of simultaneous first order and second order ordinary differential equations with initial conditions by Runge-Kutta and Milne's methods. Numerical solution of boundary value problems by finite difference method.

Part – II

Statistical Methods: Moments, skew ness and kurtosis.

Probability: Various approaches of probability, two theorems (without proof), conditional probability, Bayes theorem.

Random variable: Definition, probability mass & density functions, distribution function, mathematical expectation and moment generating function.

Probability distributions: Bernoulli, binomial, Poisson and normal distributions.

Theory of least squares and curve fitting.

Correlation and Regression: Simple, multiple & partial correlation coefficients, regression lines, regression coefficients and their properties.

Test of significance: Normal test, t-test, chi square test and F test.

Textbooks:

1. Higher Engineering Mathematics by B.S. Grewal.
2. Fundamentals of Mathematical Statistics by S.C. Gupta and V.K. Kapoor.

Reference Books:

1. Fundamentals of Statistics Vol I by A.M. Goon, M.K. Gupta, B. Dasgupta.
2. Elementary Statistics by H.C. Saxena.
3. Miller & Freund's Probability and Satistics for Engineers by Rachard and Jhonson.
4. Introductory Methods of Numerical Analysis by S.S. Sastry.
5. Numerical Methods in Engineering and Science by B.S. Grewal.

EER 14101 APPLIED ELECTRICAL ENGINEERING (3-0-0)

Operation and characteristics of three-phase Induction motors; Methods of starting & speed control of three phase induction motor; Ward-Leoard method of speed control of DC motor; Basic principles of Thyristor controlled variable speed DC and AC motors.

Principles of rate making of electricity and power factor improvement; Substation arrangement; Circuit breakers; Protective relays: - Induction pattern over current relay, thermal overload relay, earth fault relay, Lightning Arrester, Fuses: - types and selection.

Power cables: - Types & selection, Types of motor enclosure, FLP enclosures for hazardous area equipment, Intrinsically safe circuit.

Industrial application & control of electrical motors: - Types of electric motors and their application in Industry; Controller for the speed control of DC & AC motors.

Diesel – Electrical oil rigs. I.E rules applied to mines & oil fields.

Textbooks:

1. Electrical Power Systems: A Husain; Cbs Publishers & Distributors.
2. Electrical Machines: P K Mukherjee & S Chakraborty; Dhanpat Rai Publications (p) Ltd.
3. Fundamentals of Electrical Drives: G. K. Dubey, CRC Press, 2002.
4. A Text Book on Power System Engineering: Soni, Gupta, Bhatnagar, Chakrabarti; Dhanpat Rai and Company Private Limited.

APC14201 PHYSICS LAB-II (0-0-3)

Experiments based on:

Photo-elastic effects and determination of photo-elastic constant of perspex glass; Dynamic light scattering; Determination of specific rotation of sugar; Determination of wavelength of sodium light (such as Newton's ring experiment, Fresnel's bi-prism); Determination of refractive index using hollow prism and liquid prism; Identification of missing order in double slit diffraction pattern; Determination of thickness and refractive index of glass plate; Fabry-Perot interferometer (determination of spectral line separation, wavelength and distance between mirrors); Study of monochromatic aberrations of optical system.

APC14202 PHYSICS LAB-III (0-0-3)

Experiments based on:

Determination of Planck's constant; Determination of e/m ratio of electron ; Plot of B-H loop of ferromagnetic material and calculation of hysteresis loss; Determination of magneto-resistance of semiconductor; Determination of band gap; Determination of

bending moment of cantilever; Measurement of contact angles of water and organic liquids on Teflon and glass substrates; Determination of velocity of transverse waves in stretched strings; Determination of velocity of sound in air at room temperature by study of resonances in organ pipes.

SEMESTER-V

APC15101 QUANTUM MECHANICS (3-0-0)

Introduction: Wave-particle duality, notion of state vector and its probability interpretation;
Structure of Quantum Mechanics: Operators and observables, significance of eigenfunctions and eigenvalues, commutation relations, uncertainty principle, measurement in quantum theory.
Schrödinger Equation: Time-dependent Schrödinger equation, stationary states and their significance, time-independent Schrödinger equation;
Potential Problems: Free-particle solution, Potential Barrier and tunneling, simple harmonic oscillator,
Motion in a central potential: Separation of variables in spherical polar coordinates, spherical harmonics, free particle in spherical polar coordinates, hydrogen atom problem.
Representation Theory: Linear vector space, Dirac notations of Bra - Ket, Matrix representation of Observables and states, operators and their properties; unitary transformation, Parity and parity operators
Theory of Angular Momentum: Relation between rotation and angular momentum, Rotation operators, angular momentum algebra: commutation rules, Matrix representations, addition of angular momenta, spinors and Pauli spin matrices.
Approximation Methods: Time-independent Perturbation theory: (non-degenerate and degenerate) and applications to fine structure splitting, WKB approximation; Variational method; Time-dependent perturbation theory, transition probability calculations, Fermi golden rule.
Scattering Theory: Introduction, partial wave analysis, Born approximation.

Textbooks:
1. Introduction of Quantum Mechanics; Griffiths; Pearson Education; 2010
2. Quantum Mechanics; Thankappan; New Age International Pub; 1993
3. Quantum Mechanics, 3rd Edition; Merzbacher; John Wiley; 2005

Reference Books:
1. Principles of Quantum Mechanics; R. Shankar, Plenum Press; 1994
2. Modern Quantum Mechanics; Sakurai; Pearson; 1994
3. Quantum Mechanics 2nd Edition; Bransden & Joachain; Pearson; 2000
4. Introduction to Quantum Mechanics; Pauling and Wilson; Dover Publications 1985
5. Quantum Mechanics: Theory and Applications, 1e; Ghatak & Lokanathan; Kluwer Academic Publishers; 2004

APC15102 ANALOG AND DIGITAL ELECTRONICS (3-0-0)

Analog: Introduction to diodes and transistor, rectifier; 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: integrators, differentiator, arithmetic circuits, active filters, voltage controlled oscillators, A/D and D/A converters, sample and hold circuits and other applications of Op-amps; 555 timer IC, multivibrators.

Digital: Number systems; Transistor as a switch; Logic gates; Boolean Algebra, De Morgan's laws; Karnaugh map; Arithmetic circuits; RS, JK, JK Master-Slave, T, D Flip-Flops; Registers; Synchronous, Asynchronous and Cascade Counters; Comparators; A/D and D/A conversion; Multiplexer, Demultiplexer; Basics of Microprocessors and Microcontrollers.

Textbooks:

1. Electronic Devices and Circuit Theory, Robert L. Boylestad & L. Nashelsky, Pearson, 2013
2. Electronic Devices and Circuits (SIE); Cathey; Mcgraw-Hill Education (India) Ltd; 2008
3. Foundations of Analog and Digital Electronic Circuits, A. Agarwal & J. Lang, Elsevier, 2005.
4. Basic Digital Electronics, J.A. Strong, Springer, 1991.
5. Digital Logic Design, B. Holdsworth & R.C. Woods, Elsevier, 2003.
6. Digital Principles and Applications; Leech & Malvino; Tata Mcgraw Hill; 2006
7. Introduction to Microprocessors and Microcontrollers, John Crisp, Elsevier, 2004
8. Understanding 8085/8086 Microprocessors and Peripheral ICs, S. K. Sen, New Age International, 2010

Reference Books:

1. Millman's Electronic Devices and Circuits; Millman; Tata Mcgraw Hill; 2007
2. Microelectronic circuits, A. S. Sedra & K.C. Smith, Oxford University Press, 2008
3. Op Amps and Linear Integrated Circuits, R. K. Gaykwad; Prentice-Hall of India, 2002
4. Electronic Devices and Circuits; Gupta; S.K. Kataria & Sons; 2010
5. Digital Fundamentals; Thomas L Floyd; Pearson Education Limited;
6. Electronic Fundamentals & Applications: Int. & Discrete Systems; Ryder; PHI Learning; 2009
7. Electronics; Fundamentals & Applications; Chattopadhyay & Rakshit; New Age; 2010
8. Microprocessor Architecture, Programming, and Applications with the 8085; Ramesh Gaonkar; CBS Publishers; 2011
9. Microprocessors and Microcontrollers; A. Nagoor Kani; Tata-Mcgraw Hill; 2012

APC15103 ELECTRODYNAMICS (3-0-0)

Electrostatics: Differential form of electrostatic field equation, Poisson and Laplace equations, formal solution for potential with Green's functions, Dirichlet and Neumann boundary conditions, boundary value problems, examples of image method and Green's function method, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics, polarization of a medium, electrostatic energy, Multipole Expansion.

Magnetostatics: Biot-Savart law, Ampère's law, differential equation for static magnetic field, vector potential, magnetic field from localized current distributions, examples of magnetostatic problems, Faraday's law of induction, magnetic energy of steady current distributions.

Maxwell's Equations: Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges, electromagnetic energy and momentum, conservation laws, inhomogeneous wave equation and Green's function solution. Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity, metallic wave guides, boundary conditions at metallic surfaces, propagation modes in wave guides, resonant modes in cavities.

Radiation: Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, radiation by moving charges, Lienard-Wiechert potentials.

Textbooks:

1. Classical Electrodynamics; Jackson; John Wiley; 2007
2. Classical Electricity and Magnetism; Panofsky and Phillips; Dover Publications, Inc.; 1990
3. Classical Electrodynamics; Greiner; Springer; 1998
4. Introduction to Electrodynamics; Griffiths; PHI Learning; 2009

Reference Books:

1. Electricity & Magnetism; Chattopadhyay & Rakshit; New Central Book Agency; 2005
2. Feynman Lectures, Vol-II; Feynman, Leighton & Sands; Narosa Publishing House; 1998
3. Fundamentals of Magnetism and Electricity; Vasudeva; S. Chand Publisher; 2004
4. Foundations of electromagnetic theory; Reitz, Milford & Christy; Pearson; 2009.
5. Electrodynamics; Gupta, Kumar & Sharma; Pragati Prakashan; 2010
6. Classical Electromagnetic Theory; Vanderlinde; John Wiley & Sons; 1993

APC15104 SENSOR AND TRANSDUCERS (3-0-0)

Basics of sensors and transducers: Principle, Classifications, Parameters: Characteristics, Environmental parameters.

Sensors:

Mechanical and Electromechanical sensors: Resistive potentiometer, Inductive sensor, Capacitive sensor, Stress sensors, Ultrasonic sensors.

Thermal sensors: Gas thermometric, Thermal expansion type thermometric, Resistance change type thermometric, Thermo-emf, Semiconductor junction type, Thermal radiation sensors.

Magnetic sensors: Magnetoresistive, Hall effect, Inductance, Eddy-current, Switching magnetic, SQUID sensors.

Radiation sensors: Characteristics, Photodetectors, X-ray and Nuclear radiation sensors, Fibre optic sensors.

Electroanalytical sensors: Electrochemical cell; Cell potential, Liquid junction and other potentials; Polarization; Electrodes.
Smart sensors, Recent trends in sensor technology; Applications of sensors.

Transducers:

Mechanical transducers: Temperature, Pressure, Force, Torque, Density, Liquid-level, Viscosity, Flow measurements; Displacement-to-Pressure transducer, Seismic displacement transducer.
Passive electrical transducers: Resistive, Inductive, Capacitive transducers.
Active electrical transducers: Thermoelectric, Piezoelectric, Magnetosrictive, Hall-effect, Electromechanical, Photoelectric, Ionization, Digital, Electrochemical transducers.
Feedback transducer systems: Temperature balance, Beam balance, Feedback accelerometer, Bimorph position-control systems.

Textbooks:

1. Sensors and Transducers by D. Patranabis; PHI, Eastern Economy Edition 2004
2. Transducers and Instrumentation (2 Ed) by D. V. S. Murty, PHI Learning (2008)

Reference Books:

1. Sensors and Transducers by Ian Sinclair, Newnes, 3rd Edition 2001
2. Sensors and Transducers by MJ Usher, Scholium International 1985
3. Sensors and Transducers by Kieth Briendley, CRC Press 1988

MSC15152 INDUSTRIAL ENGINEERING AND MANAGEMENT (3-0-0)

Basic functions of management – planning, organizing, staffing, directing and controlling.
Introduction to industrial Engineering techniques.
Productivity: definition, measurement.
Work study and its role in improving productivity of an organization.
Types of Production systems.
Introduction to production planning and control.
Concepts of human resource management – selection, training and development.
Finance management – capital budgeting techniques, payback period, ARR, NPV, IRR, PI; Sources of capital; Costs concepts and Break even analysis.
Project management – Introduction, Network construction & identification of critical activities in CPM & PERT.

Reference Books:

1. Essentials of Management, Koontz a andO'Donne.
2. Finance Sense, Prasanna Chandra
3. Industrial Management, M E ThukaramRao.
4. Work Study, I.L.O.
5. A Management Guide to PERT/CPM, J D Wiest and F K Levy.

APC15201 PHYSICS LAB-IV (0-0-3)

Experiments based on:

Verification of Wien's displacement law; Verification of Stefan-Boltzmann law of thermal radiation; Study of Seebeck effect; Design of RC filter circuit and calculation of phase factor and time constant; Study of single stage and cascade amplifier in CE and CB configuration; Phase shift oscillator circuit design, current voltage characteristics and Q-factor; Plot static characteristics of JFET and MOSFET and determine the transistor parameters; Operational amplifier for mathematical operations (differentiator and integrator); Multivibrator (555 timer).

SEMESTER-VI

APC16101 NUCLEAR SCIENCE AND ENGINEERING (3-0-0)

Basics of nucleus and its stability: Masses, sizes, spins, angular momentum, magnetic moments, parity, quadrupole moments, energetic and stability against particle emission, Gamow's theory of Alpha decay, Fermi theory of Beta decay, Gamma decay, Internal conversion, Nuclear isomerism.

Two Nucleon Problem: Nature of nuclear forces, Meson theory of nuclear forces, Deuteron problem, Nucleon-Nucleon scattering, scattering length, coherent and incoherent scattering, Effective range theory.

Nuclear model: Liquid drop model, Shell model, Semi-empirical mass formula

Detectors & Accelerators: Gas-Filled Ionization Detectors, Proportional counter, G.M. counter, Semiconductor Detectors, Solid State Scintillation Counters, Synchrotrons, Linear Accelerators, Colliding/Beam Accelerators.

Nuclear Reactions: Conservation laws, Classification, Compound Nucleus theory, Continuum and Statistical theories, Cross-sections, Breit-Wigner formula, Direct Reactions.

Elementary particles: Leptons, Mesons and Baryons, concept of antiparticle, discrete symmetries and conservation laws, Weak interactions (nuclear and particle decays, neutrinos etc.). Isospin and strangeness, Gellmann-Nishijima formula, quark model, color, resonances.

Nuclear reactors: Nuclear fission, critical size of reactor, general aspect of reactor design, classification of reactors, neutron moderation, Fissile and fissionable material, neutron economy, homogeneous reactor examples, infinite and finite reactor, operation and control, accidents, fast breeders, hybrid reactors. Fusion: Basic reactions and energetic, Lawson's criteria for fusion, Stellar fusion, nucleogenesis, controlled fusion- plasma confinement, laser implosion.

Application of nuclear techniques: Dating techniques, Radiation therapy, Particle therapy.

Textbooks:

1. Atomic & Nuclear Physics; Vol.2; S. N. Ghoshal; S. Chand; 1994
2. Fundamentals of Nuclear Physics; Verma, Bhandari and Somayajulu; CBS Publisher; 2010
3. Nuclear Physics; D. C. Tayal; Himalaya Publishing House; 2013
4. Introductory Nuclear Physics; Wong; Prentice Hall of India; 2010
5. Nuclear and Particle Physics; Burcham and Jobes; John Wiley & Sons; 1995

6. Theory of Nuclear Structure; S.K.Gupta; Alfa Publication; 2011
7. Nuclear Physics: Theory and Experiments; Roy & Nigam; New Age International; 2014

Reference Books:

1. Introductory Nuclear Physics; Kenneth S. Krane; Wiley India Pvt Ltd; 2011
2. Nuclear Physics; I. Kaplan; Narosa; 2006
3. Quarks and Leptons; Halzen and Martin. Wiley India Pvt Ltd; 2008

APC16102 ATOMIC AND MOLECULAR PHYSICS (3-0-0)

Atomic spectra: Atomic orbital, Hydrogen spectrum-Pauli's principle, Spin orbit interaction and fine structure in alkali Spectra, Equivalent and non-equivalent electrons, Normal and anomalous Zeeman effect – Paschen Back effect, Stark effect-Two electron systems.
Atom model: Vector atom model, interaction energy in L-S and J-J Coupling, Hyperfine structure, Line broadening mechanisms, Doppler and Lorentz Broadening.
Molecular spectra: Rotational spectra of diatomic molecules as a rigid rotor and non rigid rotor, intensity of rotational lines, Frank-Condon principle. Vibrational and rotational spectra, Vibrational energy of diatomic molecule. Raman spectroscopy, Rotational Raman spectra of diatomic molecules.
Nuclear spectra: Mossbauer spectroscopy, Nuclear Magnetic Resonance and Magnetic Resonance Imaging.

Textbooks:

1. Introduction to Atomic Spectra; White; Mcgraw-Hill Education; 1934
2. Atomic Spectra And Atomic Structure; Herzberg; Dover; 2008
3. Physics of Atoms and Molecules; B.H. Bransden and C.J. Joachain, Addison-Wesley; 2003
4. Introduction to Molecular Spectroscopy; Barrow; Mcgraw-Hill Education; 1962

Reference Books

1. Fundamentals of Molecular Spectroscopy; Banwell; Mcgraw-Hill Education Ltd; 2000
2. Atomic & Molecular Spectra; Raj Kumar, Kedar Nath Ram Nath, New Delhi , 1997
3. Modern Spectroscopy; Hollas; Wiley India Pvt Ltd; 2010.

APC16103 SOLID STATE PHYSICS (3-0-0)

Crystallography: Crystal structure, fundamental translational vectors, unit cell, Wigner-Seitz cell, Symmetry elements, lattice types, lattice planes, Miller indices, Common crystal structures., Reciprocal lattice, Bragg's law and applications.
Bonding in crystals: Potential between a pair of atoms; Lennard-Jones potential, concept of cohesive energy, covalent, Van der Waals, Crystal Defects.
Thermal properties: Lattice vibrations, vibrations of one dimensional monoatomic and diatomic linear chain of atoms, concept of phonons, Debye model.

Free electron theory of metals: Drude-Lorentz theory, Sommerfield's Model, Fermi-Dirac Distribution, free electron concentration, electrical conductivity, Thermal Conductivity, Sommerfield theory of electrical conductivity.
Band structure: Electrons in periodic potential: Bloch theorem, Kronig-Penny Model, energy bands.
Dielectric properties: Static, electronic, ionic and orientational Polarization, Lorentz internal field, dielectric loss and relaxation time, Piezo, Pyro, Ferro electric properties and applications.
Magnetic Properties: Diamagnetic, Paramagnetic and Ferromagnetic Materials, Curie-Weiss law of susceptibility, Weiss Molecular field theory.

Textbooks:

1. Introduction to Solid State Physics; C. Kittle; Wiley; 2012
2. Crystallography Applied to Solid State Physics; Verma & Srivastava; New Age; 1991
3. Solid State Physics; A. J. Dekker; Macmillan; 2010
4. Solid State Physics; Ashcroft and Mermin; Cengage Learning India Pvt Ltd; 2010
5. Elements of X-Ray Diffraction, B. D. Cullity, Addison-Wesley Publishing Company, INC., MA, USA 1956
6. Solid State Physics (Introduction to the theory), J. Patterson, B. Bailey, Springer-Verlag Berlin Heidelberg, 2010
7. Principles of Electronic Materials And Devices, S. O. Kasap, McGraw Hill Company, INC., 2006

Reference Books:

1. Solid State Physics: Structure and Properties of Materials; M. A. Wahab; Narosa; 2009
2. Solid State Physics; S. O. Pillai; New Age International; 2010
3. Elements of Solid State Physics; J. P. Srivastava; Prentice Hall of India; 2013
4. Solid State Physics; R. L. Singhal; Kedar Nath Ram Nath; 1998
5. Fundamentals of Solid State Physics; Saxena, Gupta, Saxena; Pragati; 2012
6. Elementary Solid State Physics; Ali Omar; Pearson; 2010

EIC16103 DIGITAL SIGNAL PROCESSING (3-0-0)

Introduction: Sampling of Continuous-time signals: frequncy-domain representation of Sampling, reconstruction of bandlimited signal from its samples, discrete-time processing of continuous-time signals, Sampling rate changes- Upsampling and downsampling. Digital Filter Design: Design of IIR Filters (Analog approximations- Butterworth, Chebyshev and Transformations- Impulse Invariance and Bilinear Transformation), FIR filter design using Windowing and Frequency Sampling methods. Digital Filter Structures: Direct forms, Cascade and Parallel forms, Linear phase and Frequency sampling structures for FIR systems Discrete Fourier Transform: Definition, Properties, Computation of DFTs, radix-2 FFT algorithms (Decimation-in-time and Decimation-in- frequncy), DFT based Spectral analysis. Finite Word Length Effects: Discrete-time Random signals, Quantization effects, Coefficient quantization, Round-off noise. Digital Signal Processors: Introduction to TMS-320 family of

Digital Signal Processors Applications of DSP (e.g. Musical Signal Processing, Speech Processing) Introduction to Advanced Topics (Wavelets and Multiresolution analysis, Adaptive Signal Processing)

Reference books:

1. Discrete Time Signal Processing by A. V. Oppenheim, R. W. Shafer and J. R. Buck, *(Publisher-Pearson Education)*
2. Digital Signal Processing by J. G. Proakis and D. G. Manolakis, *(Publisher-Pearson Education.)*
3. Digital Signal Processing: A Computer based approach by S. K. Mitra *(Publisher- McGraw-Hill international)*
4. Digital Signal Processing by A. Nagoor Kani *(Publisher- Tata McGraw-Hill)*

APC16104 LOW TEMPERATURE PHYSICS AND SUPERCONDUCTIVITY (3-0-0)

Cooling techniques and cryogenics: Liquefaction of gases, Expansion engines, operation principle and technical realizations, separation of liquefied gases, Inverse Carnot Engine, Joule-Thomson expansion, closed cycle refrigerators and Gifford-McMahon coolers, Pulse tube cooler, Liquid He cryostat. Basics of dilution refrigerator.

Basics of superconductivity: Zero resistance, perfect diamagnetism, type-II super conductor (shubinkov phase), flux quantization, flux pinning, Josephson effects.

Thermodynamics of superconductors: Condensation energy, entropy, specific heat capacity.

Electrodynamics of super conductors: Drude model, London theory. BCS theory of superconductivity, properties of fermions and coherent states of fermions. Ginzburg-Landau theory, phase transition, screening, GL coherence length.

Applications: Superconducting magnets, Magnetic levitation, application of Josephson junction, SQUID, high T_c superconductors.

Textbooks:

1. Low-temperature Physics: An introduction for scientists and engineers by PVE McClintock, DJ Meredith, JK Wigmore; Springer Science 1992
2. Low-temperature Physics by C. Enss, S. Hunk linger, Springer-Verlag Berlin Heidelberg 2005
3. Experimental Techniques for Low temperature measurements by JW Ekin, Oxford Univ. Press 2006

Reference Books

1. Matters and Methods at Low-Temperatures by Frank Pobel; Springer-Verlag Berlin Heidelberg 2007
2. Introduction to Superconductivity: Michael Tinkham; Dover Publications; Second Edition; 2004

APC16201 PHYSICS LAB-V (0-0-3)

Determination of transition temperature of high T_c superconductor; Indexing X-rays and electron diffraction patterns and identification of crystal structure; I-V characteristics of Si solar-cell and calculation of the efficiency; Study of line spectra of Li; GM counter; Vacuum and Gauges; Surface plasmon resonance sensors.

SEMESTER-VII

APC17101 STATISTICAL MECHANICS (3-0-0)

Ensemble Theory: Concept of Phase space, Liouville's theorem, Microcanonical ensemble, canonical and grand canonical ensembles; partition function, calculation of statistical quantities, Energy and density fluctuations; Meyer cluster expansion method for classical gas, virial quation of state.

Quantum Statistics: Density matrix, statistics of ensembles, statistics of indistinguishable particles; Maxwell-Boltzman, Fermi-Dirac and Bose Einstein statistics; properties of ideal Bose and Fermi gases, Bose-Einstein condensation. Application of Fermi-Dirac statistics to white dwarf stars and Chandrasekhar limit.

Phase transitions and critical phenomena: Ising model: mean-field theories of the ising model in one, two and three dimensions, Exact solutions in one dimension; Landau theory of phase transition, critical indices, scale transformation and dimensional analysis.

Non-equilibrium statistical mechanics: Correlation of space-time dependent fluctuations, fluctuations and transport phenomena, Brownian motion, Langevin theory, fluctuation dissipation theorem. The Fokker-Planck equation.

Textbooks:

1. Statistical Mechanics: R. K. Pathria; Elsevier; 2002
2. Fundamentals of Statistical and Thermal Physics; Reif; McGraw-Hill; 1965
3. Thermodynamics and Statistical Mechanics; Greiner; Springer; 2007

Reference Books:

4. Statistical Mechanics: K Haung; Wiley Eastern; 2003
5. Modern Theory of Critical Phenomena: Shang Keng Ma; Levant Books; 2007
6. Statistical Mechanics: Landau and Lifshitz; Butterworth-Heinemann; 1976
7. Introduction to Phase Transitions and Critical Phenomena; H. Eugene Stanley; Oxford University Press; 1987

APC17102 PHYSICS OF NANOMATERIALS (3-0-0)

Introduction: Nanomaterials; Small-scale nonequilibrium systems; Phase transitions in nanocrystals; Geometric evolution of the lattice in nanocrystals; Nanothermodynamics, Solid–liquid transitions; Melting point of nanomaterials; Inverse systems: Nanoporous solids, Confined fluids, Phase diagram and Metastability; Graphene, Fullerenes and Carbon Nanotubes; Supramolecular structures; Nanocomposites.

Electronic structure: Band Structure, Density of States (DOS) in bands, Variation of DOS with energy, Variation of DOS and band gap with size of crystal; Dimensional dependence of DOS of Fermi gas electrons. Electron confinement in infinitely deep and finite square well potentials; Physical concepts of circular, parabolic and triangular well potentials.

Quantum size effect: Properties of nanoparticles, Characteristic lengths, Clusters, Magic Numbers; Quantum well, Quantum wire, Quantum dot; Energy subbands; Conduction electrons and dimensionality; Properties dependent on DOS. Electrical transport properties, Diffusive and ballistic regime, Single electron tunneling, Quantum structural properties in Superconductivity; Excitons, Optical absorption in quantum well; Surface plasmon resonance; Dynamics at the nanoscale; Nanomagnetism; Nanomechanical properties.

Overview of preparation methods: Classification, Top-down and Bottom-up approach, Overview of different fabrication and synthesis techniques such as Ball Milling, Chemical bath Deposition, Electrodeposition, Sol-Gel, Physical Vapor Deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy.

Textbooks:

1. Introduction to Nanotechnology, Poole & Owners, Wiley India Pvt Ltd, 2007.
2. Nanotechnology: A Crash Course, Raul J. Martin-Palma, Akhlesh Lakhtakia, SPIE Publications, 2010.
3. Handbook of Nanophysics – Principles and Methods: By Klaus D. Sattler; CRC Press, 2010
4. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Cao; World Scientific Publishing Company, 2011.
5. Introduction to Nanoscience and Nanotechnology, Chattopadhyay & Banerjee, PHI Learning Pvt. Ltd., 2009.
6. Nanoscience and Nanotechnology – Fundamentals to Frontiers: By M. S. Ramachandra Rao, S. Singh; Wiley, 2013.
7. Chemistry of Nanomaterials: Synthesis, Properties and Applications, Rao, Muller & Cheetham, Wiley VCH; 2004.

Reference Books:

1. Materials Science and Engineering: An Introduction, W. D. Callister, John Wiley & Sons, 2006.
2. Materials Science and Engineering, V. Raghvan, PHI Learning Pvt. Ltd., 2004.
3. Nanotechnology: A Crash Course, R. Raul J. Martin-Palma, Akhlesh Lakhtakia, SPIE Press, 2010.
4. Nanoscience and Nanotechnology in Engineering, V. K. Varadan, World Scientific, 2010.
5. Introduction to nanoscience and nanotechnology, Gábor Louis Hornyak, Harry F. Tibbals, Joydeep Dutta, CRC Press, 2009.
6. Quantum Dots, Jacak, Hawrylak & Wojs, Springe, 1998.
7. Nanotechnology: Principles and fundamentals, Günter Schmid, Wiley-Vch, 2008.
8. Nanomaterials and Nanochemistry: By C. Brchignac, P. Houdy and M. Lahmani; Springer, 2008.

APC17103 THIN FILM TECHNOLOGY (3-0-0)

Vacuum Generation:

Basic terms and concepts; Continuum and Kinetic gas theory; Pressure ranges; Types of flow; Conductance.

Vacuum pumps – a survey; Principle of operation, Diaphragm pump, Rotary pump, Diffusion Pump, Turbomolecular Pump (TMP), Sputter-ion pumps; Cryogenic Pump.

Vacuum gauges: Thermal conductivity vacuum gauges, Ionization vacuum gauges.

Analysis of gas at low pressures: Residual gas analyzers, Quadrupole mass spectrometer. Leaks and their detection.

Thin Film Fabrication:

Nucleation and Growth: Film formation and structure; Thermodynamics of nucleation, Nucleation theories: Capillarity model – homogeneous and heterogeneous nucleations, Atomistic model – Walton-Rhodin theory; Post-nucleation growth; Deposition parameters; Epitaxy; Thin film structure; Structural defects and their incorporation.

Preparation methods: Electrochemical Deposition (ECD); Spin coating; Physical Vapor Deposition (PVD)- thermal evaporation, electron beam evaporation, rf-sputtering; Pulsed Laser deposition (PLD); Chemical Vapor Deposition (CVD), Plasma-Enhanced CVD (PECVD), Atomic Layer Deposition (ALD), Molecular Beam Epitaxy (MBE).

Thickness measurement and monitoring: Electrical, mechanical, optical interference, microbalance, quartz crystal methods.

Textbooks:

1. Thin Film Phenomena; Chopra; McGraw-Hill; 1969
2. Handbook of Thin Film Technology; Maissel & Glang; McGraw-Hill; 1970
3. Thin Film Fundamentals; Goswami; New Age International Pvt. Ltd; 2007
4. Vacuum Science and Technology, by Rao, Ghosh and Chopra; Allied Publishers, 1998

Reference Books:

1. Materials Science of Thin Films; Milton Ohring; Academic Press; 2001
2. Thin Films; Heavens; Dover Publications Inc.; 1991
3. Thin-Film Deposition: Principles and Practice; Smith; McGraw-Hill; 1995
4. Thin Film Processes I; Vossen & Kern; Elsevier Science & Technology Books; 1978
5. Thin film processes II; Vossen & Kern; Academic Press; 1991
6. Handbook of Vacuum Science and Technology, by Hoffman, Singh and Thomas; Academic Press; 1998
7. Vacuum Technology, by Roth; North Holland, 1990
8. Fundamentals of Vacuum Technology; Umrath; Leybold, 1998.

APC17104 OPTICAL COMMUNICATION (3-0-0)

Introduction: Introduction of optical fiber and fabrication, transmission characteristics of optical fiber- Maxwell's equations in homogeneous and inhomogeneous medium, solution for planner waveguide and Step Index Fiber, concept of TE, TM, hybrid and LP modes.

Dispersion- concept of dispersion in fibers, intramodal, intermodal and overall dispersion, attenuation in fiber.

Optical sources: basic principles of LEDs and LDs, modulation characteristics and drive circuits.

Optical detectors: p-n, p-i-n, APD type detectors, principle of operation and performance characteristics, receivers performance, link power budget using direct detection. Fiber optic connectors, couplers and multiplexers. Optical amplifiers, Coherent Optical Communication and WDM Techniques.

Textbooks:

1. An Introduction to Fiber Optics; Ajoy Ghatak, K. Thyagarajan; Cambridge University Press; 1998.
2. Integrated optoelectronics: Waveguide optics, Photonics, Semiconductors, Karl J. Ebeling, Springer London; 2011
3. Optics, Eugene Hecht, Addison-Wesley, 2001.

Reference Books:

1. Optical waves in layered media, Pochi Yeh, Wiley, 2005.
2. Principles of Optics, Max Born & Emil Wolf, Cambridge University Press, 1999.
3. Physics of Optoelectronic Devices, Chuang, S. L., Wiley-Interscience, 1995.

APC17105 ASTROPHYSICS AND COSMOLOGY (3-0-0)

Fundamentals of Astrophysics:

Overview of major contents of universe, Mass, length and time scales in astrophysics, Celestial coordinates, Astronomy in different bands of electromagnetic radiation, Interaction of radiation with matter , Black body radiation, Basics of radiative transfer, Radiative transfer through stellar atmospheres, Stellar colors, Stellar distances, Basic knowledge of stellar atmospheres, Binaries, variable stars, clusters, open and globular clusters, Compact objects , Shape, size and contents of our galaxy, Normal and active galaxies, Evolution of a stars: White Dwarfs, Neutron stars, Supernovae, Pulsar, Stellar blackholes.

General Relativity: Foundations of general relativity, Riemannian geometry of Euclidean signature manifolds: tensors on Euclidean manifolds and their transformation laws; Christoffel symbol and Riemann tensor; geodesics; general properties of the Riemann tensor. Einstein's equation Schwarzschild and Kerr space-times

Cosmology: Introduction**,** observational tests, the early universe, the microwave background, formation of structures dark matter and dark energy**.** Cosmological models: principles of homogeneity and isotropy; Newtonian cosmology, FRW metric; open, closed and flat universes; relation between distance, red-shift and scale factor.

Textbooks:

1. Theoretical Astrophysics, Padmanabhan T., Vols. 1-3, Cambridge University Press, 2005.
2. Astrophysics for Physicists, Arnab Rai Choudhuri, Cambridge University Press.

3. Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, Steven Weinberg
4. An Introduction to Cosmology, 3rd Edition, Narlikar.
5. The Early Universe: E. Kolb and M.S. Turner.

Reference Books:

1. Shu, F., The Physical Universe, University of California, 1982.
2. Harwit, M. Astrophysical Concepts, 3rd ed, Springer-verlag, 2006.
3. Landau, L.D. & Lifshitz, E.M., The Classical Theory of Fields, 2nd ed., Pergamon Press, 1995.
4. Hartle, J. B., Gravity: Introduction to Einstein's General Relativity, Pearson Education, 2003.
5. Peebles, P.J.E., Physical Cosmology, Princeton University Press, 1993.

SEMESTER-VIII

APC18101 PHOTONICS AND OPTOELECTRONICS (3-0-0)

Introduction to Photonics: Polarization of light waves, Dielectric polarization, Electromagnetic Waves and Interfaces I, Electromagnetic Waves and Interfaces II, Mirrors, Interferometers and Thin-Film Structures, Holographic interferometry, Integrated Optics: planar and 2D Waveguides, Coupled Mode Theory, Optical Resonators, Exciton, Semiconductor photon sources and detectors, Photonic Crystals, Photonic band gap on dimensionality, Plasmonic crystal, Plasmonic cavity, Negative refractive index, Metamaterials, Optical clocking,

Applications: Organic and polymeric light emitting diodes, Organic and inorganic solar cells, Quantum well photodetector, OLED lasers, Nanophotonic lasers- Photonic crystal laser, Plasmonic laser, SPASERs, Quantum cascade lasers, Photonic sensors, Plasmonic sensors, Photonic switching.

Textbooks:

1. Fundamentals of Photonics, Bahaa E. A. & Malvin Carl Teich, Wiley-Interscience, 2007.
2. Optics, Eugene Hecht, Addison-Wesley, 2001.

Reference Books:

1. Optical waves in layered media, Pochi Yeh, Wiley, 2005.
2. Principles of Optics, Max Born & Emil Wolf, Cambridge University Press, 1999.
3. Diode Lasers and Photonic Integrated Circuits, Coldren, and Corzine, Wiley-Interscience, 1995.
4. Physics of Optoelectronic Devices, Chuang, S. L., Wiley-Interscience, 1995.
5. Integrated optoelectronics: Waveguide optics, Photonics, Semiconductors, Karl J. Ebeling Springer London, 2011.
6. Handbook of Semiconductor Lasers and Photonic Integrated Circuits. London: Chapman and Hall, 1994.
7. Electromagnetic principles of integrated optics. Donald L. Lee , John Wiley & Sons, 1986.

8. Photonic Crystals: Molding the Flow of Light, John D. Joannopoulos et al, Princeton University Press, 2011.
9. Plasmonics: Fundamentals and Applications, S. A. Maier, Springer; 2007.

APC18102 CHRACTERIZATION TECHNIQUES (3-0-0)

Microscopic: Light microscopy- bright field, dark field, phase contrast illumination.
Spectroscopic: Spectrophotometry, Spectral reflectance, Ellipsometry, Luminescence spectroscopy, Fourier Transform infrared (FTIR) spectroscopy, Raman spectroscopy, Surface plasmon resonance (SPR) spectroscopy, Dynamic light scattering (DLS), Inductively Couple Plasma Mass Spectroscopy (ICPMS). X-ray and Ultra-violet Photoelectron Spectroscopy (XPS & UPS), Energy Dispersive X-ray analysis (EDAX), X-ray Fluorescence Spectroscopy (XRF), Rutherford Backscattering Spectroscopy (RBS), Inductively Coupled Plasma Mass Spectrometry (ICPMS). X-ray diffraction (XRD), Transmission Electron diffraction (TED).
Structural: Scanning Electron Microscope (SEM), Transmission electron microscope (TEM), Atomic force microscopy (AFM), Magnetic force microscopy (MFM), Scanning tunneling microscopy (STM).
Magnetic: Vibrating Sample Magnetometer (VSM), Superconducting Quantum Interference Device (SQUID), and Magnetic Force Microscopy (MFM).
Thermal: Differential Scanning Calorimeter (DSC), Thermo-Gravimetric and Differential Thermal Analyzer (TG-DTA), Thermomechanical analyzer (TMA), Dynamic mechanical analyzer (DMA).

Textbooks:

1. Microstructural characterization of materials, D. Brandon and W. Kaplan, John Wiley & Sons, 2013.
2. Surface Characterization Methods: Principles, Techniques and Applications; Milling; CRC Press; 1999
3. ASM Handbook: Volume 10: Materials Characterization; George M. Crankovic; ASM International; 1986.

Reference Books:

1. Encyclopedia of Materials Characterization - Surfaces, Interfaces, Thin Films; Brundle, Richard, Evans & Shaun; Elsevier; 1992.
2. Characterization of Semiconductor Materials - Principles and Methods; McGuire; William Andrew Publishing/Noyes; 1989
3. Optical Techniques for Solid-State Materials Characterization, Rohit P. Prasankumar, Antoinette J. Taylor, CRC Press, 2010.
4. Foundation of Spectroscopy. Simon Duckett & Bruce Gilbert. Oxford University Press. 2005.
5. Frontier of Molecular Spectroscopy. Jaan, L. Elsevier S & T, 2008
6. Practical Handbook of Spectroscopy, James W. Robinson, CRC Press, 1991.
7. Surface and Thin Film Analysis: A Compendium of Principles, Instrumentation, and Applications, Gernot Friedbacher, Henning Bubert, John Wiley & Sons, 2011.

8. Elements of X-ray Diffraction, Cullity B D., Stock S R, Prentice Hall, Inc. 2001.
9. Scanning Electron Microscopy and X-ray Microanalysis: Third Edition, Joseph Goldstein, Springer, 2003.
10. The Principles and Practice of Electron Microscopy, Ian M. Watt, Cambridge University Press, 1997.
11. Principles of Thermal Analysis and Calorimetry, Peter J. Haines, Royal Society of Chemistry, 2002.

APC18103 LASER PHYSICS AND TECHNOLOGY (3-0-0)

Overview: Gaussian beam, Monochromaticity, Directionality, Coherence; Atomic energy levels.

Energy distributions and laser design: Boltzmann distribution, Population inversion, Rate equations, Stability conditions, Three level and four level lasers; Issues in designing a laser; Pumping mechanisms; Stable and unstable resonators, Laser Cavity, Longitudinal and Transverse Modes, Mode Selection, Gain in a Regenerative Laser Cavity; Q-switching, Mode locking, Laser amplification, Frequency conversion, Pulse expansion, Pulse shortening – Pico-second and Femto-second operations, Spectral narrowing and Stabilization.

Laser systems: Basics of tunable, ultrafast and power lasers; *Gas lasers*: He-Ne, He-Cd, Ar, Kr ion, CO_2, Excimer lasers; *Solid state lasers*: Diode pumped solid state lasers, Lamp pumping and thermal issues; Ruby, Nd-YAG, Fiber lasers; *Semiconductor lasers*: Laser materials, Laser structure, Frequency control of laser output, Modern diode laser, Quantum cascade lasers, p-Ge lasers, Vertical-cavity surface-emitting laser.

Applications of laser: Laser cooling; Laser barcode scanner, Laser trimming, Cutting, Welding, Drilling and Tracking, Pattern formation by laser etching; LIDAR; Laser-tissue interaction, Laser surgery; Holography, Interferometry, Microscopy.

Textbooks:

1. Laser Fundamentals, by William T. Silfvast, Cambridge University Press (2008)
2. Principles of Lasers, by Orazio Svelto; Springer, 4 ed (2009)

Reference Books:

1. Laser Physics, by Simon Hooker and Colin Webb; Oxford (2010)
2. Lasers, by A. E. Siegman; University Science Books (1986)
3. Laser Application in Surface Science and Technology, by H. G. Rubahn; John Wiley and Sons (1999)
4. Laser Physics, by P. W. Milonni, J. W. Eberly; John Wiley and Sons (2010)
5. Laser Cutting: Guide for manufacturing, by C. L. Caristan; Society of Manufacturing Engineers (2004)
6. Lasers – Theory and Applications, by K. Thyagarajan and A. K. Ghatak; Macmillan India, Delhi (1981)
7. Optical Electronics, by Ghatak & Thyagarajan, Cambridge
8. Essentials of Optoelectronics, by A. Rogers, Chapman Hall
9. Lasers and Non-Linear Optics, 2 ed, by B. B. Laud; New Age International, New Delhi (1991)

10. Laser Spectroscopy: Basic Concepts and Instrumentation, by Demtroder; Springer (2004)

APC18104 COMPUTATIONAL PHYSICS (3-0-0)

Numerical Techniques: Review of Numerical integration (Trapezoidal and Gaussian quadrature methods), Interpolation and extrapolation; linear algebra and matrix manipulations, inversion, diagonalization, eigenvectors and eigenvalues, root searching; random number and pseudorandom number generation, using random numbers to evaluate integrals. Introduction to Fast Fourier transform.
Random Walk: Theory and simulation of random walks in one, two and three dimensions. Self avoiding walk; Stochastic processes: Brownian motion.
Computer Simulations: 1. **Monte Carlo simulation**: Basic idea, Importance Sampling, Metropolis algorithm, Markov chain, and Some applications 2. **Molecular Dynamics**: Basic idea, Equation of motion; Program initialization, The force calculation, Integrating the equation of motion and Some applications.
Introduction to parallel computation.
Introduction to MatLab Programming.

Textbooks:
1. Numerical Recipes: The Art of Scientific Computing; William H. Press; Cambridge University Press; 2007
2. A Guide to Monte Carlo Simulations in Statistical Physics, D. P. Landau and K. Binder, Cambridge University Press.
3. I. Prigogine and Stuart A. Rice, New Methods in Computational Quantum Mechanics, Wiley

Reference Books:
1. Matlab: A Practical Introduction to Programming and Problem Solving; Stormy Attaway; Butterworth-Heinemann; 2011
2. FORTRAN 90 for Scientists and Engineers; Brian Hahn; Butterworth-Heinemann; 1990
3. Computer Programming in Fortran 77; V. Rajaraman
4. Computational Physics, Joseph Marie Thijssen, Cambridge University Press
5. An Introduction to Computational Physics, Tao Pang, Cambridge University Press
6. Computer Simulation of Liquids, M. P. Allen and D. J. Tildesley, Clarendon Press
7. D. Frankel and B. Smit, Understanding Molecular Simulation, second edition, Academic Press.
8. R. G. Parr and W. Yang, Density Functional theory of atoms and molecules.

APC18105 NANOTECHNOLOGY (3-0-0)

Working environment: Cleanroom and classifications, Proper handling of materials, Types of contamination, Chemical and physical cleaning of specimen, Wet and Dry etching techniques. Environment safety and health regulations, societal implications and legal aspects.

Nanofabrication: Chemical synthesis techniques, Self-Assembled Monolayers (SAM), Langmuir–Blodgett method, Layer-by-Layer assembly; Nanolithography: Photolithography, Electron beam lithography, Nano-imprint Lithography, Dip-pen lithography, Two-Photon Polymerization, Focused Ion-Beam Technique, Ion-Beam Sculpting; Physical, Chemical and Epitaxial growth techniques of nanostructures.
Commercial production: Nanopattern structures, Nanoparticles-Metals, Alloys, Oxides; Carbon based nanomaterials: Graphene, Fullerene, Nanotubes; Transparent Conducting Oxides (TCO) films. Nanotechnology industries.
Applications: *Energy*-Photovoltaic, Fuel cells, Hydrogen energy; *Optoelectronics*- Single electron transistor, Quantum dot and quantum well laser, Flexible electronics; *Environment and Medical*- Wastewater treatment, Air purification, Drug delivery and therapeutics, Chemical and Biological Sensors; Micro/nano electromechanical systems (MEMS/NEMS),

Textbooks:

1. Nanotechnology: An Introduction to Nanostructuring Techniques, Michael Köhler, Wolfgang Fritzsche, John Wiley & Sons, 2008.
2. Nanofabrication: Techniques and Principles, Maria Stepanova & Steven Dew, Springer; 2012.
3. Micro-Nanofabrication: Technologies and Applications, Zheng Cui, Springer, 2010.
4. Nanotechnology Applications and Markets, Lawrence Gasman, Artech House, 2006.
5. Nanotechnology: Health and Environmental Risks, by Jo Anne Shatkin; 2nd Edition, CRC Press, Boca Raton (2012).

Reference Books:

1. Fuel Cells, Hydrogen Energy and Related Nanotechnology – A Global Industry and Market Analysis, by Alton Parish, Innovative Research and Products, Stamford (2009).
2. Nanotechnology: Volume 8: Nanostructured Surfaces, Lifeng Chi, John Wiley & Sons, 2010.
3. Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications; Vladimir V. Mitin; Cambridge University Press; 2008
4. Nanofabrication: Fundamentals and Applications, Ampere A. Tseng, World Scientific, 2008.
5. Handbook of Nanofabrication, Gary Wiederrecht, Academic Press, 2010.
6. Nanofabrication Handbook, Stefano Cabrini, Satoshi Kawata, CRC Press, 2012.
7. Fundamentals of Microfabrication: The Science of Miniaturization, Marc J. Madou, CRC Press, 2002.
8. Introduction to Microfabrication, Sami Franssila, John Wiley & Sons, 2010.
9. Environmental and Human Health Impacts of Nanotechnology, Jamie R. Lead, Emma Smith, John Wiley & Sons, 2009.