SCIENCE FACULTY

NORTH MAHARASHTRA UNIVERSITY, JALGAON

SYLLABUS

FOR

M. Sc. I

PHYSICS

(With effect from June - 2017)

NORTH MAHARASHTRA UNIVERSITY, JALGAON

Class: M. Sc.(I)

Subject: Physics

The revised syllabus for M. Sc. (I) Physics prepared by different committees was discussed and finalized in the workshop for M. Sc. (I) Syllabi revision on 23rd February 2017. The titles of the papers for M. Sc. (I) Physics are as given below;

Semester	Title of Course	Periods	Marks	
			Ext.	Int.
I	PHY 101: Mathematical Methods for Physics	60	60	40
	PHY 102: Classical Mechanics	60	60	40
	PHY 103: Quantum Mechanics	60	60	40
	PHY 104: Solid State Physics	60	60	40
	PHY 105: Basic Physics Laboratory – I	60	60	40
II	PHY 201: Statistical Mechanics	60	60	40
	PHY 202: Classical Electrodynamics	60	60	40
	PHY 203: Material Science	60	60	40
	PHY 204 (A) : Physics of Semiconductor Devices Or PHY 204 (B) : Electronic Instrumentation Or PHY 204 (C) : Bio- Physics	60	60	40
	PHY 205: Basic Physics Laboratory – II	60	60	40

Number of teaching days /year	180
Number of teaching days /term	90
Number of periods for theory course or practical course/ week	04

Number of teaching periods /term	52
Number of periods /term for test, seminars and tutorials	08
Total number of periods / term for course	**52 + 08 = 60**

PHY-101 Mathematical Methods for Physics

1. Vector Space

Definition of vector space, Sub spaces, Linear combinations of vectors, Linear span, Linear dependence and independence, Basis and dimensions, Linear transformations, Linear operator, Matrix representation of linear operator.

Inner product space - Definition of inner product space, Properties (Conjugate symmetry, linearity, non negativity), Norm of a vector, Schwarz's inequality, Triangle in equality, Cauchy's inequality, Law of Parallelogram, Orthogonality , Orthonomal set, Orthonomalbasis, Gram-Schmidt Orthogonalization Process. **(H6, M8)**

2. Matrix Algebra

Types of matrices (Symmetric, Skew symmetric, Hermition, Skew Hermition, Adjugate, Unitory and Orthogonal), Eigen values and Eigen vectors of a matrix, Diagonalization of matrix, Caley-Hamilton theorem. **(H5, M6)**

3. Fourier Series

Definition, Determination of Fourier coefficient, Dirichlet theorem, Extension of interval, Half range Fourier sine and cosine series, Complex form of Fourier series, Parseval'sidentity, Fourier integrals **(H10, M8)**

4. Integral Transforms

Definition of Laplace Transform, Properties(Linearity, Shifting, Change of Scale), Laplace Transform of derivative, Laplace transform of integrals, Derivative of Laplace transform, initial and final values theorems, Multiplication by power of t, division by t, Inverse Laplace transform- Definition, Proofs of Linearity, I^{st}&II^{nd} Shifting theorem, Convolution theorem(Statement only) , Applications to solution of differential equations. Definition of Fourier transformation, Fourier cosine transforms.**(H14, M18)**

5. Special Functions

Legendre, Hermite, &Laguerre Functions (Generating functions, Recurrence relations, Orthogonality, Rodriguee's Formula), Associated Legendre equation, Associated Legendre function, Properties of Associated Legendre function, Recurrence formulae for Associated Legendre function, Laguerre polynomials, Associated Laguerre Polynomials, Orthogonality of associated laguerre polynomials, Recurrence formulae for Associated Lageurre polynomials. Generating function for Jn(x), Integral representation for Jn(x), Reccurence relation for Jn(x), Bessel's Function of half odd order ($J_+1/2(x)$, $J_-1/2(x)$, $J_+3/2(x)$, $J_-3/2(x)$), Integral formula of Laguerre polynomials Orthogonality of Bessel's equations. **(H12, M15)**

6. Complex Analysis

Complex number, Conjugate complex numbers, Function of Complex variable, Analytic function, Cauchy- Riemann condition, Cauchy's theorem, Cauchy's integral formula, Derivative of analytic function, Taylors theorem, Lorent's theorem, Cauchy's residue theorem, Evaluation of definite integrals. **(H5, M5)**

(Total H-52 M-60)

References:-

1. Linear algebra By Seymour Lipschutz ,Schaum outline series
2. Theory & Problems of Matrices by Frank Ayres
3. Mathematical Method For Physics by Arfken
4. Mathematical Method in Physics by B. D. Gupta
5. MMP by H.K.Das (S. Chand Publication)

6 .Mathematical Physics by B. S. Rajput
7. Fourier Series by Seymour Lipschutz ,Schaum outline series
8. Laplace Transforms by Seymour Lipschutz ,Schaum outline series
9. Complex Variables & Applications by J. W. Brown
10. Mathematics for physical science by Mary Boas

PHY-102: Classical Mechanics

1. Mechanics of System of particles:
Conservation of linear and angular momentum of system of particles, Relation between about any point and about centre of mass, Discuss similar relations for kinetic energy also. Scattering of Particles: Elastic and inelastic collision, Lab. and C.M. system of coordinates, Differential and total cross section, Impact parameter, Rutherford's scattering, Relation of cross-section between C.M. and Lab. frame. **(H-10 M-14)**

2. Hamilton's equation of motion:
Introduction, Legendre's dual transformation, Hamilton's function and Hamilton's equations of Motion, Properties of the Hamiltonian and of Hamilton's equations of motion, Routhian, Configuration space, Phase space and State space, Lagrangian and Hamiltonian of relativistic particles and light rays. **(H-10 M-14)**

3. Principle of Least Action and Hamilton's principle:
Introduction, Principle of least action, Hamilton's principle, Comparison between Fermat's principle of least action in optics &Maupertuis' principle of least action in mechanics, Derivation of Euler - Lagrange equations of motion from Hamilton's principle, Derivation of Hamilton's equations of motion for holonomic systems from Hamilton's principle, Invariance of Hamilton's principle under generalized coordinate transformation, Hamilton's principle and characteristic function. **(H-12M-14)**

4. Canonical transformations and Hamilton - Jacobi theory:
Gauge transformation, Canonical transformation, Condition for transformation to be canonical, Poisson brackets, Canonical equations in terms of Poisson bracket notation, Infinitesimal transformation, Relation between infinitesimal transformations and Poisson brackets, The Hamilton - Jacobi equations, Separation of variables. **(H-10 M-10)**

5. Theory of Small Oscillations:
General case of coupled oscillations, Eigen vectors and Eigen frequencies, Orthogonality of Eigen vectors, Normal co-ordinates and normal frequencies of vibration, system with few degrees of freedom: The parallel pendulum, Double pendulum, Small oscillations of particles on string.
(H-10 M-8)

(Total H-52 M-60)

Reference Books:

1. Introduction to Classical Mechanics: R. G. Takwale and P. S. Puranik.
2. Classical Mechanics: N. C. Rana and P. S. Joag. Tata McGraw -Hill Publishing Co. Ltd.
3. Classical Mechanics: Panat P. V., Narosa Publishing House.2008
4. Classical Mechanics: Gupta, Kumar and Sharma,Pragati Publication
5. Classical Mechanics: Herbert Goldstein, Narosa Publishing House.

PHY-103: Quantum Mechanics

1. Operator methods in quantum mechanics: Linear vector space and its properties, examples, Linear independence of vectors , dimensions, bases and expansion theorem, Inner product & unitary spaces, Orthonormal sets, completeness, Hilbert spaces. Operators: Linear operators, Identity operator, Null operator, Inverse operator, Eigen values &eigen functions, Hermitian operators and their properties, Expansion of eigen functions, Continuous spectrum, Parity operator & its properties, Projection operator, Equation of motion. **(H-10 M-12)**

2. Matrix formulation of Quantum Mechanics: Dirac's Bra and Ket notations for vectors and their properties, Ket vector as a column matrix and bra vector as a row matrix, Operators as matrices, Matrix form of wave function, Unitary transformation, Eigen value problem, Quantum Dynamics: Schrodinger, Heisenberg and Interaction representations, Defining equations for the operators a and a+, Computation of values of a a+, a+a, [a, a+], [a, H], [a+, H], Eigen values & Eigen functions of 1-D harmonic oscillator using ladder operators a and a+, Matrices for the operators: a, a+, x, p, H, Derivation of Schrodinger's equation from a and a+. **(H-14 M-16)**

3. Angular Momentum Total angular momentum operator J. Commutation relation of components Jx, Jy and Jz.Ladder Operators J+ and J- , Commutation relations of J2 and Jz with J+ and J- , Commutation between J+ and J- , Eigen values and Eigen functions of J2 and Jz , Angular momentum Matrices, Electronic states in a central field, Addition of angular momenta, Computation of Clebesch- Gordan coefficients for (j1 = ½ & j2 = ½) and for (j1 = 1 & j2 = ½) **(H-14 M-16)**

4. Approximation Methods: a) Time independent Perturbation Theory: Non degenerate case – Evaluation of first order energy and first order wave function, Evaluation of second order energy and second order wave function, Application to: Perturbed Harmonic Oscillator, b) Variation Method: Basic principles, Applications to: one dimensional harmonic oscillator, Ground state energy of hydrogen atom. c) The WKB approximation: The principle of the method, the WKB wave function, Application to: transmission through a barrier. **(H-14 M-16)**

(Total H-52 M-60)

Reference Books:

1. Advanced Quantum Mechanics SatyaPrakash, KedarnathRamnath, Meerut.
2. Quantum Mechanics: G. R. Chatwal& S. K. Anand, Himalaya Publishing House.
3. A text book of Quantum Mechanics :P.M.Mathews&K.Venkatesan, Tata McGraw Hill Pvt. Ltd.
4. Quantum Mechanics : John L Powell & Bernd rasemann.,Narosa Publishing House.
5. Quantum Mechanics :A.K.Ghatak&S.Loknathan, The Macmillan company of India Ltd..
6. Quantum Mechanics L. I. Schiff. McGraw Hill.

PHY-104: Solid State Physics

1. Band theory of Solids:
Nearly free electron model, Bloch theorem (with proof), Kronig Penny model, Motion of electrons in 1-D according to band theory, Distinction between metals, insulators and intrinsic semiconductor, origin of energy gap, Effective mass of an electron. (Ref: 2, 6 & 8) **(H-8 M-8)**

2. Defects in solids:
Defect (Imperfection), Classification of defects, Point defect: Schottky defect, Frenkel defect and Interstitial defect, Elementary idea about dislocation. (Ref:1,4&9) **(H-5 M-8)**

3. Lattice vibrations and phonons:
Concept of lattice vibration, Elastic waves in an infinite and finite one dimensional array of identical atoms, Lattice vibrations of diatomic lattice, Optical and Acoustic modes of vibrations, Quantization of lattice vibrations: Phonons. (Ref: 5 & 6) **(H-7 M-8)**

4. Theory of Dielectrics, Piezoelectricity and Ferroelectrics:
Polarization of dielectric, Dielectric constant, Local electric field, Polarizability, Clausius-Mosotti relation, Dipolar polarizability, Calculation of Ionic & Electronic polarizability, Total polarizability, Piezoelectricity, Ferroelectricity, Theories of ferroelectricity: Dielectric behavior above Tc, Spontaneous polarization below Tc and Ferroelectric Hysteresis, Applications of ferroelectrics. (Ref: 1, 3, 6, 8& 9) **(H-9 M-10)**

5. Magnetism:
Origin of magnetic moments, Classification of magnetic materials, Langevin's classical theory of diamagnetism, Langevin's classical theory of paramagnetism, Weiss theory of paramagnetism, Paramagnetic susceptibility of conduction electron, Ferromagnetic domains, ferromagnetic Hysteresis, Exchange energy, Anisotropy energy, Bloch wall, Weiss theory of ferromagnetism, Two sub-lattice model of Anti ferromagnetism, Neel's model of ferrimagnetism. (Ref: 1, 4,8&9)
(H-13 M-14)

6. Superconductivity:
Basic concept, Occurrence, Meissner effect, Critical field, Type-I and type-II superconductors, Heat capacity, Energy gap, Microwave and IR properties, Critical currents, Thermodynamics of super conducting transitions, London equation, Coherence length, London penetration depth, BCS theory of superconductivity, High Tc super conducting materials, Qualitative discussion of Josephson superconductor tunneling (a.c. &d.c.). (Ref: 1, 3, 6, 7,8& 9)
(H-10 M-12)
(Total H-52 M-60)

Reference Books:

1. Fundamentals of Solid State Physics: B.S.Saxena ,R.C.Gupta&P.N.Saxena,PragatiPrakashan, Meerut 11 thEd.
2. Solid State Physics : R. L. Katiyar, Campus Books International, New Delhi . 2009
3. Solid State Physics : R. L. Singhal, KedarnathRamnathPrakashan, Meerut.
4. Solid State Physics : S.L. Gupta & V. Kumar, K. Nath& Co. Meerut.
5. Solid State Physics: A.J. Dekkar, McMillan students Ed.
6. Introduction to Solid State Physics: C. Kittle, Wiley Eastern Ltd; 7th Ed.
7. Solid State Physics: C. M. Kachhava, Tata McGraw Hill Eds.
8. Solid State Physics: R. K. Puri and V. K. Babbar
9. Elementary Solid State Physics: M. Ali Omar

PHY-105: Basic Physics Laboratory-I

Note: At least 4 experiments from each group and minimum, 10 experiments should be performed

Group A

1.λ by Michelson Interferometer.
2.Febry -Perot Interferometer. Determination of wavelength of monochromatic source.
3. To determine ultrasonic velocity and to obtain compressibility of a given liquid.
4. Magnetic susceptibility of paramagnetic material by Quincke's method.
5. "e/m" by Millikan oil drop method.
6. Diffraction at single and double slits using laser source.
7. Surface tension by ripples method.
8. Determination of elastic constants by Cornu's method.
9 .Determination of thickness of thin transparent sheet like mica using Michelson interferometer.
10.Determination of Rydberg constant using Hydrogen discharge tube.
11.To find the values of Cauchy's constants for the material of the given prism using Hg source.
(Ref: Practical Physics by C.L.Arora page 163)

Group B

1. Design and build ERPS using IC 723 and study its line and load regulation.
2. Design, build and test the phase shift oscillator using IC-741.
3. Design, build and test Schmitt trigger circuit using 741.
4. To study the characteristics of LDR, Photodiode and Phototransistor.
5. Design, build and test first order & second order low pass filter using IC 741.
6. Design, build and test first order & second order high pass filter using IC 741.
7. Design, build and test precision rectifier using IC 741.
8. Design, build and test Astable /monostablemultivibrator using IC 741/IC 555.
9. Design, build and test voltage to frequency converter.
10.Design, build and test the temperature to frequency converter.
11.Design, build and test transformer less class-B push pull amplifier.

NOTE: This list is flexible; one can add any suitable experiment (of appropriate standard) from Physics with prior permission of BOS in Physics, NMU, Jalgaon.

PHY-201: Statistical Mechanics

1. **Phase Space and Ensembles:**

Phase space, Liouville's theorem, Principles of conservation of density and extension in phase space,Grand canonical ensemble, Physical interpretation of α, Chemical potential in the equilibrium state, Fluctuations in number of particles of a system in grand canonical ensemble, Partition function of Classical ideal gas and calculation of thermodynamic quantities, Entropy of mixing and Gibb's paradox, Sackur-Tetrode equation. **(H 10, M10)**

2. Classical and Quantum Statistical Mechanics:

Brief outline of classical and Quantum statistics, Symmetry of wave functions, The quantum distribution functions, Maxwell Boltzmann statistics, Bose Einstein. Statistics, Photonstatistics, Fermi Dirac statistics, The Boltzmann limit of Boson and Fermions gases, Evaluation of partition function for quantum monatomic gas, Partition function for diatomic molecules, Equation of state for an ideal gas. **(H 10, M12)**

3. Ideal Bose Systems:

Photon gas: Black body radiation, radiation properties such as pressure, density, emissivity and equilibrium number of photons in a cavity. Einstein's derivation of Planck's law, Bose Einstein condensation, Specific heat from lattice vibrations, Debye's model of solids: Phonon gas.

(H 8, M10)

4. Ideal Fermi Systems:

Fermi energy, Mean energy of fermions at absolute zero temperature, Fermi energy as a function of temperature, Electronic specific heat, White Dwarfs, Compressibility of Fermi gas, Pauli paramagnetism, Relativistic degenerate gas. **(H 8, M10)**

5. Phase transition and Critical Phenomena:

Phase transitions, Conditions for phase equilibrium, Order parameter, Ist order phase transition, IIndorder Phase transition, Critical indices, van der Waals theory of liquid gas transition, Mayer theory of condensation, Curie Weiss theory of magnetic transition, Ising model.

(H 8, M10)

6. Non equilibrium processes:

Distribution function, Boltzmann transport equation, Relaxation approximation, Electrical conductivity from relaxation approximation, Boltzmann non linearintegro differential equation, Boltzmann's H-theorem, Maxwell-Boltzmann distribution from Boltzmann equation. **(H 8, M8)**

(Total H-52 M-60)

Reference Books:

1. Fundamentals of Statistical Mechanics: B.B. Laud, New Age Int.l Publishers (2003)
2. Introduction to Statistical Mechanics: S. K. Sinha, Narosa Publication, New Delhi (2007)
3. Fundamentals of Statistical & Thermal Physics: F. Reif, Mcgraw Hill Company, (1965)
4. Statistical Mechanics: R. K. Patharia, Butterworth-Heinemann (Elsevier) (2/e Reprint 2004)
5. Statistical Physics: Harvey Gould and Jan Tobochnik.

PHY-202 Classical Electrodynamics

Chapter I: - Electrostatics AndMultipole Fields

Electrostatics energy and energy density and free space and in dielectrics ,Thermodynamicinterpretation of Electrostatics energy, Electric dipole, multipole expansion of potential, Thedipole potential, The quadrupole potential and quadupole moment, further remarksconcerning electric multipoles. **(H10, M10)**

Chapter II: - Electromagnetic Waves

Plane waves in non-conducting media, Polarization, Energy Flux in a plane wave, RadiationPressure and Momentum, Plane waves in a conducting medium, the Skin effect, Currentdistribution in conductors – The Skin depth. **(H10, M10)**

Chapter III: - Reflection, Refraction and Dispersion

Boundary conditions for the electromagnetic field vectors B, E, D and H at interface betweentwo media, Reflection and Refraction at the boundary of two non-conducting media, Generaltreatment of reflection and refraction, Fresnel's equations-Incident wave polarized with its vectors E normal and parallel to the plane of incidence, The coefficients of reflection and transmission at the interface between two dielectrics, Brewster angle and degree of polarization, Rectangular wave guide, Dispersion (Normal and Anomalous), Dispersion inliquid and solid. **(H12, M15)**

Chapter IV: - Electromagnetic Fields and Radiating systems

Lienard-Wiechart Potentials, Electric and magnetic fields of charge in uniform rectilinearmotion, Electric and magnetic fields produced by arbitrary moving charge, Radiation due tonon relativistic charges and relativistic charges, Radiating systems, Radiation due to anoscillating electric dipole, Radiation due to a small current element, Linear half waveantenna. **(H12, M15)**

Chapter V:- Relativistic Electrodynamics

Galilean transformations, Lorentz transformations, Velocity momentum and energy inrelativity, four vectors in electrodynamics.Covariant form of electric and magnetic field- Electromagnetic field tensor. **(H8, M10)**

(Total H-52 M-60)

Reference books:-

1) Electrodynamics by Gupta, Kumar and Singh
2) Classical Electromagnetic Radiation by Jerry B. Marion
3) Electromagnetic by B. B. Laud.
4) Classical Electrodynamics by J. D. Jackson
5) Introduction to Electrodynamics by A. Z. Capri & P. V. Panat
6) Classical Electricity & Magnetism by Panofsky Phillips
7) Foundations of Electromagnetic theory by Reitz & Milford
8) Electromagnetic theory & Electrodynamics by Satyaprakash, Kedarnath.
9) Introduction to Electrodynamics by David Griffith

PHY-203 Material Science

Unit-I: Phase diagram

Solid solutions, types of solid solutions, Hume-Rothery rules, intermediate phase/ compounds Phase equilibrium, Gibbs Phase rule, Lever rule, Equilibrium Phase Diagrams, Unary diagrams, Binary diagrams, typical isomorphous Phase diagram, Cooling curves for isomorphous binary system Al_2O_3-Cr_2O_3, properties of eutectic, peritectic, monotectic and eutectoid-systems. Phase diagram for isomorphous system-. Eutectic phase diagram for Pb-Sn system**.** **(H11, M12)**

Unit-II: Phases in alloys and Phase transformations

Iron-Carbon phase diagram and different phases of the system. Phase transformations in steel during heating and transformation of austenite during cooling. Transformation rate effects and TTT diagrams, Microstructure and Property Changes in Fe-C Alloys**.** **(H13, M14)**

Unit-III: Applications and Processing of Metals and Alloys:

Types of metals and alloys: Ferrous materials -.A Steels: Low carbon steels,Medium carbon steels,High carbon steels,Stainless steels. Cast irons: Gray cast iron,White cast iron,Nodular (or ductile) cast iron,Malleable cast iron.Non-ferrous materials:Aluminium, alloys, Copper alloys, Magnesium alloys, Titanium alloys, Refractory metalsNoble metals, free cutting steel, structural steel, high speed steel, ball, bearing steel.Cu-alloys: Brasses and Bronzes-Properties and applications, Cu-Ni – alloys. Thermal processing of metals and alloys: Annealing processes: Process annealing, Stress relief, Full annealing, Normalizing. Quenching and Tempering processes.Case Hardening: Induction hardening, Flame hardening, Laser hardening, Carburizing, Cyaniding. **(H14, M16)**

Unit-IV: Applications and Processing of Ceramics

Ceramics- structure, types and properties.Glasses, Clay products, Refractories, Abrasive ceramics, Cements, Advanced ceramics, typical ceramics and respective applications.Fabrication and processing of ceramics.Glasses- structure, Glass transition, properties of glasses. Metallic glasses-introduction, preparation of metallic glasses, mechanical and magnetic properties, principal uses of metallic glasses**.** **(H8, M12)**

Unit V: Solar Energy materials

Solar energy spectrum, photovoltaic conversion materials: Si, GaAs, CdS, $CuInSe_2$, fabrication of CdS/Cu_2S cell, introduction to organic solar cells. **(H6, M6)**

(Total H-52 M-60)

Reference Books:

1. Inroduction to engineering materials: B. K. Agrawal, Tata McGraw-Hill Pub.
2. Material Science and Engineering, A first course : V. Raghavan, Prentice Hall Of India.
3. Introduction to Materials Science: H. B. Lal, Dominant Publishers, New Delhi.
4. Composite Material Science and Engineering, Springer, 2001. By Krishnan K Chawla.
5. Material Science and Engineering: R. K. Rajput ,S. K. Kataria& Sons, New Delhi,2002.
6. Solid State Physics-Structure and Properties of Materials: M. A. Wahab, NarosaPublishing
7. Material Science and Engineering- An introduction W. D. CallisterJr sixth edition,
8. Foundations of Material Science and Engineering- William F. Smith.
9. Mechanical Metallurgy, Third Edition, G. E. Dieter McGraw-Hill, New York, 1986.
10. Introduction of Dislocations, D. Hull, Third Edition, Butterworth-Heinemann, Woburn, UK,
11. Introduction to Ceramics, Second Edition W. D. Kingery, H. K. Bowen, and D. R. Uhlmann,
12.Physical Ceramics for Engineers L. H. Van Vlack, Addison-Wesley Longman,
13. Heat treating, Vol. 4, ASM Handbook, , ASM International, Materials Park, OH, 1991.

PHY-204(A) Physics of Semiconductor Devices

1. Charge Carriers and Fermi Level in Semiconductors in Equilibrium:
Equilibrium distribution of electrons and holes, Intrinsic carrier concentration and Fermi level position, Doping of semiconductors with impurities, Extrinsic semiconductors: Equilibrium distribution of electronsand holes, Degenerate and non-degenerate semiconductors, Impurity carrier concentration, Charge neutrality equation, Equilibrium electron and hole concentration and its temperature dependence, Position of Fermi level and its variation with temperature and concentration. **(H-9 M-10)**

2. Current Transport Phenomena and Continuity Equation:
Drift of carriers: Drift current, mobility and its temperature dependence. Diffusion current, iffusion constant, Total current density, Non-uniform impurity distribution and induced internal field. Einstein's relation, Non-equilibrium excess carriers and Continuity equation. Excess carriergeneration, recombination and injection and its mathematical analysis using continuity equation, Life-time and diffusion length of carriers, Concept of quasi fermi levels. **(H-9 M-10)**

3. Characterisation of semiconductor solids:
Hall effect : Measurement of resistivity, mobility, carrier concentration, diffusivity, Hall coefficient nd carrier types for majority carriers, Hall effect in intrinsic semiconductors. Haynes-Shockley experiment, Mobility, diffusivity and life time of minority carriers. **(H-5 M-7)**

4. P-N Junctions-Characteristics and Devices:
Junction in equilibrium, Continuity of Fermi level across the junction, Junction under forward and reverse bias,Zero bias, Builtin- potential, Electric field in depletion region, Space Charge width, Biased junction, Space charge width under electric field, Junction Capacitance, Diffusion capacitance, One sided junction, Non-uniformly doped junctions, Linearly graded, Hyperabrupt etc., Break down in P-N junction, Avalanche andZener Breakdown.
a) PN Junction diode: Carrier distribution profile, Ideal P-N junction current, Small signal equivalent, Current voltage characteristics of junction diode.
b) Zener diode: Reverse bias breakdown, principle of operation, device design for particular breakdown voltage.
c) Photovoltaic Cell: Principle of operation, forward and reverse bias characteristics, equivalentcircuit,applications. **(H-13 M-15)**

5. Metal-semiconductor Junction Diode:
Structure, metal semiconductor contacts, energy band diagram for different cases, barrier formation, Schottkybarrier diode, Nonideal effects on barrier heights, Current voltage characteristics, Comparison of barrier diodeand PN-junction diode, Metal Semiconductor Ohmic Contact, Ideal non-rectifying barriers, Heterojunction.

(H-7 M-8)

6. Bipolar Junction Transistor:
Structure, The basic principle of operation, Modes of operation, Carrier concentration profile in various regions in forward active mode, current gain and current gain factors, Equivalent circuit models: Ebers-Moll model, the dependence of Ebers-Moll parameters on the structure and operating point, Maximum transition current, Voltage and power rating.

(H-9 M-10)
(Total H-52 M-60)

Reference Books:

1. Semiconductor and electronic Devices, Adir Bar-lev (1987), Prentice Hall of India.
2. Advanced Theory of Semiconductor Devices, Hess, K.(1988)Englewood Cliffs, N. J. , PH India

3. Physics of Semiconductor Devices, Roy.D.K. (1992), University Press, India.
4. Physics of Semiconductor Devices, Shur,M.(1990) Englewood Cliffs, N. J. Prentice Hall of India.
5. Solid State Electronic Devices, Streetman, B.G. (1990),3rded; Englewood Cliffs, N. J. PH India.
6. Semiconductor Devices; Physics and Technology, Sze, S.M. (1981) Wiley Eastern Ltd.
7. Physics of Semiconductor Devices, Sze, S. M. (1985) Wiley Eastern Ltd.
8. Fundamentals of Semiconductor Theory and Device Physics, Wang, S.(1989) Englewood Cliffs. N.J., PHIndia
9. Semiconductor Devices - Basic Principles, Jasprit Singh, John Wiley &Sons,Inc.(2002).
10. Semiconductor Devices, Zambuto, M .(1989), McGraw Hill

PHY-204(B): Electronic Instrumentation

1. Signal representation & generation
Periodic signals, periodic signals, modulated signals (A.M., F.M., P.M.), sampled data pulseModulation (PWM, PAM, PPM), definition and their graphical representation. Generation of.sine, Square, triangular, linear ramp & saw tooth waveforms. **(H-8, M-10)**

2. Measurement of electrical signals:
Meters: comparison of analog & digital meters, moving coil, moving iron, electrodynamics, Induction meter, clamp on meter. CRO: Detail study of CRT, Block diagram of generalpurpose CRO, Dual beam and dual trace oscilloscope, measurement of voltage, current,resistance, frequency, phase, capacitance & inductance using CRO. **(H-14 M-14)**

3. Bio-electric Signals and Electrodes:
Basic Physics of membrane potential, resting membrane potential of nerves, nerve action potential, origin of bio-electric signals, recording electrodes, polarization, skin contact impedance, electrodes for ECG, electrodes for EEG, electrical conductivity of electrodes jellies and creams, microelectrodes. **(H-8 M-10)**

4. Telemetry System:
Multiplexer: Analog & digital multiplexer, Sample and hold Circuit. Data transmissionsystem. Telemetry system Block diagram, Characteristics, Land line Telemetry, Radiotelemetry, Processing system. **(H-8 M-10)**

5. Applications of electronic system:
Frequency selective wave analyzer, Spectrum analyzer, Lock-in amplifier, Fiber opticsensors. Measurement of Humidity, Hygrometers, Measurement of pH, Measurement ofthermal Conductivity (gas analyzer), Nuclear instrumentation-types of radiation, Geigermullertube, ionization chamber. Flow meters: Classification, working principle,electromagnetic flow meter, Ultrasonic flow meter. **(H-14,M-16)**

(Total H-52 M-60)

Reference Books:

1. Transducers& Instrumentation: D.V.S.Murthy.
2. Instrumentation-Devices &system: C.S.Rangan,G.R.Sharma,V.S.V.Mani.
3. Principles of measurement and Instrumentation : Alan S.Morris.
4. Electronic Instrumentation: Kalsi
5. Electrical & electronic measurement Instrumentation: A.K.Sawhney.
6. Modern electronic instrumentation & measurement Technique: Helfrick Cooper.
7. Handbook of Bio-medical Instrumentation – R.S. Khandpur, TMH, New Delhi
8. Introduction to Bio-medical equipment Technology- J.J Carr, Pearson Pvt.Ltd.

PHY-204(C): Bio-Physics

1. Cellular Basis of Life:
Cell components-structure and function, plant and animal cells, Biomolecules- General idea about structure and functions- H_2O, Proteins, carbohydrates, fats and nucleic acids, Introduction to Biological energy, Energy consumption, Respiration, Energy production, photosynthesis, ATP synthesis. **(H-12 M-8)**

2. Protein structure:
4 levels, Ramachandran plot, Interpretations, classifications (by structure and function), Nucleic acids, Types of DNA, properties, RNA, Base pairing, Transcription and Translation.
(H-6 M-8)

3. Confirmation Analysis:
Asymmetric carbon, Fisher conventions, L-D type systems, Torsion angle, Newmann projection, Cis-trans peptide. **(H-6 M-6)**

4. Membrane Biophysics & Transport:
A) Structure and function of membrane, membrane proteins.
B) Transport across membrane, processes, chemical potential, flux equation, Nernst equation, Using –Teorell unidirectional flux ratio, Osmotic pressure, Osmotic phenomenon in leaky membrane, The Donnan equilibrium – Goldmann equation. **(H-10 M-11)**

5. Bioenergetics:
Entropy in biological systems, Information processing, Photosynthesis pathways, Redox potentials, Glow curves, Orders of kinetics, Thermodynamics in photosynthesis, Thermo luminescence, Mitochondrial bioenergetics. **(H-8 M-11)**

6. Enzyme Kinetics:
Classification of enzymes, Activation energy barrier, substrate concentration, Vmax, Km competitive inhibition, Allosteric enzymes. **(H-5 M-8)**

7. Neurobiophysics:
Structure and function of neuron, types of synapses, testing potential, local depolarization, action potential: Generation and propagation, equivalent circuit of cell, voltage clamp, Na-K pump, equivalent circuit. **(H-5 M-8)**

(Total H-52 M-60)

Reference Books:

1. Biophysics: A introduction by Rodney M.S., Colteril. John Willey and Sons Ltd.
2. Biophysics :VasanthaPattabhi, M.Gantham, Narosa Publishing House.
3. Biophysical Plant Physiology and ecology, P.S. Nobel (University of California, Los Angeles and W.H. Freeman & Co., Sanfranscisco, 1983)
4. Biophysics & Physiology of excuitable membranes, Adleman, (Van-Nostrand eehihod.Co.1971).
5. Problems of Biological Physics. L.A.Bluemonfeld (Springer-Verlag-Berlin 1979)
6. The structure and function of proteins. L Dickerson &J.Geis (Harpes&Reod 1975)
7. Biology, a human approach, I.W.Sherman and V.G.Sherman (Oxford Uni. Press 1979).
8. Essentials of Biophysics, P.Narayanan, New Age Publications, 2000
9. Principles of Biochemistry: Lahninger
10. Neuron to brain, S.W. Kuffler and J.G. Nichols (SinacuerAsso. Inc. 1995)

PHY-205: Basic Physics Laboratory II

Note: At least 4 experiments from each group and minimum, 10 experiments should be performed

Group A

1.Determination of Brewster's angle & estimation of refractive index of a given transparent material by using spectrometer and sodium lamp.
2. Study of normal Zeeman effect using LG plate.
3.Construction & study of Pb-Sn binary phase diagram from direct cooling curve of a particular composition and the given transition temperature data.
4. Determination of ionic conductivity & activation energy of NaCl/KCl solid specimen.
5. Hall effect: Determination of Hall coefficient, mobility and type of charge carriers.
6.To investigate the characteristics of radiation emitted by bodies at elevated temperatures (Black body radiation) and determine various constants.
7. Study of magneto resistance in semiconductors.
8. Determination of dielectric constant at high frequency by Lecher wire.
9.To determine Young's modulus of a metallic rod by Searle's optical interference method (Newton's Rings).
10.Audiometry of human using an audiometer.
11.Magnetic susceptibility by Guoy method.
12.Measurement of electrical conductivity of silicon/germanium material at different temperatures by Four Probe method.

Group B

1. Design, build & test square, triangular and sine wave generator using IC -741.
2. Build & test dual power supply using three pin regulators: 78XX and 79XX series.
3. Instrumentation amplifier with thermocouple transducer AD-590.
4. Capacitance measurement using IC 555
5. Design, Build and test Inductance simulation circuit using IC 741.
6. Design, build and test the DC to DC converter circuit.
7. Design, build & test Notch filter using IC-741
8. Study of voltage control oscillator using IC 566.
9. Study of optocoupler MCT 2E and their applications.
10.Active filters for bio-signals: design & testing.
11.Build and test temperature controller using Solid State Relay (SSR) and PT-100.

NOTE: This list is flexible; one can add any suitable experiment (of appropriate standard) from Physics with prior permission of BOS in Physics, NMU, Jalgaon