INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH THIRUVANANTHAPURAM

An autonomous institution under the

Ministry of Human Resource Development, Government of India

CURRICULUM AND SYLLABUS FOR THE FOUNDATION COURSES OF

THE BS-MS DUAL DEGREE PROGRAMME

Contents

Structure

FIRST FOUR SEMESTERS

FOUNDATION COURSES FOR FIRST TWO YEARS (4 SEMESTERS)

Semester –I						Semester -II					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
BIO 111	Biological Diversity and Evolution	3	1	0	3	BIO 121	Biological Structure and Function	3	1	0	3
CHY 111	Atomic Structure & Chemical Bonding	3	1	0	3	CHY 121	Concepts in Inorganic Chemistry	3	1	0	3
MAT 111	Single Variable Calculus	3	1	0	3	MAT 121	Introduction to Algebra	3	1	0	3
PHY 111	Mechanics	3	1	0	3	PHY 121	Electromagnetism	3	1	0	3
IDC 111	Mathematical Tools-I	2	0	2	3	IDC 121	Mathematical Tools-II	2	0	2	3
HUM 111	Communication Skills	1	0	0	1	HUM 121	Humanities	1	0	0	1
BIO 112	Biology Lab-I	0	0	3	1	BIO 122	Biology Lab-II	0	0	3	1
CHY 112	Chemistry Lab-I	0	0	3	1	CHY 122	Chemistry Lab-II	0	0	3	1
PHY 112	Physics Lab-I	0	0	3	1	PHY 122	Physics Lab-II	0	0	3	1
Total		**15**	**4**	**11**	**19**	**Total**		**15**	**4**	**11**	**19**
Cumulative Credits at the End of First Year: 38											
Semester -III						**Semester -IV**					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
BIO 211	Genetics	3	1	0	3	BIO 221	Cell Biology and Signaling	3	1	0	3
CHY 211	Basic Concepts in Organic Chemistry	3	1	0	3	CHY 221	Principles of Physical Chemistry	3	1	0	3
MAT 211	Multi Variable Calculus	3	1	0	3	MAT 221	Introduction to Probability and Statistics	3	1	0	3
PHY 211	Optics	3	1	0	3	PHY 221	Thermal &Statistical Physics	3	1	0	3
IDC 211	Physical Principles in Biology	3	1	0	3	IDC 221	Principles & Applications of Spectroscopy	3	1	0	3
HUM 211	Humanities	1	0	0	1	HUM 221	Humanities	1	0	0	1
BIO 212	Biology Lab-III	0	0	3	1	BIO 222	Biology Lab-IV	0	0	3	1
CHY 212	Chemistry Lab-III	0	0	3	1	CHY 222	Chemistry Lab-IV	0	0	3	1
PHY 212	Physics Lab-III	0	0	3	1	PHY 222	Physics Lab-IV	0	0	3	1
Total		**16**	**5**	**9**	**19**	**Total**		**16**	**5**	**9**	**19**
Cumulative Credits at the End of Second Year: 76											

Syllabus

THEORY COURSES

Biology Courses

BIO 111 Biological Diversity and Evolution [3103]

A. Overview of Biology: What is life?
B. Diversity of life: Scales in biology. Origin of life.
C. Principles of Evolutionary Biology: History of Evolutionary thought; Fundamental concepts (variation, selection, units of selection, adaptation); Genetic drift; Gene flow (Migration); Species (concepts, speciation); Introduction to Macroevolution; Phylogenetics, Tree of life, Convergent evolution, fossil record); Pattern and process in macroevolution (Adaptive radiations, mass extinctions, etc).
D. Principles of Ecology: Biomes, food webs, Community ecology (ecological succession, microhabitats, Niche, Species interactions); Population ecology (population characteristics, growth, metapopulations).
E. Behavioural ecology: Adaptive value of behaviour; Sexual selection; Sociality (altruism, cooperation, kin selection, reciprocal altruism, etc.); Optimal foraging theory; Mating systems, Parental care.
F. Conservation Biology: Taxonomy and Systematics; Measuring diversity; Global change; Biodiversity of India. In-situ and ex-situ conservation, Invasive Species, Island biogeography.

TEXTBOOKS

1. Molles, *Ecology: Concepts and Applications*
2. Futuyma, *Evolution*
3. Barton *et al.*, *Evolution*
4. Stearns and Hoekstra, *Evolution: An Introduction*
5. Nicholas Gotelli, *A primer of Ecology*
6. Begon *et al.*, *Ecology: From Individuals to Ecosystems*

BIO 121 Biological Structure and Function [3103]

A. Biological molecules and their structure and functions
B. Stabilizing interactions in biological molecules

C. Principles of biophysical chemistry (pH, reaction kinetics, thermodynamics)
D. An introduction to metabolic pathways
E. Biological catalysis, enzymes and kinetics, enzyme regulation
F. Basic physiological processes in plants and animals: Nervous system and sensory systems, muscles and movement, respiration and exchange of gases, heart and circulatory system, kidney and osmo-regulation, plant responses to light, flower development

TEXTBOOKS

1. Rodney F Boyer, *Concepts in Biochemistry*
2. Thomas Miilar, *Biochemistry Explained: A Practical Guide to Learning Biochemistry*
3. Lubert Stryer *et al.*, *Biochemistry*
4. David L Nelson, and Michael M Cox *et al.*, *Lehninger principles of biochemistry*
5. Richard Hill, Gordon Wyse, and Margaret Anderson, *Animal Physiology*, Third Edition
6. G Ray Noggle and, George J Fritz , *Introductory Plant Physiology*

BIO 211 Genetics [3103]

A. Introduction to genetics
B. Mendelian genetics: Mendel?s law and examples, Monohybrid and dihybrid cross, recessive and dominant mutation, concept of allele
C. Non-Mendelian genetics: incomplete dominance, semi-dominance, and introduction to epigenetics, Cytoplasmic inheritance, infection heredity
D. Genetic interactions: approach towards generating a network (epistasis, redundancy, synthetic lethality, lethal interactions)
E. Model organisms and studies on molecular and genetic interactions
F. Basics of Expression genetics, transcription, translation
G. Genome composition and organization, Cot analysis
H. Chromosome structure and function
I. Mitosis and Meiosis
J. DNA replication, Mutations

TEXTBOOKS

1. Anthony J F Griffiths *et al.*, *An Introduction to Genetic Analysis*

2. Watson *et al.*, *Molecular Biology of the Gene*
3. Jocelyn E Krebs *et al.*, *Lewin?s Genes*
4. Richard Kowles, *Solving Problems in Genetics*

BIO 221 Cell Biology and Signalling [3103]

A. Structure of prokaryotic and eukaryotic cells
B. Membrane structure and function
C. Structural organization and function of intracellular organelles
E. Cell division and cell cycle
F. Principles of signal transduction and role of secondary messengers (basic level)
G. Hormones and their receptors
H. Cellular communications
I. Signalling in cancer
J. Signalling in immune systems

TEXTBOOKS

1. Gerald Karp, *Cell Biology*
2. Wayne M. Becker *et al.*, *World of the Cell*
3. Bruce Alberts *et al.*, *Essential Cell Biology* 4th Edition
4. Richard Goldsby and Thomas J Kindt, *Kuby Immunology*

ChemistryCourses

CHY 111 Atomic Structure and Chemical Bonding [3103]

Atomic Structure: Recap of dual nature of radiation and matter, Bohr theory and Hydrogen atom spectra.

Introductory quantum mechanics for chemistry, quantization of energy and angular momentum, the Schroedinger equation, postulates of quantum theory, understanding of postulates via model problems, particle in a one dimensional box, probabilities and electron density.

Hydrogen atom, separation of variables, quantum numbers, orbitals and nodes. Approximations used for multi electron atoms, effective nuclear

charge, Slater's rule and qualitative description of SCF theory.

Chemical Bonding: Molecular symmetry, symmetry elements and classification of molecules to point groups.

General discussions on bonding, valence bond and molecular orbital theory, linear combination of atomic orbitals (LCAO) approach, Hybridization, molecular orbitals, normalization of molecular orbitals, overlap integral.

Bonding and anti-bonding orbitals, bonding in homonuclear diatomic systems, dihydrogen molecule-ion and dihydrogen molecule, homonuclear diatomic molecules of the second period, their energetics, bond orders, bond lengths and bond strengths.

Bonding in heteronuclear diatomic molecules (selected ones), polar bonds, electronegativity.

Photoelectron spectroscopy: Principle and application to simple spectra of diatomic molecules.

HMO theory, π conjugation, delocalization energy. Application of HMO theory to simple conjugated systems and aromaticity.

TEXTBOOKS/REFERENCES

1. P. W. Atkins and Julio de Paula, *Physical chemistry*, 8th Ed., Oxford University Press.
2. D. A. Mc Quarrie, *Quantum chemistry*, 2nd Ed.
3. J. Barrett, *Structure and bonding, Tutorial Chemistry Text*, Royal Society of Chemistry.
4. K. J. Laidler and J. H. Meiser, Physical chemistry, Indian Ed.

CHY 121 Concepts in Inorganic Chemistry [3103]

Periodic Trends in chemical elements: Basis for periodicity; Effective nuclear charge; Screening effect; Size of atoms and ions; Ionization energies; Electronegativity, Electron affinity; Diagonal relationships; Inert

pair effect; Lanthanide contraction; Fajan's rules.

Acids and Bases: Various theories of acids and bases; Brönsted acids and bases; Concepts of pH, pKa, pKb as applied in different chemical structures; Acidity and basicity of oxides; Lewis acidity; Hard and soft acids and bases, non aqueous solvents.

Redox Chemistry: Redox potential and stability; Electrode potentials; Nernst equation; Diagrammatic representation of electrochemical data; Applications of redox chemistry in the extraction of elements, corrosion, etc.

Simple Inorganic Solids: Ionic structures; close packing; Radius ratios; Energetics; Structures of NaCl, CsCl, Wurtzite; Solubility of ionic compounds.

Non-metal chemistry: Structures of compounds formed by s and p block elements including structures of elemental B, C, Si, P, S, Ge.

Transition Elements: Coordination compounds; Ligands; Nomenclature; Spectrochemical series of ligands; Crystal field theory; Splitting of d-orbitals in the presence of octahedral, tetrahedral and square planar crystal field; Low-spin and high-spin complexes; Application of CFT to explain color and magnetism in transition metal complexes.

Nuclear Chemistry: Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

TEXTBOOKS/REFERENCES

1. F. A. Cotton, G. Wilkinson and P. L. Gaus, *Basic Inorganic Chemistry*, 3rd Ed. (1995).
2. J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi, *Inorganic Chemistry: Principles and Reactivity* 4th Ed., Pearson Education, (2008).
3. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins, *Inorganic Chemistry* 4th Ed., Oxford University Press (2008).
4. B. Douglas, D. McDaniel and J. Alexander, *Concepts and Models in Inorganic Chemistry* 3rd Ed., Wiley (1994).

CHY 211 Basic concepts in organic chemistry [3103]

Use of arrows in organic chemistry, introduction to stereochemistry. Concept of chirality, Fisher projection formula, Newmann projection, and Sawhorse projection sequence rule, R and S notations in cyclic and acyclic compounds, optical isomerism of compounds containing one or more asymmetric carbon atoms, erythro, threo, and meso vs racemic mixture; Conformational analysis of ethane and butane.

Geometrical isomerism-E and Z notation of compounds with one and more double bonds in acyclic systems, inter conversion of geometrical isomers, stereochemistry of other classes of double bonded systems.

Electrophilic addition to the alkenes. Basicity, acidity, pKa.

Reactive intermediates: Formation, structure, stability and fate of various reactive intermediates (carbanion, carbocation).

Nucleophilic substitution at saturated carbons (S_N1, S_N2 and S_Ni): Types, stereochemical consideration, role of solvent, neighbouring group participation.

Elimination reactions: Types (E1, E2 and E1cB), stereochemical consideration, role of solvents, Hofmann rules, Zaytsev Rules, Bredt's rule, nucleophilic addition to the carbonyl group, nucleophilic substitution at the carbonyl group.

Electrophilic aromatic Substitution: Benzene and its reaction with electrophiles, Effect of functional groups.

Nucleophilic aromatic substitution: via addition elimination and elimination addition; diazonium compounds, benzyne mechanism.

TEXTBOOKS/REFERENCES

1. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, 6th Ed., Prentice Hall (1992).
2. J. Clayden, N. Greeves, S. Warren and P. Wothers, *Organic chemistry*, Oxford University Press (2000).

3. P. Sykes, *A guidebook to Mechanism in organic chemistry*, Addison-Wesley (1996).
4. M. B. Smith and J. March, *Advanced Organic Chemistry: reactions, mechanism and Structures*, 6th Ed., Wiley Interscience (2007).
5. F. A. Carey and R. J. Sundberg, *Advanced organic chemistry*.
6. Lowry and Richardson Lowry and Richardson, *Mechanism and Theory in Organic Chemistry*, 3rd Ed.

CHY 221 Principles of Physical Chemistry [3103]

Kinetic Theory of Gases: Revision of Gas Laws, Ideal Gas Equation of State; Kinetic Theory; Interpretation of Pressure; Velocity distribution; Maxwell's distribution of speed, average, most probable and rms speed. Gas effusion, molecular collisions and mean free path. Transport phenomena, diffusion, time evolution of concentration gradient.

Real Gases: Van der-Waals equation of state, virial equation of state, critical constants, liquefaction of a gas, compressibility factor, Boyle temperature, law of corresponding states, Fugacity.

Molecular Interactions: Electric dipole moment and molecular polarizability, interactions between molecules; ion-ion, ion-dipole, dipole-dipole, dipole-induced dipole, induced dipole-induced dipole, quadrupolar interactions, dispersion interactions and hydrogen bonding.

Review of Laws of Thermodynamics: Temperature, Energy and Enthalpy, Entropy, Gibbs Energy and Helmholtz energy, review of Maxwell's relations

Ideal and Real Solutions: Colligative properties (elevation of boiling point, depression of freezing point and osmotic pressure), binary solutions; Phase Diagrams: Phase rule and two component systems, phase stability and transitions, Clausius-Clayperon equation, liquid-vapour interface; Le-Chateliers principle, phase transformation of substances, chemical potential; vapour pressure diagram, temperature composition diagram, fractional, azeotropic and steam distillations and their importance in organic chemistry.

Gibbs energy of a reaction mixture. Expressing chemical equilibrium in terms of chemical potential, Gibbs free energy changes in chemical reaction, equilibrium constants.

Chemical Kinetics: Reactions of various orders, Arrhenius equation, collision theory, theory of absolute reaction rates, chain reactions, enzyme kinetics, fast reactions, photophysical and photochemical processes, catalysis and surface reactions.

Electrochemistry: Thermodynamic properties of ions in solutions, Debye Huckel theory, Nernst equation, standard electrode potential, electrochemical series, redox reactions, EMF and free energy.

TEXTBOOKS/REFERENCES

1. P. W. Atkins and Julio de Paula, *Physical chemistry*, 8th Ed., Oxford University Press.
2. K. J. Laidler and J. H. Meiser, *Physical chemistry*, Indian Ed.

Mathematics Courses

MAT 111 Single Variable Calculus [3103]

Properties of real numbers, the least upper bound and the greatest lower bound properties.

Limits of Sequences: Convergence and limit laws, suprema and infima of sequences, some standard limits, Subsequences.

Series: Finite and infinite series, sums of non-negative numbers, absolute and conditional convergence of an infinite series, tests of convergence, examples.

Continuous functions on the real line: Formal definition, continuity and discontinuity of a function at a point; left and right continuity, examples of continuous and discontinuous functions, the Maximum principle, intermediate value theorem, monotonic functions, uniform continuity, limits at infinity.

Differentiation of functions: Definition and basic properties, local maxima, local minima, and derivatives, monotone functions and derivatives, inverse functions and derivatives, Rolle's theorem, mean value theorem, Taylor's theorem.

Riemann Integration: Partitions, piecewise constant functions, upper and lower Riemann integrals, basic properties of the Riemann integral, Riemann integrability of continuous functions, monotone functions, and discontinuous functions, non-Riemann integrable functions, the fundamental theorems of calculus, the consequences of the fundamental theorems.

TEXTBOOKS

1. T. M. Apostol, *Calculus*, vol 1, 2nd ed., Wiley, 2007.
2. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 4th ed., Wiley, 2011.

REFERENCES

1. S. Lang, *A first course in Calculus*, 5th ed., Springer India, 2006.
2. W. Rudin, *Principles of Mathematical Analysis*, 3rd ed., McGraw Hill India, 1953.
3. M. Spivak, *Calculus*, Publish or Perish, 2008.
4. J. Stewart, *Calculus: Concepts and Contexts*, 3rd ed., Thomson Brooks/Cole, 2005
5. T. Tao, *Analysis I*, Hindustan Book Agency, 2006.

MAT 121 Introduction to Algebra [3103]

Linear Algebra: Fields, systems of linear equations, matrices and elementary row operations, row reduced echelon matrices, matrix multiplication, invertible matrices, rank of a matrix. Definition of a linear vector space and examples; linear independence of vectors, basis and dimension, subspaces; linear transformations, isomorphism, linear functionals; inner product, orthogonal basis, Gram-Schmidt orthogonalization process; linear operators; orthogonal and Hermitian matrices, eigenvectors of a matrix and matrix diagonalization, applications.

Group Theory: Definition and examples of groups, finite groups, abelian and cyclic groups, subgroups, functions and permutations, groups of permutations, cycles and cyclic notation, even and odd permutations, the alternating group, example of matrix groups.

TEXTBOOKS

1. L. N. Childs, *A Concrete Introduction to Higher Algebra*, Springer, 2009.
2. S. Kumaresan, *Linear Algebra : A Geometric Approach*, Phi Learning, 2009.

REFERENCES

1. M. Artin, *Algebra*, 2nd Edition, Addison Wesley,2010.
2. P. Halmos, *Finite Dimensional Vector Spaces*, Van Nostrand, Princeton, N.J, 1958.
3. I. N. Herstein, *Topics in Algebra*, 2nd Edition, Wiley and Sons, 1996.
4. K. Hoffman and R. Kunze, *Linear Algebra*, 2nd edition, Pearson Education, New Delhi, 2006.
5. S. Lang, *Undergraduate Algebra*, 3rd Edn.,Springer,2004
6. G. Strang, *Linear Algebra and its Applications*, 4th Edition, Brooks/Cole, India 2006.

MAT 211 Multivariable Calculus [3103]

Limits and continuity of functions of several variables: Definition, properties and examples. Differentiability: Partial derivatives, total differential, composite functions, chain rule, partial derivatives of higher order, change of variables, calculation of second order partial derivatives, Jacobians, directional derivatives, gradient and curl. Inverse and implicit function theorems (without proof), applications. Unconstrained maxima and minima, constrained optimization, Lagrange multipliers.

Leibniz's formula, Taylor's formula, Mean Value theorems.

Multiple Integrals: Double integrals on rectangular regions, conditions of integrability, properties of inte- grable functions, repeated or iterated integrals, double integrals over any finite region, change in the order of integration, Fubini-Tonelli Theorem (without proof), triple integrals over any bounded domain, evaluation of multiple integral by change of variables. Surface area, volume of a region. Theorems of Green, Gauss, and Stokes (without proof), applications.

TEXTBOOKS

1. T. M. Apostol, *Calculus*, vol. 2, 2nd ed., Wiley (India), 2007.
2. S. Lang, *Calculus of several variables*, 3rd ed., Springer 1987.

REFERENCES

1. V. Zorich, *Mathematical Analysis I*, Springer 2004.
2. V. Zorich, *Mathematical Analysis II*, Springer 2004.

MAT 221 Introduction to Probability and Statistics [3103]

Basic probability: Set operations, counting, finite sample spaces, axioms of mathematical probability, conditional probability, independence of events, Bayes' Rule, Bernoulli trials, Poisson trials, multinomial law, infinite sequence of Bernoulli trials.

Random variables and probability distributions: Discrete and continuous distributions and limit theorems: Binomial distribution, geometric distribution, Poisson distribution, normal distribution, exponential distribution, Gamma distribution, Beta distribution. Cumulative and marginal distribution functions. Transformation of random variables in one and two dimensions.

Mathematical expectations: Expectations for univariate and bivariate distributions, moments, variance, standard deviation, higher order moments, covariance, correlation, moment generating functions, characteristic functions. Central limit theorem, law of large numbers.

Linear Regression.

Hypothesis testing: Tests for means and variances, hypothesis testing and confidence intervals, goodness-of- fit tests, Kolmogorov-Smirnov goodness-of-fit test.

TEXTBOOKS

1. R. V. Hogg, J. McKean and A. T. Craig, *Introduction to Mathematical Statistics*, Pearson, 7th ed., 2012
2. S. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, 3rd ed., Elsevier, 2004.

REFERENCES

1. C. M. Grinstead and J. L. Snell, *Introduction to Probability*, 2nd ed., American Mathematical Society, 1997.
2. S. Ross, *A first course in Probability*, 8th ed., Prentice Hall, 2009.
3. S. Ross, *Introductory Statistics*, 2nd ed., Elsevier (India), 2006.
4. K.L. Chung, *Elementary Probability Theory*, 4th ed., Springer, 2003.

5. P. G. Hoel, S.C. Port and C.J. Stone,*Introduction to Probability Theory*, 1st ed, Houghton Mifflin, 1972.
6. W. Feller, *An Introduction to Probability Theory and its Applications*, Volume 1, 3rd ed., Wiley, 2008.
7. W. Feller, *An Introduction to Probability Theory and its Applications*, Volume 2, 2nd ed., Wiley, 2008.
8. R.G. Laha and V. K. Rohatgi, *Probability theory*, Wiley, 1979.

Physics Courses

PHY 111 Mechanics [3103]

Newton's Laws [3]:
Critical analysis of the Newton's laws, Concept of homogeneity and isotropy of space-time, symmetry, Concept of inertial, non inertial reference frames, Fictitious forces, Introduction to Galilean Relativity.

Motion in one dimension [6]:
Analytical solutions of EOMs, Conservation of momentum, Work energy theorem, Use of potential energy graphs to understand motion. Examples: Motion under gravity (rocket motion, block-pully systems); Simple harmonic oscillator and damped oscillator.

Motion in higher dimensions [8]:
Position vector and its derivatives. EOM in Cartesian and Polar Coordinates; Force as the gradient of potential energy; Conservation of angular momentum for a point particle; Examples: Projectile motion, Motion under central force, The Kepler problem.

Rigid bodies [8]:
Centre of mass; Rotational inertia, Momentum and Energy, Conservation laws, Moment of inertia-Examples with simple symmetric bodies. Torque and work energy theorem.

Non-inertial frames [3]:
Rotating reference frames and pseudo-forces;

Special Theory of Relativity [5]:
Measuring space-time in Galilean relativity; Michelson-Morley experiment, Postulates of special relativity, Lorentz transformation-Relativity of Simultaneity, Length contraction, Time dilation; Minkowski space-time diagram, Examples: Twin paradox, Doppler effect.

TEXTBOOKS

1. D. Kleppner and R. Kolenkow, *An introduction to Mechanics*, McGraw-Hill Science/ Engineering/ Math ,1973.

REFERENCES

1. Serway and Jewett, *Physics for Scientists and Engineers*, Brooks/Cole Publishers 2004.
2. C. Knight, W. D. Ruderman, M. A. Helmholz, C. A. Moyer and B. J. Kittel, *Berkeley Physics Course: Vol. I – Mechanics*, McGraw-Hill, 1965.
3. R. Shankar, *Fundamentals of Physics*, Yale Press.

PHY 121 Electromagnetic Theory [3103]

Electrostatics: Coulomb's law and Gauss's law Simple application; Differential form of the Gauss's law; Electrostatic potential, electrostatic energy Calculation for some simple cases;Conductors; Surface charges induced on a conductor; Solutions of Poisson's and Laplace's equations. Method of images; Solution by the method of separation of variables in cartesian and spherical polar coordinates; Potential due to an arbitrary charge distribution; Monopole and dipole terms; Electrical field and potential due to a point dipole; Dipole in an electric field.

Magnetostatics: Biot - Savart and Ampere's laws; Ampere's law in differential form; Magnetic vector potential; Determination of magnetic fields for simple cases. Energy in a magnetic field; Current electricity: Electromotive force.Ohm's law; Motional emf; Electromagnetic induction;Faraday's law; Self inductance and mutual inductance; Impedance; LCR circuit.

Electrodynamics: Maxwell's equations; Equation of continuity; Poynting's theorem; Electric and magnetic fields in matter; Fields D and H; Constitutive relations; Linear and nonlinear media; Electromagnetic Waves: EM waves in vacuum and in a dielectric medium; Boundary conditions on an interface; Reflection and transmission at an interface; Conducting surface.

TEXTBOOKS/REFERENCES

1. D. J. Griffths, *Introduction to Electrodynamics*, Prentice-Hall India, 2007.
2. E. M. Purcell, *Berkeley Physics course: Vol 2. Electricity and Magnetism*, McGraw Hill.

3. Serway and Jewett, *Physics for Scientists and Engineers*, Brooks/Cole Publishers, 2004.

PHY 211 Optics [3103]

What is light? [1]:
The corpuscular model and wave model, Particle nature of light and wave nature of matter.

Geometrical Optics [7]:
Fermat's Principle, Laws of reflection and refraction from Fermat's principle, Refraction at a Single Spherical Surface, The thin lens, Thin lens equation, Matrix method in paraxial optics, Thin lens combinations, Aberrations, Prisms, Optical Systems.

Wave Optics [12]:
Wave Motion, One dimensional waves, Harmonic Waves, Phase Velocity, Group Velocity of a wave packet, three-dimensional wave equation, Spherical waves, and cylindrical waves. Polarisation: The nature of polarized light, Polarizers, Malus law, Dichroism, Birefringence, Scattering and Polarization, Polarization by reflection, Brewster angle, Retarders; full-wave plate, half-wave plate, quarter-wave plate, Circular Polarizers, Polarization of Polychromatic light, Maxwell's equation, wave equation, Fresnel reflection coefficient, Total internal reflection, Optical fibre, single mode fibre, multimode fibre, evanescent wave.

Interference [7]:
The superposition principle, phasors and the addition of waves, Condition for interference, Coherence, Two beam interference by division of wavefront; Fresnel' Biprism, Interference by division of amplitude; interference by a plane parallel film, Newton's rings, Michelson interferometer, Multiple beam interferometry; Fabry-Perot interferometer.

Diffraction [7]:
Fresnel diffraction: Fresnel Half-period zones, The zone-plate, Diffraction by a straight edge, The Fresnel propagation, Fraunhofer approximation, Fraunhofer diffraction and Fourier optics: Single slit diffraction, Diffraction by a circular aperture, Two-slit Fraunhofer diffraction, N-slit Fraunhofer diffraction, The diffraction grating, Oblique incidence, X-ray diffraction.

TEXTBOOKS

1. Eugune Hecht and A. R. Ganesan, *Optics*, Addison Wesley Longman, 2002.
2. Francis A. Jenkins and Harvey E. White, *Fundamentals of Optics*, McGraw-Hill Higher Education, 4th Edition.

REFERENCES

1. Ajoy Ghatak, *Optics*, Tata Mgraw-Hill, 2009.
2. Frank S. Crawford, *Waves: Berkeley Physics Course Vol. 3*, Tata Mgraw Hill, 2008.

PHY 221 Thermal and Statistical Physics [3103]

Macroscopic description of the state, Extensive and intensive variables, Thermodynamic variables (pressure, temperature, etc), Thermal equilibrium, Equation of State, Zeroth Law of Thermodynamics. [3]

Temperature Scales; Work, Heat and Internal energy, Thermodynamic Processes (reversible, irreversible, quasi-static, adiabatic, isothermal, etc), First law of thermodynamics, Specific heat capacity, Enthalpy, Enthalpy, Joule Thomson experiment. Thermo-chemistry, Hess'Law. [8]

The Second Law of thermodynamics, Gasoline Engine, Carnot cycle and Kelvin temperature scale, Clausius' theorem, entropy and its physical interpretation, entropy change for simple processes. [8]

Thermodynamic functions (Helmholtz free energy, Gibbs free energy, etc), conditions of equilibrium, Maxwell's relations, Chemical potential. [4]

Equilibrium between two phases, general equilibrium conditions, the Clausius-Clapeyron equation, Stability conditions: Le-Chatelier's principle, phase transformation of substances, Third law of thermodynamics. [5]

Fluctuations and equilibrium, irreversibility and approach to equilibrium. Probability concepts-joint probabilities, binomial distribution, mean values, continuous distributions. Concept of ensembles and statistical postulates. Accessible states of an isolated system; association with it's equilibrium parameters and general thermodynamic concepts. [8]

TEXTBOOKS

1. M. W. Zemanski and R. H. Dittman, *Heat and Thermodynamics*, McGraw-Hill, 1997.

2. F. Reif, *Statistical Physics: Berkeley Physics Course Vol. 5*, Tata Mcgraw-hill, 2011.

REFERENCES

1. Daniel V. Schroeder, *An introduction to thermal Physics*, Addison- Wesley, 2000.
2. S. J. Blundell and K. M. Blundell, *Concepts in Thermal Physics*, Oxford, 2006.

Interdisciplinary Courses

IDC 111 Mathematical Tools I [2023]

Preliminary Topics:
Functions of several variables - partial differentiation. Cartesian, Spherical and Cylindrical coordinate systems: introduction and equivalence. Parametric representation of an equation. Introduction to Taylor's series with practical examples.

Mathematica Exercises: [4 weeks]
Introduction to MATHEMATICA. Importing/exporting formatted datasets. Plotting of functions and data in 2D, 3D; Plotting parametrically defined functions. Basic mathematical operations; symbolic differentiation of single and multi variable functions. Simple data fitting (e.g. polynomial, exponential functions etc), error estimation. Examples for Taylor series expansion, demonstration of convergence. Programming in MATHEMATICA, debugging and execution.

Vector Analysis:
Review of vector algebra: addition, subtraction and product of two vectors - polar and axial vectors with examples; triple and quadruple product. Concept of Scalar and Vector fields. Differentiation of a vector w.r.t. a scalar unit tangent vector and unit normal vector. Directional derivatives - gradient, divergence, curl and Laplacian operations and their meaning. Concept of line, surface and volume integrals. Statement of Gauss' and Stokes' theorems with physical examples. Gradient, divergence and curl in spherical polar and cylindrical coordinate systems.

Mathematica Exercises: [4 weeks]
Plotting vectors in 3D; algebraic operations, span and linear independence. Visualizing the plane determined by two vectors; determining the

unit normal from vector product. Obtaining equation of the plane and parametric representation of the same. Plotting a system of simple contours and surfaces as a visual representation of scalar fields. Determining the gradient of a scalar field and graphical representation of the gradient as vectors. Visualization of various types of vector fields (divergent, rotational etc.) in 2D and 3D. Determination of divergence and curl of vector fields and their graphical representation. Real life scalar (temperature) and vector fields (static and rotating garden sprinkler, liquid vortex) and practical applications of the gradient, divergence and curl.

Fourier Series:
Fourier expansion of a periodic functions.

Mathematica Exercise: [1 week]
Demonstration of Fourier series representation for simple waveforms (e.g. Square, triangular, saw tooth).

Complex numbers and functions:
Arithmetic operation, conjugates, modulus, polar form, powers and roots; Derivative;

Mathematica Exercise: [1 week]
Algebraic Manipulation of complex functions.

TEXTBOOKS

1. E. Kreyszig, *Advanced Engineering Mathematics*, 8th Edition Wiley India Pvt Ltd, 2006.
2. Murray R. Spiegel, *Schaum's Outlines Vector Analysis*, Tata Mcgraw Hill 2009.
3. Murray R. Spiegel, *Schaum's Outlines Fourier Analysis with Applications to Boundary Value Problems*, Tata Mcgraw Hill 2006.
4. Murray R. Spiegel, Seymour Lipschutz, John Schiller, Dennis Spellman, *Schaum's Outlines Complex Variables*.
5. Stephen Wolfram, *The MATHEMATICA Book*, 5th Edition.

IDC 121 Mathematical Tools II [2023]

Matrices:
Revision of Matrices, Matrix operations, Hermitian adjoint and inverse of a matrix; Hermitian, orthogonal, and unitary matrices; Eigenvalue and eigenvector (for both degenerate and non-degenerate cases); Similarity transformation; diagonalisation of real symmetric matrices.

Matlab/Octave/Python Hands-ON Exercises: [4 weeks]
Introduction to MATLAB/Octave/Python. Data handling. Basic Plotting 2D and 3D. 2D Matrix operations and manipulation; Addition, subtraction, inverse, transpose, multiplication, element by element operations. Check whether given matrix is symmetric, hermitian, unitary, orthogonal, antisymmetric, singular. Diagonalisation and Eigenvalue problem. Regression Analysis.

Ordinary Differential Equations:
First order differential equations: Basic concepts and ideas; separable differential equations, Integrating factors, linear differential equations; Second order linear differential equations homogeneous equations with constant coefficients, Linear Independence of solutions-Wronskian, Non-homogeneous equations general solution. System of Linear ODEs.

Matlab/Octave/Python Hand-ON Exercises: [6 weeks]
Numerical differentiation. Euler's method to solve ODEs. First ODE Examples: Free particle under gravity, Evolution of chemical concentration in a reaction, Motion in viscous media/magnetic field Second ODE Examples: Harmonic oscillator with/without damping. First order coupled ODE: Predator-Prey problem. Solution of a system of linear ODE.

TEXTBOOKS

1. E. Kreyszig, *Advanced Engineering Mathematics*, 8th Edition Wiley India Pvt Ltd, 2006.
2. Richard Bronson, Gabriel Costa, *Schaum's Outlines Differential Equations*, 3rd Edition Mcgraw-hill 2009.
3. C. Edwards and D. Penny, *Elementary Differential Equations with Boundary Value Problems*, 5th Edition Prentice Hall 2007.

IDC 211 Physical Principles in Biology

A. Physical biochemistry of the cell: Chemical forces translation and rotation, diffusion, directed movements, bio-molecules as machines, work, power and energy, thermal, chemical and mechanical switching of biomolecules, Responses to light and environmental cues
B. Physical principles of molecular structure: organization of biomolecules, molecular census in size and time, macromolecular assemblies, sizing up HIV, channels, transporters and motors
C. Molecular recognition: principles of specificity in biological recogni-

tion, hormone-receptor interaction, antigen-antibody interaction, transient interactions, importance of transient interaction in biology.
D. Linearity and non-linearity in biological systems : Definitions and example of linear and non-linear systems. Representing linear and non-linear functions and applications (3-4 lectures)
E. Stochasticity in Biological systems (3-4 lectures)

TEXTBOOKS

1. John Kuriyan, *The Molecules of Life : Physical and Chemical Principles*
2. Rob Phillips *et al.*, *Physical Biology of the Cell. Garland Science*
3. Peter Atkins and Julio de Paula, *Physical Chemistry for the Life Sciences*

IDC 221 Principles and Applications of Spectroscopy [3103]

Introduction: Electromagnetic radiation, absorption, emission and scattering, Einstein A and B coefficients, lasers, basic elements of practical spectroscopy, signal to noise ratio, resolving power; Atomic Spectroscopy: Spectra of hydrogen atom, many electron atoms, coupling of orbital and spin angular momenta, term symbols, fine and hyperfine structure, Zeeman and Stark effects.

Rotational Spectroscopy: Rigid rotor as a model system for rotations, rotational angular momentum, energy levels, selection rules, structure determination from rotational constants, isotope effects.

Vibrational Spectroscopy: Morse oscillator, Harmonic oscillator as a model system for vibrations, diatomic molecules, vibrational selection rules, dissociation energies.

Raman Spectroscopy: Light scattering and Raman effect, classical model for scattering, Stokes and anti-Stokes lines, polarizability.

Spin Resonance Spectroscopies: nuclear spin and electron spins, effect of applied external fields, Nuclear Magnetic Resonance (NMR) spectroscopy, Electron Spin Resonance (ESR) spectroscopy, basic principles and examples.

Mössbauer Spectroscopy: Principles and applications.

TEXTBOOKS/REFERENCES

1. J. Michael Hollas, *Modern Spectroscopy*, John Wiley & Sons.
2. C. N. Banwell and E M McCash, *Fundamentals of molecular spectroscopy*.

Humanities Syllabus

Institute will offer some of the humanities courses from the list below from time to time.

Introduction to Psychology

Psychological Science- Assumptions, schools, methods of doing psychology research, The relationship between brain, body and mental functioning, Sensation, perception and making sense of the world, Consciousness, Life span development and motor and language development, Nature and nurture controversy, The learning process and some important explanations of how we learn, Meaning of motivation and explanations, Theories of emotions and expression and regulation of emotions, Basic cognitive processes, Language development, why we remember and why we forget- some explanations, Different kinds of intelligence, explanations of creativity, Differences among individuals and explanations for personality differences, Application of psychology to everyday life- enhancing health and well-being, performance, social relations, and sensitivity to environmental, social and cultural contexts.

Theories of Personality

Personality: Meaning & Assessment. Psychoanalytic & Neo-Psychoanalytic Approach ; Behavioural Approach; Cognitive Approach; Social- Cognitive Approach; Humanistic Approach; The Traits Approach; Models of healthy personality: the notion of the mature person, the self-actualizing personality etc. Personality disorders; Psychotherapeutic techniques and Yoga & Meditation; Indian perspective on personality; Personality in Socio-cultural context.

Environment, Development and Society

Students will be exposed to contemporary themes and debates on connection between environment, development, and society; industrialization and risk society; challenge of sustainable development; perception of the environment, dependence for livelihood, identity, and power on natural resources; social ecology; what is the role of religion in determining our world view and relation with the environment?; recognition of indigenous knowledge; rise of environmental movements, development projects and recent conflict over natural resources; understanding major environmental disasters and industrial accidents; global climate change negotiations; gender and environment.

Introduction to Sociology

The course will introduce students to the study of sociology and some basic underpinnings of sociological theory and methodology. The emergence of sociology as a scientific discipline is examined in the context of the development of Industrial society in Western Europe. The course will examine the writings of key classical social thinkers such as Marx, Durkheim and Weber as well as more contemporary theorists such as Michel Foucault, with a view to understanding various sociological approaches to modern industrial society

Science, Technology and Society

The course will begin with social theories on the production of technology and scientific knowledge systems, stratification within the community of technologists and scientists, discrimination (race, class, gender, caste) and the role of power in shaping the production of technology and scientific knowledge. Scientific controversies, both historical and emerging, and the organization of innovation and its geographies will be discussed. Case studies exploring ethical questions arising from new technologies such as information technology, nanotechnologies, biotechnologies, etc. will be used. Discussions on public understanding of science and role of the public and of experts in influencing policies related to science and technology will conclude the course.

Introduction to Logic

In this course, students are introduced to fundamentals of informal logic and verbal analysis, material and formal fallacies of reasoning often found ordinary discourse, deductive and Inductive reasoning, validity and soundness, formal rules and principles of the deductive system of Aristotelian logic, traditional square of opposition; propositional calculus; first order predicate calculus; the modern square of opposition and the problem of existential import; identity and definite descriptions; methods for formulating natural language arguments in symbolic forms and techniques for checking their validity; various meta-logical theorems and their proofs.

Introduction to Philosophy

What makes philosophical thinking radically critical? Investigation of the nature of knowledge about the world and justification of knowledge claims. Metaphysical understanding of the Absolute and Mind-Body relation. The nature of ethical and aesthetic beliefs and attitudes as part of understanding the nature of values. The discussion of the above issues will be influenced by three philosophical orientational perspectives: Anglo-American Analytic, Continental Phenomenological and Classical Indian.

Philosophy of Mind

An appreciation of how the fundamental mental concepts are essentially amenable to philosophical sense over and above their usual psychological understanding and analysis. To explain why our mental conceptual scheme does not easily admit of their reduction to physical conceptual scheme. To reflect on whether mentally endowed human person differ, ontologically, from the rest of nature

Philosophy of Science

Science is regarded as the most significant cognitive enterprise of the modern society. In view of this, the course addresses the question what sets science apart from other epistemic activities. Further It concentrates on debates on the nature of scientific methods, logical reconstruction of

scientific explanation, the relation between theories and laws on the one hand, and empirical evidence on the other, the nature of the justification and the notion of truth involved in scientific knowledge, and the societal influence on scientific practice.

Communication Skills (Advanced Level)

Introduction to major grammatical models. Phonological and syntactical structure of present- day English. Language of science and technology. Aspects of style. Some common errors. Technical presentations design and delivery. Audio Visuals in communication. Collecting materials for research. Organization of research paper/dissertation

Introduction to Economics

What is Economics? Scarcity, choice and economic systems; Supply and demand; elasticity of demand; Comparative advantage and international trade; Consumer choice; Consumer theory with indifference curves; Production and cost; How firms make decisions: profit maximization; Perfect competition;Monopoly and imperfect competition; Economic efficiency and the role of government;Labor markets and wages; Introduction to macroeconomics; Production, income and employment; The monetary system, prices and inflation; Economic growth & rising living standards;Economic Fluctuations; The banking system, the Fed & monetary policy; Aggregate demand and aggregate supply

Planning and Economic Development (Advanced Level)

Economic growth. Economic development. Historic growth and contemporary development. Lessons and controversies. Characteristics of developing countries. Obstacles to development. Structural changes in the process of economic development. Relationship between agriculture and industry. Strategies of economic development. Balanced/ Unbalanced growth. International trade and economic development. Population. Planning for economic development. Use of input-output model and linear programming techniques in planning. Indian plan experience. Strategy of Indian planning. Indian plan models.

International Economics

Basic concepts of national income accounting, money, and balance of payments; output and exchange-rate determination under fixed and flexible exchange-rate regimes; fiscal and monetary policies in an open economy; international capital movements and their impacts; Case Studies: East Asian crisis, global financial crisis; theories of international trade including factor-proportions and economies of scale; the international trading regime and its implications for developing countries.

Industrial Economics

Basic concepts: Plants, firm and industry. Market structure. Economics of scale and optimum firm size. Pricing under alternative market structures. Market power and concentration. Integration, diversification and merger. Behavioural and managerial theories of the firm, growth of the firm. Industrial productivity and its measurement. Industrial location. Input- output analysis. Project appraisal and capital budgeting. Industrialisation and economic development. Problems of industrialisation in India. Role of public and private sectors. Growth of small-scale industries and their problems. Government regulation of industry. Balanced regional development.

Applied Game Theory

This module introduces students in economics and other social sciences to game theory, a theory of interactive decision making. This module provides students with the basic solution concepts for different types of non-cooperative games, including static and dynamic games under complete and incomplete information. The basic solution concepts that this module covers are Nash equilibrium, subgame perfect equilibrium, Bayesian equilibrium, and perfect Bayesian equilibrium. This module emphasizes the applications of game theory to economics, such as duopolies, bargaining, and auctions.

LABORATORY COURSES

Biology

BIO 112 BIO LAB-I

Semester-long group projects designed to expose students to: A. The concept of hypothesis testing
B. Designing simple experiments to test the hypothesis
C. Data analysis and interpretation of results
D. Oral presentation of the study
E. Report writing

BIO 122 BIO LAB-II

A. Plant and animal cells under a microscope
B. Structure and function of plant tissues
C. Buffer preparation, PI value analysis of proteins
D. Quantitative analysis of biomolecules
E. Analysis of light reaction of photosynthesis by DCPIP method
F. Estimation of water potential in plant tissues
G. Protein profile by SDS-PAGE

BIO 212 BIO LAB-III

A. Mutation frequencies, fluctuation tests
B. Analyze data from crosses: theoretical problem solving
C. Mitosis
D. Meiosis
E. DNA isolation and quantification
F. Agarose gel electrophoresis

BIO 222 BIO LAB-IV

A. Cell fractionation (nuclear, mitochondrial, cytosolic)
B. Enzyme assays for mitochondrial proteins
C. Tubulin blockers or mitotic inhibitors to assess effects on proliferation
D. Image analysis

Chemistry

CHY 112 Chemistry Lab I [0031]

1. Qualitative inorganic salt analysis containing two anions and two cations (5 mixtures)
2. Inorganic preparations: (a) Preparation of potash alum from scrap aluminium (b) Preparation of hexamine Ni(II) chloride (c) Preparation of tetramine Cu(II)sulphate
3. Organic preparations: (a) Preparation of paracetamol (b) Preparation of aspirin
4. Introduction to Chromatography: (a) Separation of metallic ions using paper chromatography (b) Separation of plant extracts using thin layer chromatography
5. Introduction to colorimetry using photoelectric colorimeter: (a) Estimation of iron (b) Estimation of chromium (c) Estimation of nickel and (d) Estimation of phosphate in cola drinks
6. Introduction to titrimetric analysis (acidimetry and alkalimetry): Estimation of antacid capacity of antacid

CHY 122 Chemistry Lab II [0031]

1. Permanganometry: (a) Estimation of hydrogen peroxide, nitrite and checking the purity of potassium nitrate (b) Estimation of Calcium.
2. Dichrometry: (a) Estimation of ferrous and ferric iron using N-Phenyl anthranilic acid indicator (b) Estimation of Zinc using potassium ferrocyanide.
3. Iodometry: (a) Estimation of barium (b) Estimation of copper (c) Estimation of dissolved oxygen and (d) Estimation of available chlorine in bleaching powder
4. Iodimetry: Estimation of ascorbic acid in fruit juice.
5. Argentometry: (a) Estimation of chloride ion using Morh's and Volhard's methods (b) Estimation of potassium bromide using adsorption indicator.
6. Complexometry: (a) Estimation of calcium in milk powder (Eriochrome black T indicator) (b) Estimation of hardness of water (Eriochrome black T indicator) (c) Estimation of calcium and magnesium using Patton and Reeders indicator (d) Estimation of copper using fast sulphon

black indicator (e) Estimation of zinc and magnesium using (Eriochrome black T indicator) (f) Estimation of nickel using Eriochrome black T indicator and murexide indicator.
7. Gravimetric Analysis: (a) Estimation of barium/sulphate as barium sulphate (b) Estimation of iron as ferric oxide.

CHY 212 Chemistry Lab III [0031]

1. Determination of melting and boiling points.
2. Purification of organic compounds by crystallization.
3. Identification of organic functional groups (5 compounds).
4. Single stage preparations including nitration, acetylation, benzoylation, bromination, oxidation etc.
5. Two stage preparations: (a) conversion of acetanilide to p-bromoaniline (b) conversion of acetanilide to p-nitroaniline (c) conversion of nitrobenzene to m-nitroaniline.
6. Organic estimations: (a) Estimation of phenol/ aniline (b) Estimation of glucose (c) Estimation of ester (d) Saponification value of oil (e) Iodine value of oil.

CHY 222 Chemistry Lab IV [0031]

1. Phenol water system:
   Determine the mutual solubility curve of phenol and water and hence the consolute point.
   Determine the critical solution temperature of phenol and water in presence of (i) 1% of sodium chloride (ii) 0.5% of naphthalene and (iii) 1% succinic acid. Determination concentration of aqueous solution of KCl by study-ing mutual solubility of phenol and water.

2. Distribution Ratio:
   Determine the distribution coefficient of iodine between an organic solvent such as carbon tetrachloride, carbon disulphide, kerosene etc. and water at a given temperature
   Determine the equilibrium constant of the reaction KI +I_2 $\Rightarrow$$KI_3$ by distribution method
   Study the distribution of benzoic acid /succinic acid between toluene and water

Determine the formula of the complex ion formed between the cupric ion and ammonia by distribution method

3. Solid liquid equilibrium:
   Determination of molal depression constant of naphthalene Determination of molecular weight of solute

4. Transition temperature:
   Determination of transition temperature of a salt hydrate
   Determination of transition temperature coefficient of a salt hydrate
   Determination of molecular weight

5. Three component system
   (a) Construction of the triangular phase diagram of acetic acid, chloroform and water
   (b) Construction of the tie line
   (c) Determination of the composition of the given mixture

6. Chemical kinetics
   Clock Reaction: Study of clock reaction and determination of the factors affecting a reaction
   Determination of the rate constant of hydrolysis of methyl acetate catalyzed 0.5M hydrochloric acid
   Determination of the rate constant of the hydrolysis of ester by sodium hydroxide reaction

7. Conductometric titration
   Conductometric titration of Strong acid>< Strong base
   Strong acid >< Weak base Weak acid >< Strong base Precipitation titration

8. Estimation using conductometric titrations
   Mixture of hydrochloric acid and acetic acid Mixture of hydrochloric acid and oxalic acid Mixture of acetic acid and oxalic acid
   Mixture of sulphuric acid, acetic acid and copper sulphate

Physics

PHY 112 Experiments in Mechanics [0031]

a. Simple pendulum & variable g pendulum
b. Conservation of energy
c. Conservation of momentum & ballistic pendulum
d. Centripetal force
e. Symmetric compound bar pendulum
f. Projectile motion
g. Melde's string
h. Sonometer
i. Newton's laws of Motion
j. Moment bar

PHY 122 Experiments in electrodynamics [0031]

a. Potentiometer-internal resistance of a cell
b. Magnetic field along the axis of a circular coil
c. Conversion of galvanometer to voltmeter
d. Deflection magnetometer
e. Zener regulator
f. Characteristics of pn junction diode and verification of truth tables for 'and' and 'or' gates
g. Full wave rectifier with and without filters
h. Electronic circuit using computer interface
i. Ballistic galvanometer absolute capacity of a capacitor
j. Spot galvanometer- high resistance by leakage

PHY 212 Experiments in Optics [0031]

a. Convex lens
b. Concave mirror
c. Spectrometer-refractive index of prism
d. Spectrometer-Grating
e. Newton's rings
f. Diffraction at slits-single and double
g. Liquid lens

h. Reflection grating
i. Malu's law
j. Spectrometer- (i-d curve)

PHY 222 Experiments on Heat and Thermodynamics [0031]

a. Newton's law of cooling
b. Specific latent of steam
c. Thermal conductivity of rubber
d. Specific heat capacity of solid-method of mixtures
e. Joule's calorimeter-specific heat capacity of liquid
f. Thermal conductivity-Lee's disc
g. Potentiometer-thermo e m f
h. Stefan's constant
i. Latent heat of fusion of ice
j. P V Diagram