Vidyasagar University

Post Graduate Syllabus

in

Physics & Techno Physics

under Choice Based Credit System

(CBCS)

[w.e.f. : 2016-2017]

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বিদ্যাসাগর বিশ্ববিদ্যালয়

Vidyasagar University

Department of Physics & Technophyics

Syllabus for two year M. Sc in Physics (Semester System)

Midnapore, 721 102::(Ph- 03222 276554. Extn. 439) From July 2016

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Course Structure

Semester- I				
Paper		**Subject**	**Credit**	**Marks**
PHS 101	A	Methods of Mathematical physics – I	2	25
	B	Classical Mechanics	2	25
PHS 102	A	Quantum Mechanics – I	2	25
	B	Solid State -I	2	25
PHS 103	A	Electrodynamics	2	25
	B	Material Preparation and characterization	2	25
PHS 104	A	Analog Electronics – I	2	25
	B	Digital Electronics – I	2	25
PHS 105		Electronics Practical – I	4	50
PHS 106		Computer Practical	4	50

Semester- II				
Paper		**Subject**	**Credit**	**Marks**
PHS 201	A	Quantum Mechanics-II	2	25
	B	Methods of Mathematical physics – II	2	25
PHS 202	A	Solid State-II	2	25
	B	Semiconductor Physics	2	25
PHS 203	A	Analog Electronics – II	2	25
	B	Digital Electronics - II	2	25
PHS 204		Concepts of Physics : Inventions and applications (CBCS)	4	50
PHS 205		Electronics Practical – II	4	50
PHS 206		Advance Practical – I	4	50

Semester- III				
Paper		**Subject**	**Credit**	**Marks**
PHS 301	A	Quantum Mechanics-III	2	25
	B	Statistical Mechanics-I	2	25
PHS 302	A	Molecular Spectroscopy and Laser Physics	2	25
	B	Nuclear Physics-I	2	25
PHS 303		Special Paper – I	4	50
PHS 304		Science of Universe (CBCS)	4	50
PHS 305		Advance Practical - II	4	50
PHS 306		Special Practical – I	4	50

Semester- IV				
Paper		**Subject**	**Credit**	**Marks**
PHS 401	A	Particle Physics	2	25
	B	Statistical Mechanics-II	2	25
PHS 402	A	Nuclear Physics-II	2	25
	B	Quantum Field Theory	2	25
PHS 403	A	Semiconductor Devices	2	25
	B	Applied Optics	2	25
PHS 404		Special Paper – II	4	50
PHS 405		Special Practical - II	4	50
PHS 406		Project, Seminar and Grand viva	4	50

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First Semester

Course No: PHS 101(A)
Methods of Mathematical Physics Marks : 25
Classes:25

1. Vector spaces and matrices: Vector spaces of n dimensions, inner product, Schmidt's orthogonalisation, Schwarz and Bessel inequality.

2. Hermitian and unitary matrices, eigenvectors and elgenvalues, diagonalization, unitary transformation. Cayley Hamilton theorem.

3. Complex variable: Cauchy Reimann conditions, cauchys integral and residue theorem, singularities, poles, branch points, contour integration. Taylor & layrebt series expansion, Principle value of an integral Reimann Surface.

4. Special functions, regular and irregular singularities, series solution. Hermite & Legendre (only revision).Laguerre and Bessel functions / polynomials, Gamma, Beta and error functions.

Books Recommended

1. M. R. Spiegel (Schaum's outline series) – Theory and Problems of Complex Variables.
2. G. Arfken (Academic Press) – Mathematical Methods for Physicists.
3. J. Mathews and R. I. Walker (Benjamin) – Mathematical Methods of Physics.
4. P. Dennery and A. Krzywicki (Harper and Row) – Mathematics for Physicists.
5. Grewal-Higher Engineering Mathematics
6. Joshi – Group Theory for Physicists
7. Hamermesh- Group Theory
8. Tulsi Dass- Mathematical Methods Of Physics

Course No: PHS 101(B)
Classical Mechanics Marks: 25
Classes: 25

1. Recapitulation of Mechanics of System of particles, Lagrange and Hamiltonian of different systems. Lagrange & Hamiltonian for Non conservative system: Velocity – dependent potential, dissipation function, charge particle is moving in an electro-magnetic field, Gauge function for Lagrangian, Canonical Transformations, Legendre Transformation, Poisson Bracket, Lagrange Bracket, Phase Space, Liouville's Theorem, Routhian Function.

2. Variational Principles, Hamilton's Principle from Newton's equation & D'Alemberts Principle, Lagrange's equation from Hamilton's Principle, Euler-Lagrange equation, Principle of least action, Modified Hamilton's Principle, Hamiltons Canonical equations.

3. Hamilton – Jacobi Theory, Hamilton – Jacobi equation for Hamilton's principal function, Physical significance of Hamilton's principal function, Hamilton – Jacobi equation for Hamilton's characteristic function, Physical significance of Hamilton's characteristic function Hamilton-Jacobi equation from Schrodinger equation, Action-angle variables.

4. Small Oscillations: One Dimensional Oscillator, Systems with many Degrees of Freedom: The Eigen value Equation and Normal Coordinates, Different examples.

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Books Recommended:

1. Classical Mechanics, by H.Goldstein, Narosa Publishing Home, New Delhi.
2. Classical Dynamics of Particles and Systems, by Marion and Thornton, Third Edition, Horoloma Book Jovanovich College Publisher.
3. Classical Mechanics, by P.V.Panat, Narosa Publishing Home, New Delhi.
4. Classical Mechanics, by N. C. Rana and P. S. Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
5. Introduction to Classical Mechanics, by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
6. Classical Mechanics, by J. C. Upadhyaya, Himalaya Publishing House

Course No: PHS 102(A)
Quantum Mechanics-I Marks : 25
Classes:25

1. Recapitulation of :

   I. Chronological evolution of quantum mechanics, Wave particle dualism, Uncertainty principle, Wave packets in space and time.
   II. Formalism of Quantum Mechanics: Development of the wave equation, the Schrodinger wave equation, statistical interpretation of the wave function, probability density and probability current density, Ehrenfest's theorem, stationary states, energy eigen functions, one dimensional square well potential, parity.
   III. Some bound state problems: Linear harmonic oscillator, Spherically symmetric potential, the Hydrogen atom, Particle in a spherical cavity.

2. Operators and operator algebra, eigen functions and eigen values, expectation values, Dirac bra-kets, Completeness and closure property, Hilbert space of state vectors minimum uncertainty product, form of minimum packet. Coordinate and momentum representation, Unitary transformations
3. Schrodinger, Heisenberg and interaction pictures, Matrix theory of harmonic oscillator.

Books Recommended:

1. 'Quantum Physics' by Robert Eisberg and Robert Resnick (John Wiley and sons).
2. Quantum Mechanics' by L. I. Schiff (McGraw-Hill Book, New York).
3. Quantum Mechanics' by F Schwabl (Narosa).
4. 'Quantum Theory' by D. Bohm (Prentice-Hall).
5. 'Quantum Mechanics: Theory and Applications' by A. K. Ghatak and S. Lokanathan (Macmillan India Ltd.).
6. 'Quantum Mechanics' by Cohen and Tanandji

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Course No: PHS 102(B)
Solid State-1 Marks: 25
Classes:25

1. Crystal structure: Bravis Lattice, Symmetry elements, Point group, Space group, Polycrystalline, single crystalline and amorphous materials.

2. X-ray diffraction & reciprocal lattice: Scattering of X-ray by a crystal and Derivation of Laue equation, reciprocal lattice vectors, Brillouin Zone, Atomic form factor, Structure factor and experimental diffraction methods, Debye Waller effect.

3. Vibrations of monoatomic and diatomic linear lattice(qualitative), Equivalence of vibrational mode and simple harmonic oscillator, Phonons, Anharmonic crystal interactions, thermal expansion

4. Energy Bands: Physical origin of the energy gap, Bloch function, essential features of Kronig penny model, extended, reduced and periodic zone schemes, effective mass, distinction of metal, insulator and semiconductor.

Books recommended

1. Woolfson : X ray crystallography
2. Kittel: Solid State Physics
3. Dekker: Solid State Physics.
4. Christmaan-solid state physics (academic press)
5. Warren- X-ray Diffraction

Course No: PHS 103(A)
Electrodynamics Marks : 25
Classes:25

1. Radiation loss of energy by the free charges of plasma : Radiation by excited atoms and ions. Cyclotron or Betatron radiation, Bremsstrahlung, Recombination radiation, Transport of radiation.
2. Fundamental concepts about plasma: Mean free path and collision cross section. Effect of magnetic field on mobility of ions and electrons, Diffusion of ions and electrons; Ambipolar diffusion, Electron and ion temperature. Plasma parameters
3. Elements of Plasma Kinetic theory : Phase space, Distribution function, the Boltzman equation, The Vlasov Equation
4. Field of moving charges and radiations: Retarded potentials, Lienard Wichert potentials, Field produced by arbitrarily moving charged particle & uniformly moving charged particle, radiation from an accelerated charged particle at low velocity and at high velocity, angular distribution of radiated power. Radiation from an oscillating dipole, radiation from a linear antenna
5. Radiation in material media: Cherenkov effect, Thomson and Rayleigh Scattering, dispersion and absorption, Kramer Kronig dispersion relation.
6. Relativistic electrodynamics: Transformation equations for field vectors and. Covariance of Maxwell equations in 4 vector form, Covariance of Maxwell equations in 4-tensor forms; Covariance and transformation law of Lorentz force. Self energy of electron

Books Recommended:

1. Marion- Classical Electrodynamics
2. Jackson- Classical Electrodynamics
3. Panofsky & Phillips- Classical Electrodynamics
4. Griffith-Electrodynamics Chakraborty- Plasma Physics
5. Von Engle- Partially ionized gas

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Course No: PHS 103(B)
Materials Preparation and Characterization Marks : 25
Classes: 25

1. Materials Preparation Techniques: Various methods of crystal growth, Preparation of Amorphous Materials, Thin films preparation (Poly-Crystalline & Amorphous), Glass and Glass Transition. Synthesis of low dimensional materials. Lithography, Arc Discharge, Thermal Evaporation, Sputtering, Chemical Vapour Deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy, Electrodeposition and Sol-Gel Technique;

2. Material Characterization : X-ray Diffraction (XRD), XPS, Introduction to Microscopy: Advantages and disadvantages of optical microscopy over electron microscopy, Scanning electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Electron Spectroscopy for Chemical Analysis (ESCA), Optical Absorption & Transmission study by UV-VIS Spectro-Photometer, Photo Luminescence (PL), Introduction to thermal analysis: Phase changes, crystalline and amorphous fractions – DSC Thermo-gravimetric methods – TGA, DTA
   Energy Dispersive Analysis by X-ray (EDX). Neutron scattering and neutron diffraction, NMR

3. Different optical measurements: UV-VIS, PL, FTIR, Raman. Electrical measurements; Studies on various Conduction Mechanisms in 2D (thin films) and Low-dimensional Systems: Arrhenius type Thermally Activated Conduction, Variable Range Hopping Conduction and Polaron Conduction.

4. Concept of Vacuum techniques, production and measurement of low pressure, Pirani and Penning gauges, rotary and oil diffusion, Turbo, Ion, cryo-pumps; Elements of instruments, sensor materials.

Books recommended:

1. James F Shackelford, " Introduction to Materials Science for Engineers", 7th Edition,Pearson Prentice Hall, 2009
2. Callister W D, "Materials Science and Engineering : An Introduction", 7th Edition, John Wiley & Sons, Inc., 2007
3. Kenji Uchino," Ferroelectric Devices", Marcel Dekker, INC, 2000.
4. Rao V V, Ghosh T B and Chopra K L, "Vacuum Science and Technology', Allied publishers Ltd., 1998.
5. Leon I Maissel and Reinard Glang, "Hand Book of Thin Film Technology", McGraw Hill, 1970.
6. Kelsall Robert W, Ian Hamley and Mark Geoghegan, "Nanoscale Science and Technology", Wiley Eastern, 2004.
7. Bharat Bhushan, "Springer Handbook of Nanotechnology", 2004.
8. Michael Kohler, Wolfgang and Fritzsche, "Nanotechnology: Introduction to Nanostructuring Techniques", Wiley –VcH, 2004.
9. Charles P Poole, Frank J Owens, "Introduction to Nanotechnology", John Wiley and Sons, 2003.
10. Gregory Timp, "Nanotechnology", Springer-Verlag, 1999.

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Course No: PHS 104(A)
Analog Electronics-I Marks : 25
Classes: 25

1. Operational Amplifiers: Revision of Op-amp circuits, Differential amplifier, OP-AMP architecture, Constant current sources, Input stage of an Op-Amp, OP-AMP characteristics and parameters.

2. Elements of Communication: Principle of amplitude modulation (AM) and frequency modulation (FM), AM spectrum and FM spectrum, channel band width and signal band width, side band frequency, Generation of transmitted carrier and suppressed carrier type AM signals with necessary circuits, Principles of detection of different types of modulated signals (TC and SC types), principle of generation of F.M. wave with necessary circuits, Detection of F.M. wave-Discriminators.

   Modulation techniques in some practical communication systems: AM and FM radio, FM stereo receiver, VSB AM and QAM technique in TV broadcasting.

3. Radio wave propagation: Ground wave, Ionospheric wave and space wave and their characteristics, reflection and refraction of radio waves in ionosphere, critical frequency, skip distance, Maximum usable frequency, fading, Secant law, duet propagation.

4. Antenna: Dipole antenna, half wave antenna, antenna with two half elements, N elements array, induction field and retardation field.

5. Radar: Radar range equation, Basic pulsed radar system-Modulators, duplexers, indicators, radar antenna, CW radar, MTI radar, FM radar, Dopplar radar.

6. Amplifiers: MOSFET Characteristics and applications, FET and MOSFET Amplifiers.

Books Recommended:

1. J.D.Ryder, Electronics fundamental and application(PHI).
2. Gaykwad, Operational Amplifier.
3. Roddy and Coolen, Electronic Communication systems. (PHI)
4. Chattopadhyay and Rakshit, Electronics circuit analysis.
5. Millman and Grable, Microelectronics. Tata mcGraw Hill.
6. Frazier- Telecommunications.
7. Electronic and Radio Engineering – F. E Terman.

Course No: PHS 104 (B)
Digital electronics-I Marks: 25
Classes:25

1. Combinational logic gates: Karnaugh mapping : Methods of minimization (reduction) of Product of Sum (POS) and Sum of Products (SOP) expressions of 2, 3 and 4 variables Boolean expression, Logical implementations, Revision of Flip-Flops, Conversion of Flip-Flops.

2. Registers: Shift Register, Serial in Serial out, Parallel in Serial out, Parallel in parallel out registers, Bi-directional and Universal registers.

3. Counter: Synchronous and Asynchronous counter, modulo-Counter, decade counter, ring counter and twisted ring counter, Up/Down Counter.
4. Multivibrators: Astable and monostable (principles, Circuits and operation) using Transistors, Internal circuit of IC 555, Timer circuit with 555.
5. Digital display: Seven segment display system, developing of display system for decimal, octal number system.

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Books Recommended :

1. R P Jain, Modern digital electronics, Tata McGraw Hill.
2. Anand Kumar, Fundamentals of Digital Circuits, PHI
3. Millman and Halkias- Microelectronics. Tata McGraw Hill.
4. M. Senthil Sivakumar- Fundamental of Digital Design, S. Chand

Course No: PHS105
Electronics Practical-I
Marks: 50

1. To develop a LC filter circuit having different cut-off frequencies and to find out frequency response characteristics.
2. To study the drain characteristics & transfer characteristics ($I_{D\ sat}$ vs V_{gs} with V_{DS} as parameter) of a FET/MOSFET and to find out the drain resistance, mutual conductance and amplification factor.
3. To study a transformer and to find its various parameters.
4. To construct and design a regulated power supply using Op-Amp as comparator and power transistor as pass element and to find out its ripple factor and percentage of regulation.
5. To obtain the frequency response characteristic of an inverting operational amplifier and to find out its band width.
6. To obtain the frequency response characteristic of a non-inverting operational amplifier and to find out its band width.
7. To design a J-K master – slave flip-flop and to verify its truth table.

Course No: PHS 106
Computer Programming
Marks: 50

Computer Programming in Fortran
Use of various software's like, Mathematica, Origin, Microsoft office.

Second Semester

Course No: PHS 201(A)
Quantum Mechanics-II Marks : 25
Classes: 25

1. Symmetry and Conservation laws, Space and time displacement, rotations, angular momentum matrices, Addition of angular momentum, CG coefficients. Spin matrices and eigen functions

2. Approximation methods for bound states: Stationary perturbation theory- non degenerate and degenerate cases, Stark effect, Zeeman effect; Variation method, ground state of Helium atom, WKB approximation,

3. Relativistic wave mechanics: Klein-Gordon equation for a free particle, solution of the KG equation, A spin zero particle in EM field, Coulomb field. fine structure, Dirac's equation for a free particle, Dirac equation in covariant form, Anti commutation relations of the Dirac matrices, Spin of Dirac particle, Magnetic moment of the electron, spin orbit interaction in the Dirac equation Dirac equation in EM field and Coulomb field.

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Course No: PHS 201(B)
Methods of Mathematical Physics - II Marks : 25
Classes:25

1. Partial differential equations: Elliptic, parabolic and hyperbolic type equations, Lagranges formula for 2nd order partial differential equation, Dirchlet Neumann and cauchy Boundary value problem. Greens function with applications.

2. Integral transforms: Fourier series, Fourier transforms, laplace transformation inverse laplace transform. Solution of differential equation using LT and FT. Dirac delta function and its FT.

3. Definition and nomenclature ; Examples ; Rearrangement theorem ; Cyclicgroups , Subgroups and Cosets ; Conjugate elements and class structure ; Factor groups ; Isomorphy and Homomorphy ; Direct product groups ; Symmetric groups , Cayley's theorem ; Representation of finite groups- Definition , Unitary representation , Schur's Lemma , Orthogonality theorem , Reducible and irreducible representations , Characters ; Regular representation ; Product representation , Character table , Examples of S_3 and C_4v ; Introduction to Lie groups and Lie algebra ; Clebsch-Gordon coefficients.
4. Integral equations. Fredholm and volterra equations of the first and second kinds. Fredholm's theory for non-singular kernel.

Course No: PHS 202(A)
Solid State II Marks : 25
Classes:25

1. Superconductivity: Basic phenomenology, Thermodynamics of Superconducting transition, Resistance less circuit, Consequence of zero resistance, Meissner effect, Type I and II superconductors, Magnetic Levitation, London equation, Quantum Mechanical Current, Supercurrent Equation, Two-Fluid Model, Josephson Tunneling: D. C. Josephson Tunneling & A. C. Josephson Tunneling, Application of super conductivity.

2. Dielectrics: Review of Dielectric in DC, Local field in liquids and Solids, Clausius-Mosotti Relation, Complex dielectric constant and dielectric losses, dielectric losses and relaxation time,

Books Recommended:

1. Introduction to Solid State Physics, by C. Kittel Wiley Publishers.
2. Introduction to Superconductivity, by A. C. Rose-Innes and E. H. Rhoderick, Peragom Press.
3. Introduction to Solid State Physics, by C. Kittel, Wiley Publishers.
4. Solid State Physics, by A. J. Dekker, Macmillan India Limited.
5. Elementary Solid State Physics- Principles & Applications, by M. Ali Omar, Pearson.
6. Solid State Physics, by N. W. Ashcroft and N. D. Mermin, Cengage Learning
7. Solid State Physics, by S. O. Pillai, New Age International Publishers.
8. Solid State Physics, by R. L. Singhal, Kedar Nath Ram Nath Publishers.

Course No: PHS 202(B)
Semiconductor Physics Marks : 25
Classes: 25

1. Electron & Hole statistics in a semiconductors: Non degenerate & degenerate semiconductor, Intrinsic semiconductor, Ionization energy calculation, Distribution function over an impurity state, N type & P type semiconductor,

2. PN junction in equilibrium, Einstein Relation, Diffusion length, Derivation of diode equation, Junction capacitance, Metal Semiconductor junction

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3. Equilibrium & Non-equilibrium carriers, Photoconductivity & related device, Recombination via trap, Solar cell, Semiconductor laser, Hetero junction

Books recommended:

1. Kireev: Semiconductor Physics
2. Streatman & Banerjee: Introduction to Solid State Electronics
3. Smith: Semiconductor
4. Dekker: Solid State Physics

Course No: PHS 203(A)
Analog Electronics-II Marks : 25
Classes: 25

1. (i) Network analysis : Network theorems, equivalent circuits, two-port parameters hybrid parameters, Topological descriptions of different commonly used networks, Π to T and T to Π conversions, reduction of a complicated network into its equivalent T and Π form.
   (ii) Filter Circuit : L filter, Π filter, iterative impedance, image impedance of a network, symmetrical network, characteristic impedance and propagation constant of a network. Methods of development of different constant-k filters like high pass, low pass, band pass and band stop filter circuits.

2. Transmission Lines: Line parameters, characteristic impedance and propagation constant of a transmission line, voltage and current equations of transmission line : Telegraphers' equation, attenuation constant, phase constant, line of finite length behaving as a line of infinite length, reflection co-efficient in a line, velocity of signal in a line, voltage standing wave ratio, Input impedance of Lossless line, line at radio frequency, distortion less line, cable fault location telephone cable.

3. Thyristors: SCR, Triac, Diac, characteristics parameters, Thyristor rectifirer & control circuits., DC Power control by SCR and AC power control by Triac.

4. Transducer & sensors : Photo-transducer, thermistor, photo-electric transducer, photo-conductors, Photo diodes, photo-transistors.

Books Recommended :

1. J D Ryder, Networks line and fields.
2. Van Valkenburg - Network Analysis 3rd Edition.
3. Frazier, Telecommunications.
4. Zee, Physics of semiconductor devices.

Course No: PHS 203(B)
Digital electronics-II Marks: 25
Classes: 25

1. Combinational circuits : MUX, DeMUX, Encoder, Decoder, comparator. A to D and D to A Conversion.

2. The ALU: ALU organization, Integer representation, Serial and Parallel Adders, 1's and 2's complement arithmetic, Multiplication of signed binary numbers, Floating point representation, Overflow detection, Status flags.

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3. Memory Unit: Memory classification, Bipolar and MOS storage cells. Organization of RAM, address decoding, Registers and stack, ROM, PROM, EPROM, EEPROM, SRAM, DRAM, and FPLA. Organization and erasing schemes, Magnetic memories, Optical Memories, Semiconductor Memories.

4. Review of 8085 Microprocessor, Internal structure, organisation and assembly language. Microprocessor Programming.

5. Basic ideas of Digital Communication: Sampling theorem, Pulse amplitude modulation, Quantisation, Pulse Coded Communication System.

Books Recommended :

1. R S Gaonkar – *Microprocessor Architecture, Programming and Applications with 8085/ 8085A* (2nd Ed.).
2. R P Jain, Modern digital electronics, Tata McGraw Hill.
3. Anand Kumar, Fundamentals of Digital Circuits, PHI
4. Taub & Schilling, Principals of Communication Systems, Tata McGraw Hill.
5. G.K. Kharate, Digital Electronics, Oxford

Course No: PHS 204
Concepts of Physics : Inventions and applications
Marks : 50 Classes: 50

1. Important Developments of Physical Science before 20th century: (12L)

Archimedes' principle, Inertia: Galileo Galilei, Laws of motion and law of gravity: Newton, Concept of Classical Mechanics, Wave theory of light: Young, Atomic theory of matter: Dalton, Electrical resistance, etc.: Ohm, Electromagnetic induction: Michael Faraday, Electromagnetic waves: Hertz, Electron: Thomson.

2. Progress of Physics in 20th century: (18L)

Introduction, Photoelectric effect: Einstein, Discovery of the atomic nucleus: Rutherford, Superconductivity: Kamerlingh Onnes, Concept of Quantum Mechanics, Radioactivity, Introduction to electronics, Crystal, Nano materials, Glass, Advancement of technology in 20th century,

3. Physics in daily life : (10L)

Working principle of : Optical camera, Valve radio, Transistor radio, AM and FM radio, Television, Digital Camera, Mobile, Smart Phone, Electric heater, Microwave oven, Induction oven, Fan, electric generator, Refrigerator.

Development of different light sources : Incandescent bulb, Vapour lamp, Arc Lamp, Fluorescence Lamp (Tube light, CFL), Light Emitting Diode (LED), LASER, Field emission.

4. Medical Instrumentation : (5L)

X-ray, Electrocardiograph (ECG), Ultrasonography(USG), Magneto Resonance Imaging (MRI), Photodynamical Therapy (PDT), Spectrophotometry, Chromatology, Electrophoresis.

5. Physics of Nature: (5L)

Blue sky, Scattering of light, Colour of Sun, Rainbow, Halo, Refraction and reflection of light, Mirage.

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Books recommended:

1. Bowler, Peter J. and Iwan Rhys Morus (2005), Making Modern Science: a Historical Survey. Chicago: University of Chicago Press
2. History of Science, Samarendra Nath Sen, Saibya Prakasan Bibhag, (in Bengali)
3. Itihase Bijnan, J.D. Barnal, Ananda Publishers. (in Bengali)
4. Medical Instrumentation Application and Design, John G. Webster(Editor). Wiley 4th Edition.
5. Handbook of Biomedical Instrumentation, Dr R.S. Khandpur, McGraw Hill Education (India) Private Limited, Third Edition.
6. Introduction to Light: The Physics of Light, Vision, and Color, Gary Waldman, Dover Publications.

Course No: PHS 205
Electronics Practical-II
Marks: 50

1. To design a 4 bit ripple counter and to develop different modulo counters from it.
2. Study of differential amplifier circuit using transistors and find out its differential mode gain.
3. Design of a window comparator and study its characteristics
4. Monostable multivibrator and timer circuit with IC 555.
5. Determination of the slew rate of an Op-amp.
6. To design an LC oscillator using transistor.
7. To design and develop cascaded FET amplifier and to find out its linearity and frequency response characteristics.
8. Band gap measurement of a Semiconductor using P-N junction.
9. Simple microprocessor programming.

Course No: PHS 206
Advance Practical-I
Marks: 50

Group-A

1. Determination of electron temperature by single probe method.
2. Study of the characteristics of a GM tube.
3. Obtain X-ray Debye-Scherrer photograph and determination of Unit Cell dimensions of a crystal.
4. To Study experimentally the variation of resistivity of semiconductor with temperature and hence to find out the band gap energy.
5. Linearisation LED Characterestics and finding out the quantum efficiency.
6. Determination of Plank's constant (using photo electric effect).
7. Determination of refractive index using Michelson Interferometer.
8. To determine the resolving time of the G-M counting system.

Group-B

1. Determination of Electron / Ion temperature by Double probe method.
2. Determination of the gamma and beta ray absorption coefficients by using a G.M. counter.
3. Measurement of the Hall coefficient of a given sample and calculation of its concentration.
4. Frank Hertz experiment.
5. Measurement of e/m by magnetron valve
6. Determination of Curie temperature.
7. Study of nuclear counting statistics.
8. To estimate the separation between the two plates of a Febry-Perot interferometer.

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Third Semester

Course No: PHS 301(A)
Quantum Mechanics-III Marks: 25
Classes: 25

1. System of identical particles, permutation symmetry, symmetric and anti-symmetric wave function, Pauli exclusion principle. Spin functions for two and three electron atoms. Helium atom (ground state and first excited state)

2. Atoms, Molecules: Central field approximation, Hartree and Hartree-Fock approximation, Koopman's theorem, Thomas-Fermi statistical model, LS coupling, JJ coupling, Hund's rule, spectral terms; Zeeman effect (weak field, strong field, quadratic). Molecules, Classification of energy levels, rotation and vibration of diatomic molecules, Hydrogen molecule.

3. Time dependent perturbation; ionization of a Hydrogen atom, sudden approximation. , Fermi's golden rule, transition probabilities, constant and harmonic perturbations, semi-classical treatment of radiation. Intensity ratio of transitions in alkali atoms.

4. Quantum theory of scattering -cross sections , partial wave analysis , phase shifts , optical theorem. Schrodinger's equation as an integral equation , Green's function , Lippman-Schwinger equation, Born's approximation, Coulomb scattering.

Course No: PHS 301(B)
Statistical Mechanics - I Marks : 25
Classes – 25

1. Recapitulation: Connection between statistical mechanics and thermodynamics, Macroscopic and microscopic states, classical ideal gas, Gibbs paradox. Elements of ensamble theory: Phase space and density function, Liouville's theorem, microcasnonical ensamble, Canonical ensamble, mean-square fluctuation of an observable, energy fluctuation in the canonical ensamble: correspondence with the micro canonical ensamble, a system of harmonic oscillator, thermodynamics of magnetic systems: negative temperature problems.

2. Grand canonical ensamble: density and energy fluctuation in the grand canonical ensamble: correspondence with the other ensambles.

3. Quantum mechanical ensamble theory: Postulates of Quantum Statiatical mechanics, Density matrix, statistics of various ensambles Ideal gas in Quantum mechanical miro canonical ensamble , determination of entropy in Boltzman Gas, Bose gas, Fermi gas, Ideal gas in other quantum mechanical ensambles

Books Recommended:

1. R. K. Pathria : Statistical Mechanics
2. K. Huang : Introduction to Statistical Mechanics
3. Silvio R. A. Salinas : Introduction to Statistical Mechanics.
4. F. Reif : Fundamentals of Statistical and Thermal Physics.
5. Kadanoff : Statistical Mechanics. World Scientific.
6. R. Kubo : Statistical Mechanics. (Collection of problems)

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Course No: PHS 302(A)
Molecular Spectroscopy & Laser Physics Marks: 25
Classes: 25

1. Microwave spectroscopy: Classification of molecules, Diatomic molecular rotational spectroscopy of rigid and non-rigid diatomic molecules, triatomic molecules and polyatomic molecule, microwave spectroscopy of symmetric type of molecules, Stark effect.

2. Infra-red spectroscopy: Diatomic molecular vibrational spectroscopy with harmonic and anharmonic vibration, vibrational and rotational spectroscopy, anharmonic oscillation constant, rotational constant, Dissociation energy.

3. Visible and ultraviolet spectroscopy: Molecular electronic spectroscopy, Frank Condon principle, Molecular electronic vibrational-rotational spectroscopy, Born-Oppenheimer approximation, Fortrat diagram, Band head.

4. Laser: Laser resonator, population inversion, active and passive laser resonator, Threshold condition, saturation condition, Quality factor, classification of laser Three level laser and four level laser system, equation of population inversion and threshold power calculation for the laser systems, Rubby laser, He - Ne laser, CO_2 laser, Dye laser (tunable laser), Q swatching, mode locking, Application of laser.

Books Recommended:

1. Fundamentals of Molecular Spectroscopy, by C. N. Banwell and E. M. McCah, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Molecular Structure and Spectroscopy, by G. Aruldhas, PHI Learning Private Limited, New Delhi.
3. Molecular Structure and Molecular Spectra: vol. 1, Spectra of Diatomic Molecules, 2nd ed., by G. Herzberg, Van Nostrand.
4. Molecular Structure and Molecular Spectra: vol. 2, Infrared and Raman Spectra of Polyatomic Molecules, by G. Herzberg, Van Nostrand.
5. Molecular Spectroscopy, by G. M. Barrow, Mc-Graw Hill.
6. Optical Electronics, by A. Ghatak and K. Thyagarajan, Cembridge University Press India Pvt. Ltd, New Delhi.
7. Fundamentals of Light Sources and Lasers, by Mark Csele, John Wiley & Sons, Inc.

Course No: PHS 302(B)
Nuclear Physics-I Marks : 25
Classes:25

1. Properties of Nuclei: Double focusing mass Spectrometer (Nier and others), Nuclear Spin, magnetic moment Rabi method; nuclear shape-electric quadruple moment; parity; statistics.

2. Stable nuclides: Regularities, the odd-even classification, stable isotopes, isotones and isobars, isomers, mass and energy of nuclides, the mass parabolas for isobars.

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3. Recapitulation of α–decay spectra, systematics of α- decay energies, Gamow theory of α-decay.

4. β-decay: Continuous nature of Spectrum; neutrino detection; Fermi's theory of beta decay; Kurie plot, Simple ideas of parity violation in beta - decay.

5. γ-decay: The modes of gamma transition, theory of multiple radiation's, selection rules, internal conversions; nuclear isomerism; recoil free gamma-ray spectroscopy.

Books Recommended :

1. Introductory Nuclear Physics- Kenneths Kiane
2. Atomic and Nuclear Physics- S.N. Ghosal
3. Introduction to High Energy Physics-P.H. Berkins
4. Nuclear Physics- Kaplan
5. Concepts of Nuclear Physics- B.L. Cohen
6. Nuclear Theory- R.R. Roy and B.P. Nigam
7. The Atomic Nucleus- R.D. Evans
8. Basic Nuclear Physics- B.N. Srivastava
9. Introductory Nuclear Physics- L.R. B. Elton
10. Nuclei and Particles- E. Segre
11. Theoretical Nuclear reactions: Blatt and Weisskopf

Course No: PHS 303
Solid State Physics – Spl-I Marks : 50
Classes:50

1. Band theory of solid: Empty Lattice Approximation, Nearly free electron model, Tight binding approximation, Effective mass approximation method.

2. Optical Properties: Transverse plasma frequency & propagation of electromagnetic wave in a material, Longitudnial plasma frequency & plasmon, Electrostatic screening, Thomas Fermi dielectric function, Motts metal to insulator transition, Polariton & LST relation, Polaron. Exciton, Raman effect in crystal, Kramers Kronig releation,

3. Defect studies: Luminescence, Colour center, Point defects in solid, Diffusion in an ionic crystal, Ionic conductivity, Line defect, Plane defect, types of bonding.

4. Quantization of orbit in a magnetic field { Landau levels}, De Haas Van Alphen Effect, Magnetic breakdown, Boltzman transport equation & applied to metals to find electrical conductivity

5. Dielectrics in AC, Ferroelectric characteristics & their classification, Polarization catastrophe, Origin of ferroelectricity, Landaus theory of ferroelectric transition.

Books recommended:

1. Solid State Physics: C. Kittle
2. Kireev: Semiconductor Physics
3. Solid State Physics: Askrof and Mermin
4. O. Madelung – Introduction of Solid State Theory (Springer).
5. J.M. Ziman:Principles of the theory of solids
6. Solid State Physics: Mattis
7. Dekker : Solid State Physics

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Course No: PHS 303
Applied Electronics – Spl-I Marks : 50
Classes:50
Group A (Analog) Marks-25

1. Special OP- AMP Circuits & applications: Bridge amplifier, instrumentation amplifiers, logarithmic amplifiers, anti-log amplifier, analog multiplier, summing integrator, chopper modulator, chopper stabilized amplifier, pulse width modulator, Regenerative comparators and their uses, pulse generator, ramp generator, square and triangular wave generator, crystal oscillator, voltage controlled oscillator (VCO), active filters, Butterworth characteristics, first, second and higher order low pass and high pass active filters, band pass and band stop active filters.
2. Voltage regulators : Series Op-amp regulator, IC regulator, precision current and voltage sources, Switching Regulators.
3. Phase Lock Loop (PLL) & applications: PLL operational characteristics and parameters, Frequency multiplication, tracking, FM demodulation, Order of PLL.
4. Detectors: Peak detectors, zero-crossing detectors, phase-sensitive detectors.

Group: B (Digital) Marks-25

1. Digital Logic families: DTL, TTL, ECL, MOS, CMOS logic circuits, their advantages and disadvantages, Speed of operation, Power dissipation, Figure of merit, Fan-out.
2. Different memory systems : Memory organization and addressing, Sequential Memory : Static and Dynamic (Ratioed and Ratio-less) shift registers, Development of Read only Memory memories, RAM, MRAM, RRAM, PAL, FPLA. Charge coupled devices (CCD).
3. Revision of different types of Multiplexing, Encoders and Decoders, Code conversions : BCD to Binary converter, Binary to BCD converter.
4. Specialised Communication Systems: Mobile Communication – Concepts of cell and frequency reuse description of cellular communication standards; Pagers. Computer communication – Types of networks; Circuit message and packet switched networks; Features of network, design and examples of ARPANET, LAN, ISDN, Medium access techniques – TDMA, FDMA, ALOHA, Slotted ALOHA, CSMA/CD; Basics of protocol.

Books Recommended :

1. Gaykwad, Operational Amplifier, PHI
2. Millman and Halkias, Microelectronics. Tata mcGraw Hill.
3. Geiger, Allen and Strader – VLSI – Design Techniques for Analog and Digital Circuits.
4. Gray and Meyer – Analysis and Design of Analog Integrated Circuits.
5. S Soelof – Applications of Analog Integrated Circuits.
6. R P Jain, Modern digital electronics, Tata McGraw Hill.
7. A B Carlson – Communication Systems.
8. D Roddy and J Coolen – Electronic Communications.

Course No: PHS 303
Applied Optics and Opto-electronics – Spl - I Marks : 50
Classes: 50

1. Optical Sources : Principle of operation of LED , and Semiconductor junction Laser , Internal and External quantum efficiencies of LED , Different efficiencies of Semiconductor junction Laser ,

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Equations relating the light intensity of LED and Semiconductor Laser with applied current, Quantum well laser , Principle of operation of quantum well Laser .

2. **Optical detector :** PiN detector , Quantum efficiency of PiN detector, Avalanche photo detector, Equations relating the applied light intensity with received photo current of a PiN detector and that of a Avalanche photo detector , Dark current of a photo detector, Shot noise , Signal to noise ratio of a photo detector, Photo conductor and its principle of operation, Photo transistor and its principle of operation .

3. **Optical fiber communication :** Types of optical fiber , Propagation of electromagnetic radiation through 3-dimensional cylindrical step index optical fiber and through graded index optical fiber, Concept of TEM modes in cylindrical fiber. Dispersion in optical fiber; multi path dispersion , material dispersion, and wave guide dispersion, Derivation of the expressions of dispersions, concepts of dispersion free fiber and dispersion compensated fiber , maximum bit rate in optical fiber, Power budget equation and Time budget equation, Wavelength division multiplexing and demultiplexing.

Course No: PHS 304
Science of Universe Marks : 50
Classes: 50

1. Our Planet, our Universe : (12L)
Our motion in the Universe. The night sky, basic concepts in astronomy such as distances, constellations and the celestial sphere, Asteroids & Comets, Formation of our solar system, Sun-Moon-Earth configurations that result in Moon phases and Solar and Lunar eclipses.

2. Astronomical Tools : (13L)
Light as a tool to probe the Universe. Properties of light. The wave particle nature of light. Atoms and spectroscopy. The thermal spectrum. Stellar classification: Hertzsprung-Russell diagram. Composition of a star's outer layers and its surface temperature, The Inverse square law. Telescopes to learn about astrophysical phenomena.

3. The Sun : (5L)
Origin of solar energy, Nuclear fusion, Solar cycle, Solar activity, Solar wind. Solar missions. Main-Sequence lifetime.

4. Evolution of Stars: (10L)
Post-main-sequence evolution of a Sun-like star. Planetary nebulae. White dwarfs. Neutron Stars, Difference between stars, brown dwarfs and giant planets. Supernova explosions. Neutron stars and black holes. Color-magnitude diagrams, Binary star systems.

5. Galaxy and Cosmos : (10L)
Populations of stars and star clusters. Galaxy types and the formation and interaction of galaxies. The Milky Way, Active galactic nuclei, The rotation of our galaxy. Dark matter. The expansion of the Universe and the Big Bang Theory.

Books Recommended :

1. Schneider and Arny: Pathways to Astronomy, McGraw-Hill, 2007
2. M. Schwarzschild: Stellar Evolution
3. S. Chandrasekhar: Stellar Structure
4. K.D.Abhyankar: Astrophysics: Stars and Galaxies
5. Menzel, Bhatnagar and Sen: Stellar Interiors.

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6. Cox and Guili : Principles of Stellar Interiors – Vol.I and II.
7. Shapiro and Tevkolsky: White Dwarfs, Neutron Stars and Black Holes.
8. R.Bowers and T.Deeming: Astrophysics (John and Barlett. Boston).
9. General Relativity, Astrophysics, and Cosmology, A. K. Raychaudhuri, Sriranjan Banerji, Asit Banerjee, Springer-Verlag, 1992

Course No: PHS 305
Advance Practical-II Marks: 50

Group-A

1. Determination of Electron / Ion temperature by Double probe method.
2. Determination of the gamma and beta ray absorption coefficients by using a G.M. counter.
3. Measurement of the Hall coefficient of a given sample and calculation of its concentration.
4. Frank Hertz experiment
5. Measurment of e/m by magnetron valve
6. Determination of Curie Temperature.
7. Study of nuclear counting statistics.
8. To estimate the separation between the two plates of a Febry-Perot interferometer.

Group-B

1. Determination of electron temperature by single probe method.
2. Study of the characteristics of a GM tube.
3. Obtain X-ray Debye-Scherrer photograph and determination of Unit Cell dimensions of a crystal.
4. To Study experimentally the variation of resistivity of semiconductor with temperature and hence to find out the band gap energy.
5. Linearisation LED Characterestics and finding out the quantum efficiency.
6. Determination of Plank's constant (using photo electric effect).
7. Determination of refractive index using Michelson Interferometer.
8. To determine the resolving time of the G-M counting system.

Course No: PHS 306(a)
Solid State Physics(Spl Paper)-I
Marks: 50

Group-A

1. Study of Hall effect with variation of temperature.
2. Determination of Lande g-factor for the given sample using electron spin resonance spectrometer.
3. Determination of barrier potential and doping profile of transistor junctions
4. Determination of ionic conductivity of the given sample.
5. Study of Hysterisis loop of magnetic materials by using Hysterisis Tracer.
6. Study of characteristics of the given solar cell
7. Study of Diac & Triac characterestics with application.

Group-B

1. Study of magneto resistance of the given material
2. Determination of carrier life time in Photoconductor
3. Measurement of magnetic susceptibility and Bohr magneton number of given sample by Gouy method.
4. Absorption/Transmission spectra of thin films by using UV/VIS spectro photometer.
5. Dielectric measurement of polycrystalline ferroelectric sample.
6. Study of Thermo luminescence in a crystal.
7. Study of UJT &SCR characteristics with application.

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Course No: PHS 306(b)
Applied Electronics (Spl Paper)-I
Marks: 50

1. Design, Construction and performance testing of a Logarithmic amplifier using μA 741, diode and matched transistors.
2. Design, Construction and performance testing of an antilog amplifier using μA 741 and matched transistors.
3. Design of an IC Power Amplifier and its linearity, frequency response, efficiency, and distortion calculation.
4. Design of a Precision adjustable voltage regulator using μA 741 and series pass transistor and a transistor as current limiter and its performance comparison with LM78XX series fixed regulators.
5. Design of an Active high pass/Low pass second order Butterworth filter.
6. Design an active band pass filter using single stage μA 741 Op-amp.
7. Frequency to Voltage converter circuit design.
8. 8086 Microprocessor programming.
9. Design and study of an ECL OR-NOR circuit.
10. Design and study of a Voltage Controlled Oscillator (VCO).
11. Experiments on Microprocessor interfacing.
12. Study of Time Division Multiplexing.
13. Study of Pulse Code Modulation.
14. Design of BCD adder

Course No: PHS 306(c)
Applied optics and opto-electronics (Spl Paper)-II
Marks: 50

Group A :

1) To set up a Mach Zehnder Interferometer by Laser to measure the Phase difference of two light beams.
2) To set up a Mach Zehnder Interferometer (MZI) experiment with single mode fibers and Laser to measure phase modulation.
3) To set up an experiment for measuring displacement by optical fiber sensor.
4) To measure attenuation and splice/ connector loss by using OTDR.
5) To set-up an experiment for measuring temperature by optical fiber sensor.
6) To study interference of light by single mode fiber.
7) To study the spectral response of a photo detector using optical fiber link.

Group B :

1) To measure the V_{Π} voltage of an Electrooptic modulator.
2) To Use magneto-optic modulator for verifying Faraday effect.
3) To generate optical Manchester coded data.
4) Verification of optical cross gain modulation by SOA.
5) Use of Heterodyne detector for measuring phase and intensity of an optical signal.
6) Measurement of threshold current of a Semiconductor Junction Laser from its Light intensity vs. Current density curve.
7) Use of OP AMP for using LED as linear modulator .

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Fourth Semester

Course no – PHS 401(A)
Particle Physics Marks : 25
Classes: 25

1. Review of the fundamental classification of elementary particles and study of their different properties and decay scheme (Mesons, Muons), Conservation Laws, Gell-mann and K. Nishijima model, +Su(3) model, Quark model, charm and other flavors, color, properties of strange particles, improper symmetry, parity, charge conjugation, time reversal, CPT theorem, spontaneous symmetry breaking, parity non conservation, K-meson, complex and time reversal invariance.

Books Recommended:

1. Griffith, Introduction to Particle Physics
2. Perkins, High Energy Physics
3. Halgen & Martin, Quarks & Leptons
4. M.P. Khanna- Introduction to Particle Physics

Course No: PHS 401(B)
Statistical Mechanics-II Marks: 25
Classes – 25

1. Ideal Bose system: Thermodynamical behaviour, BE condensation, blackbody radiation
2. Ideal Fermi System: Thermodynamical behaviour; Magnetic behaviour of an ideal Fermi gas: Pauli paramagnetism, Landau diamagnetism and DeHaas-van Alphen affect, electron gas in metal, thermo ionic emission, photoelectric emission
3. Theory of phase transition : Theory of Yang and Lee ,Ising model (one and Two dimensional)

Books Recommended:

1. R. K. Pathria, Statistical Mechanics
2. K. Huang, Introduction to Statistical Mechanics
3. Silvio R. A. Salinas, Introduction to Statistical Mechanics.
4. F. Reif, Fundamentals of Statistical and Thermal Physics.
5. Kadanoff, Statistical Mechanics. World Scientific.
6. R. Kubo, Statistical Mechanics. (Collection of problems)
7. S.K. Ma, Statistical Physics(World Scintific, Singapore)
8. Ishihara, Statistical Physics

Course No: PHS 402(A)
Nuclear Physics-II Marks : 25
Classes:25

1. Nuclear interactions and reactions: Nucleon-Nucleon interaction, exchange forces and tensor forces. The deuteron - Square well potential; neutron-proton and proton-proton scattering at low energies. Classifications of nuclear reactions, Conservation laws; reaction channels; the mass & energy balance in nuclear reactions, direct and compound nuclear reaction mechanisms, compound nuclear model; basic ideas on continuum theory; nuclear resonance.

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2. Nuclear models: liquid drop model, Bohr Wheeler theory of fission, experimental evidence for shell effect, shell model, spin orbit coupling , magic numbers, angular momenta and parity of nuclear ground state; collective model of Bohr and Mottelson.

3. Neutron Physics: Classification of neutrons, Source of neutrons, Thermal neutrons; Velocity selection and time of flight methods, elements of neutron optics.

4. Reactor physics: Slowing down of neutrons in a moderator, average log decrement of energy per collision, moderating ratio.

5. High energy physics: Types of interaction –typical strength and time scale, Conservation loss, Parity & time reversal, CPT theorem

Course No: PHS 402(B)
Quantum Field Theory Marks : 25
Classes:25

1. Elements of field theory ; Symmetries and Noether's theorem ; Canonical Quantization ; Creation-Annihilation operators ; Quantization of Klien-Gordan field, Dirac field, quantization of electromagnetic field ; Discrete symmetries of the Dirac theory ; Interacting fields - Perturbation theory , Wick's theorem, Feynman diagrams , cross sections and S-matrix., Non-perturbative methods - Field and Mass renormalization ; LSZ reduction formula ; Renormalized charge and Ward Identities. , brief idea on Gauge theory, weak and strong interactions, brief discussion on Weinberg - Salem model, Grand unified theories

Books Recommended:

1. Ryder, Quantum Field Theory
2. Barger & Phillips, Collider Physics
3. Peskin & Schroeder, Quantum Field Theory
4. Palash Pal and A Lahiri, Quantum Field Theory, Narosa
5. Mandle, Quantum Field Theory

Course No: PHS 403(A)
Semiconductor Devices Marks : 25
Classes:25

1.Transistor, FET, MOSFET,. Tunnel Diode, Gunn effect oscillator, Single electron Transistor.

2.Boltzman transport equation applied to a non degenerate semiconductor, Electrical conductivity, Hall effect & Thermoelectric effect in semiconductor, Quantum Hall effect.

3.Phototransistors, UJT, Four- layer pnpn device, Diac, Triac.

Books Recommended:
1. Kireev: Semiconductor Physics
2. S.M. Zee : Physics of semiconductor devices
3. Streatman & Banerjee: Introduction to solid state electronics

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Course No: PHS 403(B)
Applied Optics Marks: 25
Classes: 25

1. Fiber optics: Different types (single and multi mode) of step index and graded index optical fiber, ray path in graded index optical fiber, Multipath broadening, Modal analysis of Electromagnetic waves in planer waveguide. Application of fiber in digital communication.

2. Holography: Coherent light and application of coherent light in holography. Recording and reconstruction of wave front.

3. Non-linear Optics: Non-linearity of medium, second and higher harmonic generation, phase matching condition, frequency addition and frequency subtraction, self focusing and self defocusing, Pokels & Kerr type of nonlinear materials, Examples of Organic and inorganic nonlinear materials.

4. Photonics Information Processing: Optical logic operations, Optical arithmetic operation with binary, optoelectronic logic gates, all optical logic gates, tristate logic system and tristate AND & OR gate.

Books Recommended:

1. Optical Electronics, by A. Ghatak and K. Thyagarajan, Cembridge University Press India Pvt. Ltd, New Delhi.
2. Semiconductor optoelectronic devices, by P. Bhattacharya, Prentice Hall publication
3. Optical Electronics, by A. Yariv, Holt McDougal
4. Laser Physics and Applications by L. Tarasov, Mir Publishers, Moscow.
5. optical computation and parallel processing, S. Mukhopadhyay, Classique Books Publisher
6. Some digital approaches in optical computation, by P. Ghosh and S. Mukhopadhyay, Premier Books publication, India

Course No: PHS 404
Solid State Physics - Spl-II Marks : 50
Classes: 50

1. Magnetism : Quantum theory of dia, paramagnetism, transition and rare-earth elements, Ferromagnetic, anti-ferromagnetic and Ferri-magnetic order, molecular fields, direct and indirect exchange interaction, Heisenberg and Ising model, domain theory, Bloch wall, spin waves, magnons, magnetic resonance, princple and application of NMR, EPR, ESR.

2. Superconductivity: Review of experimental results, London-Pippard theory, penetration depth, coherence length, electron-phonon interaction, Cooper pair, BCS theory, energy gap, transition temperature, Ginzburg Landau theory, Flux quantization, Critical Current density, SQUID, superconducting devices, recent advances on high Tc superconductors.

Books Recommended:

1. Magnetism in Condensed Matter: Stephen Bludell
2. Theory of Superconductivity, J. Robert Schrieffer,
3. Introduction to Superconductivity, 2nd Edition, by Michael Tinkham

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Course No: PHS 404
Applied Electronics – Spl-II Marks : 50
Classes: 50

Group A (Analog)

1. Television: Working principle, TV camera- Image Orthicon, Vidicon, Plumbicon ; Picture tube- B/W and Colour, scanning and deflection, synchronization, Details of composite video signal, Transmitting and Receiving systems, Vestigial Side band transmission, Television standards, Advantages of Negative modulation, TV antenna, BW TV receiver.
   Colour TV standards : NTSC, PAL SECAM, colour television principles, Colour subcarrier, transmission format of intensity and colour signal.

2. Wave Guides : Wave guides coaxial, rectangular and cylindrical; Different modes of propagation of em signal through wave guides, resonators.

3. Instrumentations: Digital voltmeter : different types, Digital ammeter and ohmmeters, Ultrasonic techniques and instrumentations.

Group B (Digital)

1. Signal processing & data conversion: Signal sampling, aliasing effect, sample and hold systems, anti-aliasing filter, analog-multiplexer, Digital image processing (ideas only). Successive approximation A/D converter.

2. Pulse modulation and demodulation techniques : Sampling the rein PAM, PWM, PPM, Pulse code modulation-Coding technique modulation and demodulation, DPCM, Delta Modulation.

3. Digital modulation techniques : ASK, FSK, PSK, DPSK, QPSK, MSK principle, modulation and demodulation.

4. Microprocessor and their applications: Architecture of 8 bit (8085) and 16 bit (8086) microprocessors; addressing modes and assembly language programming of 8085 and 8086. Interfacing concepts memory and I/O interfacing; Interrupts and interrupt controllers; microprocessor based data acquisition (DAS) system, comparison of different microprocessors. Microprocessor programming.

Books Recommended

1. R.R. Gulati – Monochrome and Color TV.
2. A M Dhake – Television and Video Engineering.
3. D Roddy and J Coolen – Electronic Communications.
4. Helfrick & Cooper- Modern Electronic Instrumentation-PHI
5. A B Carlson – Communication Systems
6. Kennedy and Davis – Electronic Communication Systems.
7. Taub and Schilling – Principle of Communication Systems., McGraw Hill
8. A P Mathur – *Microprocessors.*
9. R S Gaonkar – *Microprocessor Architecture, Programming and Applications with 8085/ 8085A* (2^{nd} Ed.).
10. D V Hall – *Microprocessor and Interfacing.*
11. Lin and Gibson – *Microprocessor*.

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Course No: PHS 404
Applied Optics and Opto-electronics – Spl - II Marks : 50
Classes:50

1. Optical modulators : Electro-optic modulators and Pockels effect , Phase modulation and Amplitude modulations in Electro-optic modulator, Optical Kerr effect , Modulation of light using optical Kerr effect, Self focusing, self defocussing, Optical switches using Kerr effect , Optical Faraday effect.

2. Optical amplifiers : Semiconductor Optical Amplifier (SOA) and its principle of operation, Self phase modulation, cross phase modulation , Cross gain modulation and wavelength conversion of SOA, EDFA and its principle of operation.
3. Photonic measurements : Homodyne and Heterodyne detectors for phase and intensity measurements, OTDR.
4. Optical encoding : Intensity encoding, frequency encoding, polarization encoding, RZ , NRZ , Manchester line encoding, Method of obtaining Manchester coded data, probability error and bit error rate.
5. Optical devices : principle of operation of Liquid Crystal Display; Charge Coupled Devices ; Fiber optic displacement, current and temperature sensors.

Course No: PHS 405(a)
Solid State Physics (Spl Paper)-II
Marks: 50

Group-A

1. Study of magneto resistance of the given material
2. Determination of carrier life time in Photoconductor
3. Measurement of magnetic susceptibility and Bohr magneton number of given sample by Gouy method.
4. Absorption/Transmission spectra of thin films by using UV/VIS spectro photometre.
5. Dielectric measurement of polycrystalline ferroelectric sample.
6. Study of Thermo luminescence in a crystal.
7. Study of UJT &SCR characteristics with application

Group-B

1. Study of Hall effect with variation of temperature.
2. Determination of Lande g-factor for the given sample using electron spin resonance spectrometer.
3. Determination of barrier potential and doping profile of transistor junctions
4. Determination of ionic conductivity of the given sample.
5. Study of Hysterisis loop of magnetic materials by using Hysterisis Tracer.
6. Study of characteristics of the given solar cell
7. Study of Diac & Triac characterestics with application

Course No: PHS 405(b)
Applied Electronics (Spl Paper)-II
Marks: 50

1. Design of a Schmitt trigger circuit using μA 741.
2. DSB-TC and DSB-SC generation using analog multiplier IC MC 1495 or MC1496.
3. Design and performance study of a VCO IC (NE 566).
4. Design and performance study of a PLL IC (NE 565).
5. Digital adder, subtractor and comparator.

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6. Shift registers and shift counter, PISO, SISO, PIPO, SISO.
7. Digital multiplexing.
8. Study of Pulse Amplitude Modulation.
9. Study of Pulse Width Modulation.
10. Pattern waveform generator for analog multiplexing.
11. To study the input stage of an Op-amp using discrete components and fine out the differential mode gain.
12. PSIPCE study the input stage of an Op-amp using discrete components and fine out the differential mode gain.

Course No: PHS 405(c)
Applied optics and opto-electronics (Spl Paper)-II
Marks: 50

Group A :

1) To measure the V_{Π} voltage of an Electro-optic modulator.
2) To use magneto-optic modulator for verifying Faraday effect.
3) To generate optical Manchester coded data.
4) Verification of optical cross gain modulation by SOA.
5) Use of Heterodyne detector for measuring phase and intensity of an optical signal.
6) Measurement of threshold current of a Semiconductor Junction Laser from its Light intensity vs. Current density curve.
7) Use of OP AMP for using LED as linear modulator .

Group B :

1. To set up a Mach Zehnder Interferometer by Laser to measure the Phase difference of two light beams.
2. To set up a Mach Zehnder Interferometer (MZI) experiment with single mode fibers and Laser to measure phase modulation.
3. To set up an experiment for measuring displacement by optical fiber sensor.
4. To measure attenuation and splice/ connector loss by using OTDR.
5. To set-up an experiment for measuring temperature by optical fiber sensor.
6. To study interference of light by single mode fiber.
7. To study the spectral response of a photo detector using optical fiber link.

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