COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

PHYSICS HONOURS

Choice Based Credit System(CBCS)

First & Second Semester Examination – 2020-21

Third & Fourth Semester Examination – 2021-22

Fifth & Sixth Semester Examination – 2022-23

GOVERNMENT AUTONOMOUS COLLEGE, PHULBANI, KANDHAMAL

SYLLABI FOR CBCS COURSE

Sem	CORE COURESE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	AECC-I			GE-1A
	CORE-II				
II	CORE-III	AECC-II			GE-1B
	CORE -IV				
III	CORE-V		SECC-II		GE-2A
	CORE-VI				
	CORE-VII				
IV	CORE-VIII		SECC-I		GE-2B
	CORE-IX				
	CORE-X				
V	CORE-XI			DSE-I	
	CORE-XII			DSE-II	
VI	CORE-XIII			DSE-III	
	CORE-XIV			DSE-IV / Project	

YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

Yr.	Sl.No.	Course Structure	Code	Credit Points
		Three-Year (6-Semester) CBCS Programme (B.Sc. Hons) (Physics Honours)		
		SEMESTER-I		
FIRST YEAR	1	Mathematical Physics-I	C-1.1	4+2
	2	Mechanics	C-1.2	4+2
	3	Chemistry	GE-1.3	4+2
	4	EVS	AECC-1.4	6
		SEMESTER-II		
	5	Electricity and Magnetism	C-2.1	4+2
	6	Waves and Optics	C-2.2	4+2
	7	Mathematics	GE-2.3	4+2
	8	MIL Communication – Odia / MIL (AE)	AECC-2.4	6
		SEMESTER-III		
SECOND YEAR	9	Mathematical Physics-II	C-3.1	4+2
	10	Thermal Physics	C-3.2	4+2
	11	Analog Systems and Applications	C-3.3	4+2
	12	Chemistry	GE-3.4	4+2
	13	Quantitative & Logical Thinking	SECC-II-3.5	6
		SEMESTER-IV		
	14	Mathematical Physics-III	C-4.1	4+2
	15	Elements of Modern Physics	C-4.2	4+2
	16	Digital Systems and Applications	C-4.3	4+2
	17	Mathematics	GE-4.4	4+2
	18	Communicative English	SECC-I-4.5	6
		SEMESTER-V		
FINAL YEAR	19	Quantum Mechanics & Applications	C-5.1	4+2
	20	Solid State Physics	C-5.2	4+2
	21	Classical Dynamics	DSE-5.3	6
	22	Nuclear and Particle Physics	DSE-5.4	6
		SEMESTER-VI		
	23	Electro-magnetic Theory	C-6.1	4+2
	24	Statistical Mechanics	C-6.2	4+2
	25	Nano Materials and Applications	DSE-6.3	6
	26	Project Work / Basic Instrumentation	DSE-6.4	6 / 4+2

Notes:
- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- SECC- Skill Enhancement Compulsory Course
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours

SEMESTER-I

C-1.1 : MATHEMATICAL PHYSICS-I

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

UNIT-I

Calculus-I: Plotting of functions, Intuitive ideas of continuous, differentiable functions and plotting of curves, Approximation: Taylor and binomial series (statements only), First Order Differential Equations and Integrating Factor, Second Order Differential equations: Homogeneous Equations with constant coefficients, Wronskian and general solution, Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral.

UNIT-II

Calculus-II: Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration, Constrained Maximization using Lagrange Multipliers,

Vector algebra: Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations, Vector product, Scalar triple product and their interpretation in terms of area and volume respectively, Scalar and Vector fields.

UNIT-III

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates, Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems, Comparison of velocity and acceleration in cylindrical and spherical coordinate system

Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular Function, Properties of Dirac delta function.

UNIT-IV

Vector Differentiation: Directional derivatives and normal derivative, Gradient of a scalar field and its geometrical interpretation, Divergence and curl of a vector field, Del and Laplacian operators, Vector identities

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)

Text Books:
1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris (2013,7th Edition., Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India), 2008

Reference books:
❖ Mathematical Physics C. Harper (Prentice Hall India), 2006
❖ Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition , Mc-Graw Hill Education)
❖ Complex variables and applications, J. W. Brown and R.V. Churchill Mathematical Physics, Satya Prakash (Sultan Chand)
❖ Mathematical Physics, B. D. Gupta (4th edition, Vikas Publication), 2009
❖ Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan), 2009
❖ Mathematical Physics–H.K. Dass, Dr. Rama Verma (S. Chand Publishing) , 2011

PRACTICAL

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.
• Highlights the use of computational methods to solve physical problems
• The course will consist of lectures(both theory and practical)in the Lab
• Evaluation done not on the programming but on the basis of formulating the problem
• Aim at teaching students to construct the computational problem to be solved
• Students can use any one operating system Linux or Microsoft Windows

Introduction and Overview: Computer architecture and organization, memory and Input/output devices.

Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow and overflow emphasize the importance of making equations in terms of dimension less variables, Iterative methods. Algorithm

Errors and error Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations. Systematic and Random Errors, Propagation of Errors, Normal Law of Errors, Standard and Probable Error.

Review of C and C++ Programming: Introduction to Programming, constants, variables and Fundamentals data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (If Statement, If else Statement, Nested If structure, Else If Statement, Ternary operator, Go to Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D and 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects

Programs: Sum and average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search,

Random number generation: Area of circle, area of square, volume of sphere, value of π and applications in physics lab.

Reference Books:
- ❖ Introduction to Numerical Analysis, S.S. Sastry, 5th Edition, 2012, PHI Learning Pvt. Ltd.
- ❖ Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw–Hill Pub.
- ❖ Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edition. 2007, Cambridge University Press.
- ❖ A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning.
- ❖ Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- ❖ Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- ❖ An Introduction to computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press.

C-1.2 : MECHANICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I

Rotational Dynamics: Centre of Mass, Motion of CoM, Centre of Mass and Laboratory frames, Angular Momentum of a particle and system of particles, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of Inertia, Perpendicular and Parallel Axis Theorems, Routh Rule, Calculation of moment of inertia for cylindrical and spherical bodies, Kinetic energy of rotation, Eulers Equations of Rigid Body motion, Motion involving both translation and rotation. Moment of Inertia of a Fly wheel.

Non-Inertial Systems: Non-inertial frames and fictitious forces, Uniformly rotating frame, Laws of Physics in rotating coordinate systems, Centrifugal force, Coriolis force and its applications.

UNIT-II

Elasticity: Relation between Elastic constants, Twisting torque on a Cylinder or Wire, Bending of beams, External bending moment, Flexural rigidity, Single and double cantilever Surface Tension: Excess pressure across a curved membrane, Quink's drop

Fluid Motion: Kinematics of Moving Fluids: Poiseuilles Equation for Flow of a Liquid through a Capillary Tube, Surface tension, Gravity waves and ripple

Viscocity: Poiseuilles Equation for Flow of a Liquid with corrections.

UNIT-III

Gravitation and Central Force Motion: Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution, Differential Equation of motion with central force and its solution, The first Integrals (two), Concept of power Law Potentials, Keplers Laws of Planetary motion, Satellites: Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS), Physiological effects on astronauts.

UNIT-IV

Oscillations: Simple Harmonic Oscillations. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Equation of motion and solution (cases of oscillatory, critically damped and over damped) Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Bar Pendulum, Katers Pendulum

Special Theory of Relativity: Michelson-Morley Experiment and its out-come, Postulates of Special Theory of Relativity, Lorentz Transformations, Simultaneity and order of events, Lorentz contraction, Timedilation, Relativistic transformation of velocity, Frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity, Massless Particles, Mass-energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics, Transformation of Energy and Momentum.

Text Books:
1. Mechanics, D.S. Mathur, PS Hemne (S. Chand Publishing), 2012
2. Introduction to Special Relativity, R. Resnick (John Wiley), 2007

Reference Books:
❖ Introduction to Mechanics Daniel Klapnner and Robert Kolenkow, McGraw Hill.2007
❖ Mechanics by K.R Simon, 1971
❖ Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, etal (Tata McGraw-Hill), 2007
❖ Physics, Resnick, Halliday and Walker (8/e.2010, Wiley)
❖ Theoretical Mechanics-M.R. Spiegel (Tata McGraw Hill), 2017
❖ Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands (Pearson), 2012
❖ Mechanics-M. Das, P.K. Jena and R.N. Mishra (Srikrishna Publications), 2009

PRACTICAL

(Minimum 5 experiments are to be done) :
1. To study surface tension by capillary rise method
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuilles method).
6. To determine the Modulus of Rigidity of a Wire by Maxwells needle.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum

Reference Books:
❖ Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
❖ Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
❖ A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Edn, 2011, Kitab Mahal

GE-1.3 : ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

SECTION A: INORGANIC CHEMISTRY-I

UNIT-I : Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrodinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Quantum numbers and their significance, shapes of s, p and d atomic orbitals, nodal planes.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbital, Anomalous electronic configurations.

UNIT-II : Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics, energy considerations. Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules and its applications.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, NO). Comparison of VB and MO approaches.

SECTION B: ORGANIC CHEMISTRY-I

UNIT- III : Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive effect, Electrometric effect, Resonance and hyperconjugation. Cleavage of bonds: Homolysis and heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Huckel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). D and L; cis-trans nomenclature; CIP Rules: R / S (for one chiral carbon atoms) and E / Z Nomenclature (for up to two C=C systems).

UNIT-IV : Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Up to 5 Carbons) *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Up to 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis-alkenes (Partial catalytic hydrogenation) and trans-alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

Alkynes: (Up to 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis.

Recommended Text Books :
1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5th Edn., 2008.
2. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd Ed., 2017.
3. Shriver D. E., Atkins P. W., Inorganic Chemistry, Oxford University Press, 5th Edn.
4. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, Pearson Education, 4th Ed. 2002.
5. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Bhal Arun & Bhal B S., Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
7. Kalsi, P. S. Stereochemistry Conformation and Mechanism; 8th Edn, New Age International, 2015.

Reference books :
❖ Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.
❖ Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.
❖ Mallick, Madan and Tuli, S. Chand Selected Topic in Inorganic Chemistry, 17thEdn. 2010.
❖ Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications.

PRACTICAL

SECTION A: INORGANIC CHEMISTRY
Volumetric Analysis
a. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
b. Estimation of oxalic acid by titrating it with $KMnO_4$.
c. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
d. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
e. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.

SECTION B: ORGANIC CHEMISTRY
a. Detection of extra elements (N, S, Cl) in organic compounds (containing up to two extra elements)
b. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   i. Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.
   ii. Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:
❖ Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
❖ Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
❖ Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

AECC-1.4 : ENVIRONMENTAL STUDIES

Full Marks – 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

UNIT – I

The Environment: The Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecology, Ecosystem, Biogeochemical Cycle (Carbon Cycle, Nitrogen Cycle), Environment Pollution: Air Pollution, Water Pollution, Soil Pollution, Radiation Pollution

UNIT – II

Population Ecology: Individuals, Species, Pollution, Community, Control Methods of Population, Urbanization and its effects on Society, Communicable Diseases and its Transmission, Non-Communicable Diseases

UNIT – III

Environmental Movements in India: Grass root Environmental movements in India, Role of women, Environmental Movements in Odisha, State Pollution Control Board, Central Pollution Control Board

UNIT – IV

Natural Resources: Conservation of Natural Resources, Management and Conservation of Wildlife, Soil Erosion and Conservation, Environmental Laws: Water Act, 1974, Air Act, 1981, The Wildlife (Protection) Act, 1972, Environment Protection, 1986, Natural Disasters and their Management

Books Recommended:

❖ Dash MC and Mishra PC, Man and Environment, McMillan, London.
❖ Mishra PC and Das MC, Environment and Society, McMillan, London.
❖ Odeem EP, Fundamentals of Ecology, Natraj Publication.
❖ Mishra DD, Fundamental Concept in Environmental Studies, S. Chand, New Delhi.
❖ Asthana DK and Asthana Meera, A Text book of Environmental Studies, S. Chand, New Delhi.
❖ Bharucah Erach, Textbook for Environmental Studies, Universities Press India Pvt. Ltd., Hyderabad.

SEMESTER-II

C-2.1 : ELECTRICITY AND MAGNETISM

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I : Electric Field and Electric Potential

Electric field: Electric field lines, Electric flux, Gauss Law with applications to charge distributions with spherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole placed in electric field, Potential calculation indifferent simple cases, Laplace and Poisson's equations, The Uniqueness Theorem, Method of Images and its application to (1) Plane Infinite Sheet and (2) Sphere.

Electrostatic energy of system of charges, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor.

UNIT-II

Magnetic Field: Magnetic Force, Lorentz Force, Biot Savarts Law, Current Loop as a Magnetic Dipole and its Dipole Moment (analogy with Electric Dipole), Amperes Circuital Law and its application to (1) Solenoid (2) Toroid (3) Helmhotz coil, Properties of B: curl and divergence, Vector Potential, Ballistic Galvanometer: Torque on a current Loop, Current and Charge Sensitivity, Electromagnetic damping, Logarithmic damping, CDR.

UNIT-III

Dielectric Properties of Matter: Electric Field in matter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric, Displacement vector D, Relations between E, P and D, Gauss Law in dielectrics. Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Ferromagnetism, B-H curve and hysteresis.

Electromagnetic Induction: Faradays Law, Lenzs Law, Self Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations

UNIT-IV

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (1) Resonance (2) Power Dissipation (3) Quality Factor, (4) Band Width, Parallel LCR Circuit.

Network theorems: Ideal Constant-voltage and Constant-current Sources, Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to DC and AC circuits. Transient Currents Growth and decay of current in RC and LR circuits.

Text Books:
1. Introduction to Electrodynamics – D.J. Griffiths (Pearson, 4th edition, 2015)
2. Foundations of Electromagnetic Theory-Ritz and Milford (Pearson) 4th Edition

Reference Books:
❖ Classical Electrodynamics, J. D. Jackson (Wiley), 1998
❖ Electricity and Magnetism D. C. Tayal (Himalaya Publishing house), 2014
❖ Electricity, Magnetism and Electromagnetic Theory- S. Mahajan and Choudhury (Tata McGraw Hill)-2012
❖ Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands (Pearson)-2008
❖ Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I (Oxford Univ. Press)

PRACTICAL

(Minimum of 6 experiments are to be done)

Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Fosters Bridge.
4. And compare capacitances using DeSautys bridge.
5. Measurement of field strength B and its variation in a solenoid/artificial coil (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To determine self inductance of a coil by Andersons bridge.
8. To study response curve of a Series LCR circuit and determine its (a) Reso- nant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
9. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonance frequency and (b) Quality factor Q.

Reference Books:
❖ Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
❖ A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal
❖ Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
❖ A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

C-2.2 : WAVES AND OPTICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT - I

Geometrical Optics : Fermats principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics, Cardinal points and Cardinal planes of an optical system, Idea of dispersion, Application to thick Lens and thin Lens, Ramsden and Huygens eyepiece. Wave Optics : Electromagnetic nature of light. Definition and properties of wave front Huygens Principle. Temporal and Spatial Coherence.

UNIT - II

Wave Motion : Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Traveling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation, Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave. Superposition of two perpendicular Harmonic Oscillations : Graphical and Analytical Methods, Lissajous Figures (1:1 and 1:2) and their uses, Superposition of N harmonic waves.

UNIT- III

Interference : Division of amplitude and wave front, Young's double slit experiment, Lloyds Mirror and Fresnels Bi-prism, Phase change on reflection: Stokes treatment, Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes), Fringes of equal thickness (Fizeau Fringes), Newton's

Rings: Measurement of wavelength and refractive index. Interferometer : Michelsons Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes, Fabry-Perot interferometer.

UNIT - IV

Fraunhofer diffraction: Single slit, Circular aperture, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnels Assumptions, Fresnels Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnels Integral, Fresnel diffraction pattern of a straight edge, as lit and a wire.

Text Books:
1. Optics P.K. Chakrabarty, New Central Agency 3rd Edition 2012
2. 2.Optics - Ajoy Ghatak (McGraw Hill)- 2017

Reference Books:
❖ Optics-E. Hecht (Pearson)-2008
❖ Fundamentals of Optics- F.A. Jenkins and H.E. White (McGraw-Hill)-2017
❖ Geometrical and Physical Optics R.S. Longhurst (Orient Black swan)-1986
❖ A text book of Optics N. Subrahmanyam and Brij Lal (S. Chand Publishing), 2006
❖ The Physics of Vibrations and Waves- H.J. Pain (John Wiley)-2013
❖ Principles of Optics- Max Born and Emil Wolf(Pergamon Press) 7th Edition 1999
❖ The Physics of Waves and Oscillations-N.K. Bajaj (McGraw Hill)-1998

PRACTICAL

(Minimum 5 experiments are to be done)
1. To determine the frequency of an electric tuning fork by Meldes experiment and verify 2 T law.
2. To plot the I-D curve and to determine • the refractive index of a prism
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
7. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books:
❖ Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
❖ A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal
❖ Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
❖ A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani

GE-2.3 : CALCULUS AND DIFFERENTIAL EQUATIONS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Objective: Calculus invented by Newton and Leibnitz is powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems using calculus and differential equation. The aim should be to expose the students to basic ideas quickly without much theoretical emphasis with importance on applications.

Excepted Outcomes: After completing the course, students are expected to be able to apply knowledge of calculus and differential equations in the areas of their own interest.

UNIT-I

Curvature, Asymptotes, Tracing of Curves (Catenary, Cycloid, Folium of Descartes), Rectification, Quadrature, Elementary ideas about Sphere, Cones, Cylinders and Conicoids.

UNIT-II

Review of limits, continuity and differentiability of functions of one variable and sceir properties, Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's theorem and Cauchy's form of remainder, Taylor's series, Maclaurin's series of $sinx$, $cosx$, e^x , $\log (1+x)$,$(1+x)^m$, L' Hospital's Rule, other Intermediate forms.

UNIT-III

Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurin's theorem for functions of two variables (statements & applications), Maxima and Minima of functions of two and three variables,

Implicit functions, Lagrange's multipliers (Formulae & its applications), Concepts of Multiple integrals & its applications.

UNIT-IV

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear). Equations of order one but higher degree. Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters.

Books Recommended :
1. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.
2. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.
3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers.

Reference Books :
❖ H.Anton,I.Bivens and S.Davis,*Calculus*,10th Ed.,John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
❖ Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
❖ Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
❖ B. P.Acharya and D. C.Sahu: Analytical Geometry of Quadratic Surfaces, Kalyani Publishers.

AECC – 2.4 : MIL COMMUNICATIONS – ODIA
(ଯୋଗାଯୋଗ ଅନୁବିଧ୍ୱ, ରୀତି ଓ ମାଧମ)

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

୧ମ ଏକକ / ୟୁନିଟ୍ – ୧ :

ଯୋଗାଯୋଗର ପରିଭାଷା, ଅନୁବିଧ୍ୱ, ପରିସର ଓ ପ୍ରକାରଭେଦ

୨ୟ ଏକକ / ୟୁନିଟ୍ – ୨ :

ସାକ୍ଷାତକାର, ଭାଷଣ କଳା

୩ୟ ଏକକ / ୟୁନିଟ୍ – ୩ :

ସମ୍ବାଦର ପରିଭାଷା ଓ ସମ୍ବାଦ ପ୍ରସ୍ତୁତି

୪ର୍ଥ ଏକକ / ୟୁନିଟ୍ – ୪ :

ଓଡ଼ିଆ ଭାଷାର ବର୍ଷମାଳା, ବର୍ଷାଶୁଦ୍ଧିର ନିରାକରଣ । (ବନାନ ତ୍ରୁଟି – ସାଦୃଶ୍ୟଜନିତ ଅଶୁଦ୍ଧି, ଲିଙ୍ଗଗତ ଅଶୁଦ୍ଧି, ସନ୍ଧିଗତ ଅଶୁଦ୍ଧି, ସମାସଗତ ଅଶୁଦ୍ଧି, ବଚନ ଓ ବିଭକ୍ତିଗତ ଅଶୁଦ୍ଧି, ବାକ୍ୟ ବିଧୂଜନିତ ଅଶୁଦ୍ଧି, ସମାର୍ଥବୋଧକ ଶଦାଶୁଦ୍ଧି, ପ୍ରତ୍ୟୟ ଜନିତ ଅଶୁଦ୍ଧି, ଶବ୍ଦ ସଂଯୋଗାମ୍ନକ ଓ ସ୍ୱରସଙ୍ଗତି ଜନିତ ଅଶୁଦ୍ଧି)

ସହାୟକ ଗ୍ରନ୍ଥସୂଚୀ :

୧. ଯୋଗାଯୋଗ ମୂଳକ ମାତୃଭାଷା (ଓଡ଼ିଆ) – ସାମଲ ବିରଞ୍ଚି ନାରାୟଣ, ସତ୍ୟନାରାୟଣ ବୁକ ଷ୍ଟୋର, କଟକ

୨. ସଂଯୋଗ ଅନୁବିଧ – ସନ୍ତୋଷ କୁମାର ତ୍ରିପାଠୀ, ନାଳନ୍ଦା, କଟକ

୩. ଭାଷଣ କଳା ଓ ଅନ୍ୟାନ୍ୟ ପ୍ରସଙ୍ଗ – କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ, ସତ୍ୟନାରାୟଣ ବୁକ୍ ଷ୍ଟୋର,କଟକ

୪. ପ୍ରାୟୋଗିକ ଓଡ଼ିଆ ଭାଷା – ଓଡ଼ିଶା ରାଜ୍ୟପାଠ୍ୟ ପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ୱର

୫. ସମ୍ବାଦ ଓ ସାମ୍ବାଦିକତା – ଚନ୍ଦ୍ରଶେଖର ମହାପାତ୍ର, ଓଡ଼ିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ୱର

୬. ନିର୍ଭୁଲ ଲେଖାର ମୂଳସୂତ୍ର – ନୀଳାଦ୍ରିଭୂଷଣ ହରିଚନ୍ଦନ, ପି.ସି.ଆର ପବ୍ଲିକେସନ, ଭୁବନେଶ୍ୱର

୭. ସର୍ବସାର ବ୍ୟାକରଣ – ନାରାୟଣ ମହାପାତ୍ର ଓ ଶ୍ରୀଧର ଦାସ, ନିୟ ଷ୍ଟୁଡେଣ୍ଟସ୍ ଷ୍ଟୋର, କଟକ

ମୂଲ୍ୟ ବିଭାଜନ ପଦ୍ଧତି : (ସବୁଥିରୁ ବିକଳ୍ପ ପଡ଼ିବ)

(କ) ପତ୍ରର ମୋଟ ନମ୍ବର – ୧୦୦

(ଖ) ଅନ୍ତଃପରୀକ୍ଷା – ୨୦ ଓ ମୁଖ୍ୟ ପରୀକ୍ଷା – ୮୦

(ଗ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକ(ୟୁନିଟ୍)ରୁ ବିକଳ୍ପସହ ଦୁଇଟି ଲେଖାଏଁ ମୋଟ ୮ଟି ୧୫ନମ୍ବର ବିଶିଷ୍ଟ ଦୀର୍ଘ ପ୍ରଶ୍ନ ପଡ଼ିବ । ବିଦ୍ୟାର୍ଥୀଙ୍କୁ ୪ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ । (୧୫ x ୪ = ୬୦)

(ଘ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକରୁ ୧୨ଟି ଅତିସଂକ୍ଷିପ୍ତ ପ୍ରଶ୍ନ ପଡ଼ିବ । ସେଥିରୁ ୧୦ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ । (୧୦ x ୨ = ୨୦)

AECC-2.4 : MIL (ALTERNATIVE ENGLISH)

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Introduction:
The paper is focused upon developing one fundamental skills of Language learning; reading which needs a thorough rethink and revision. In order to build a strong base for acquisition of the communication skills, suitable reading content is selected from diverse areas in prose form. This would boost the learner's competence in expressive and comprehension skills. The well researched language exercises in the form of usage, vocabulary and grammar is the other area that should attract the teacher and learner to work out for giving decent shape to the mastery of English language.

UNIT - I: Short Story
 a. Jim Corbett-The Fight between Leopards
 b. Dash Benhur- The Bicycle
 c. Dinanath Pathy- George V High School
 d. Alexander Baron- The Man who knew too much
 e. Will F Jenkins- Uneasy Homecoming

UNIT - II: Prose
 a. Mahatma Gandhi- The way to Equal Distribution
 b. S Radhakrishnan- A Call to Youth
 c. C V Raman-Water- The Elixir of Life
 d. Harold Nicolson- An Educated Person
 e. Claire Needell Hollander- No Learning without Feeling

UNIT - III:
Comprehension of a passage and answering the questions

UNIT - IV:
Language exercises-test of vocabulary, usage and grammar

Text Books:
1. All Stories and Prose pieces

Reference Books:
- *The Widening Arc: A Selection of Prose and Stories*, Ed. A R Parhi, S Deepika, P Jani, Kitab Bhavan, Bhubaneswar.
- *A Communicative Grammar of English*, Geoffrey Leech.
- *A University Grammar of English*, Randolph Quirk and Sidney Greenbaum
- *Developing Reading Skills*. F. Grellet. Cambridge: Cambridge University Press, 1981.

SEMESTER-III

C-3.1 : MATHEMATICAL PHYSICS-II

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Fourier Series-I: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Complex representation of Fourier series, Expansion of functions with arbitrary period, Expansion of non-periodic functions over an interval, Even and odd functions and their Fourier expansions and Application, Summing of Infinite Series, Term-by-Term differentiation and integration of Fourier Series, Parseval Identity.

UNIT-II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Singularities of Bessel's and Laguerre Equations, Frobenius method and its applications to differential equations: Legendre and Hermite Differential Equations, Legendre and Hermite Polynomials: Rodrigue's Formula, Generating Function, Orthogonality.

UNIT-III

Polynomials: Simple recurrence relations of Legendre and Hermite Polynomials, Expansion of function in a series of Legendre Polynomials, Associated Legendre Differential Equation, Associated Legendre polynomials, Spherical Harmonics

Some Special Integrals: Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral).

UNIT-IV

Partial Differential Equations: Solutions to partial differential equations using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched string

Text Books:
1.   Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris (2013, 7th Edn., Elsevier)
2.   Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) 9th Edition 2011

Reference Books:
❖   Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan)-2009
❖   Mathematical Physics–H. K. Dass, Dr. Rama Verma (S. Chand Publishing) -2011
❖   Mathematical Physics C. Harper (Prentice Hall India)-1978
❖   Schaum's Outlines Series M. Spiegel (2nd Edition, McGraw Hill Education)-2004
❖   Complex variables and applications J.W. Brown and R.V. Churchill-2017
❖   Mathematical Physics, Satya Prakash (Sultan Chand)-2014
❖   Mathematical Physics B.D. Gupta (4th edition, Vikas Publication-2009

PRACTICAL

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done on the basis of formulating the problem but not on the programming

Topics

Introduction to Numerical computation software Scilab: Introduction to Scilab, Advantages and disadvantages, Scilab computation software Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational and logical operators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program(2).

Curve fitting, Least square fit Goodness of fit, standard constant Deviation:
Ohms law to calculate R, Hooke's law to calculate spring constant

Solution of Linear system of equations by Gauss elimination Solution method and Gauss Seidal method. Diagonalization matrices, Inverse of a matrix, Eigen vectors, problems: Solution of mesh equations of electric circuits (3meshes), Solution of coupled spring mass systems (3masses)

Solution of ODE :

First order Differential equation Euler, modified Euler, Runge- Kutta methods, Second order differential equation. Fixed difference method:

First order differential equations

- Radioactive decay
- Current in RC and LC circuits with DC source
- Newton's law of cooling
- Classical equations of motion

Second order Differential Equation

- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Over damped
- Critical damped
- Oscillatory
- Forced Harmonic oscillator
- Transient and Steady state solution
- Apply above to LCR circuits also

Reference Books:

- ❖ Mathematical Methods for Physics and Engineers, K.FRiley, M.P.Hobson and S. J. 20 Bence, 3rd ed., 2006, Cambridge University Press
- ❖ Complex Variables, A.S. Fokas and M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- ❖ First course in complex analys is with applications, D.G. Zill and P.D. Shanahan, 1940, Jones and Bartlett
- ❖ Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernndez. 2014 Springer
- ❖ Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- ❖ Scilab (A free software to Matlab): H. Ramchandran, A.S.Nair. 2011 S.Chand and Company
- ❖ Scilab Image Processing: Lambert M. Surhone. 2010 Beta script Publishing

C-3.2 : THERMAL PHYSICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I

Introduction to Thermodynamics Recapitulation of Zeroth and First law of thermodynamics,

Second Law of Thermodynamics: Reversible and Irreversible process with examples, Kelvin-Planck and Clausius Statements and their Equivalence, Carnots Theorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of increase of Entropy, Entropy Changes in Reversible and Irreversible processes with examples, Entropy of the Principle of Increase of Entropy, Temperature Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics, Unattainability of Absolute Zero.

UNIT-II

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables,

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy, Their Definitions, Properties and Applications, Surface Films and Variation of Surface Tension with Temperature, Magnetic Work, Cooling due to adiabatic demagnetization

Phase Transitions: First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations: (1) Clausius Clapeyron equation (2) Relation between C_p and C_v (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases (5) Energy equations (6) Change of Temperature during Adiabatic Process.

UNIT-III

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Sterns Experiment, Mean, RMS and Most Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (No proof required), Specific heats of Gases.

Molecular Collisions: Mean Free Path, Collision Probability, Estimates of Mean Free Path,

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

UNIT-IV

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation, The Virial Equation, Andrews Experiments on CO_2 Gas. Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van der Waals Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joules Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule- Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule-Thomson Cooling

Text Books:

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)-2010
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman (McGraw- Hill)-1981

Reference Books:

❖ Theory and experiments on thermal Physics, P.K. Chakrabarty (New central book agency limited)-2017
❖ Thermodynamics, Kinetic Theory and Statistical Thermodynamics-Sears and Salinger (Narosa)-1988
❖ A Treatise on Heat- Meghnad Saha and B.N. Srivastava (The Indian Press) Heat, Thermodynamics and Statistical Physics, N. Subrahmanyam and Brij Lal (S.Chand Publishing)-2008
❖ Thermal and Statistical Physics M. Das, P.K. Jena, S. Mishra, R.N. Mishra (Shri Krishna Publication)-2009

PRACTICAL

(Minimum 5 experiments are to be done):

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barnes constant flow method.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charltons disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
4. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. To determine the specific heat of liquid by the method of cooling
6. To determine the specific heat of solid by applying radiation correction.

Reference Books:

❖ Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
❖ A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal
❖ Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
❖ A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Publications.

C-3.3 : ANALOG SYSTEMS AND APPLICATIONS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I

Semiconductor Diodes: P and N type semiconductors, energy level diagram, conductivity and Mobility, Concept of Drift velocity, PN junction fabrication (simple idea), Barrier formation in PN Junction Diode, Static and Dynamic Resistance, Current flow mechanism in Forward and Reverse Biased Diode, Drift velocity, derivation for Barrier Potential, Barrier Width and current Step Junction.

Two terminal device and their applications: (1) Rectifier Diode: Half-wave Rectifiers. center-tapped and bridge type Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, L and C Filters (2) Zener Diode and Voltage Regulation, Principle and structure of LEDS, (2) Photo diode (3) Solar Cell.

UNIT II

Bipolar Junction Transistors: n-p-n and p-n-p transistors, Characteristics of CB, CE and CC Configurations, Current gains a and b, Relation between a and b, Load line analysis of Transistors, DC Load line and Q-point, Physical mechanism of current flow, Active, Cut-off and Saturation Regions.

Transistors Biasing: Transistor Biasing and Stabilization circuits, Fixed Bias and Voltage Divider Bias.

Amplifiers: Transistors as 2-port network h-parameter Equivalent Circuit, Analysis of a single stage CE amplifier using Hybrid Model, Input and Output impedance, Current, Voltage and Power Gains, Classification of class A, B and C amplifiers, Push-pull amplifier (class B)

UNIT-III

Coupled Amplifier: RC-coupled amplifier and it's frequency response.

Feedback in Amplifiers: Effect of Positive and Negative Feedback on In-put Impedance, Output Impedance, Gain Stability, Distortion and Noise. Sinusoidal Oscillations: Barkhausen's Gaterian for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency, Hartley and Colpitt's oscillators.

UNIT-IV

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical OP-AMP (IC741). Open-loop and Closed loop Gain. Frequency Response. CMRR, Slew Rate and concept of virtual ground.

Application of Op-Amps: (1) Inverting and non-inverting amplifiers (2) Adder (3) Subtractor (4) Differentiator, (5) Integrator (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Text Books:
1. Foundations of Electronics-Raskhit and Chattopadhyay (New age International Publication), 15th Edition-2018
2. Concept of Electronics- D.C. Tayal (Himalay Publication)-2018

Reference Books:
- ❖ Electronic devices and circuits R.L. Boylstad (Pearson India)-2009
- ❖ Electronic Principles- A.P. Malvino (Tata McGraw Hill)-2008
- ❖ Electronic Devices and Circuits- S. Salivahar and NS Kumar -(Tata McGraw Hill) 3rd Edition-2012
- ❖ OP-Amps and Linear Integrated Circuit-R. A. Gayakwad (Prentice Hall) 4th Edition, 2000
- ❖ Physics of Semiconductor devices, Donald A Neamen (Prentice Hall)

PRACTICAL

(Minimum 5 experiments are to be done)
1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
2. Study of V-I and power curves of solar cells, and find maximum power point and efficiency.
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration and draw load line
4. To study the various biasing configurations of BJT for normal class A operation.
5. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
6. To design and study OP Amp-IC (741/351) as inverting and non inverting amplifier
7. To design and study OP Amp-IC (741/351) as integrator and differentiation and study frequency response.
8. To design and study OP Amp-IC (741/351) as adder and subtractor.
9. To design a Wien bridge oscillator for given frequency using a nop-amp.
10. To design a phase shift oscillator of given specifications using BJT.
11. To study the Colpitt's oscillator.

Reference Books:
- ❖ Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- ❖ Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- ❖ Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- ❖ Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

GE-3.4 : CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

SECTION A: PHYSICAL CHEMISTRY-I

UNIT-I : Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond

dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics.

Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔGo, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

UNIT- II : Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

SECTION B: ORGANIC CHEMISTRY-II

UNIT- III :

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Up to 5 Carbons) Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions.

Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$)

UNIT- IV : Alcohols, Phenols and Ethers (Up to 5 Carbons)

Alcohols: Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes and ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, Alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer Tiemann Reaction, Gattermann -Koch Reaction,

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): Formaldehyde, acetaldehyde, acetone and benzaldehyde Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction.

Recommended Text Books:
1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co, 47th Edn., 2017.
3. K. L. Kapoor, Text Book of Physical Chemistry, Mac Grow Hill, 3rd Edn. 2017.
4. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Arun Bahl & B S Bahl, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

Reference Books:
❖ Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications.
❖ Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

PRACTICAL

Section A: Physical Chemistry

Thermochemistry (any three)
1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b. Preparation of buffer solutions:
- Sodium acetate-acetic acid
- Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water) and determination of melting.
2. Preparations, recrystallisation, determination of melting point and calculation of quantitative yields of the followings:
   a. Bromination of Phenol/Aniline
   b. Benzoylation of amines/phenols
   c. Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books
- ❖ A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- ❖ Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
- ❖ Khosla, B.D.; Garg, V.C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
- ❖ Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

SECC-II-3.5 : QUANTITATIVE AND LOGICAL THINKING

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

I. QUANTITATIVE APTITUDE & DATA INTERPRETATION

UNIT – I :
Whole numbers, Integers, Rational and irrational numbers, Fractions, Square roots and Cube roots, Surds and Indices, Problems on Numbers, Divisibility
Steps of Long Division Method for Finding Square Roots:

UNIT – II :
Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture

UNIT – III :
Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed; relationship among them

UNIT – IV :
Concept of Angles, Different Polygons like triangles, rectangle, square, right angled triangle, Pythagorean Theorem, Perimeter and Area of Triangles, Rectangles, Circles

UNIT – V :
Raw and Grouped Data, Bar Graphs, Pie charts, Mean, Median and Mode, Events and Sample Space, Probability

II. LOGICAL REASONING

UNIT – I :
Analogy basing on kinds of relationships, Simple Analogy; Pattern and Series of Numbers, Letters, Figures. Coding-Decoding of Numbers, Letters, Symbols (Figures), Blood relations

UNIT – II :
Logical Statements– Two premise argument, More than two premise argument using connectives

UNIT – III :
Venn Diagrams, Mirror Images, Problems on Cubes and Dices

Books Prescribed :
1. Quantitative And Logical Thinking – Odisha State Higher Education Council, Bhubaneswar

SEMESTER-IV

C-4.1 : MATHEMATICAL PHYSICS-III

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems; known or unknown.

UNIT-I

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation Eulers formula, De Moivre's theorem, Roots of complex Numbers, Functions of Complex Variables, Analyticity and Cauchy-Riemann Conditions, Examples of analytic functions, Singular functions: poles and branch points, order of singularity, branch cuts, Integration of a function of a complex variable, Cauchys Inequality, Cauchys Integral formula, Simply and multiply connected region, Laurent and Taylors expansion, Residues and Residue Theorem, Application in solving simple Definite Integrals.

UNIT-II

Integral Transforms-I: Fourier Transforms: Fourier Integral theorem, Fourier Transform, Examples, Fourier Transform of trigonometric, Gaussian, finite wave train and other functions, Representation of Dirac delta function as a Fourier Integral, Fourier transform of derivatives, Inverse Fourier Transform.

UNIT-III

Integral Transforms-II: Convolution theorem, Properties of Fourier Trans- forms (translation, change of scale, complex conjugation), Three dimensional Fourier transforms with examples, Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat flow Equations.

UNIT-IV

Laplace Transforms: Laplace Transforms (LT) of Elementary functions,

Properties of Laplace Transforms: Change of Scale Theorem, Shifting Theorem, LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions, Inverse LT, Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Text Books:
1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris (2013, 7th Edn., Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) 10th Edition 2014

Reference Books:
❖ Mathematical Physics and Special Relativity–M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan)-2009
❖ Mathematical Physics–H. K. Das, Dr. Rama Verma (S. Chand Publishing) 2011
❖ Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition, Mc- Graw Hill Education)-2004
❖ Complex variables and applications J.W. Brown and R.V. Churchill 7th Edition 2003
❖ Mathematical Physics, Satya Prakash (Sultan Chand)-2014
❖ Mathematical Physics B.D. Gupta (4th edition, Vikas Publication)-2009

PRACTICAL

20 classes (2 hrs. duration each)

Scilab based simulations (XCos) experiments based on Mathematical Physics problems like
- Solve simple Differential Equations like

$$\frac{dy}{dx} = e^x, with \ y(x = 0) = 0$$

$$\frac{dy}{dx} + e^x = x^2, with \ y(x = 0) = 0$$

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y, with \ y(x = 0) = 0, y(x = 0) = 1$$

$$\frac{d^2y}{dx^2} + e^{-x}\frac{dy}{dx} = -y, with \ y(x = 0) = 0, y(x = 0) = 1$$

- Direct Delta Function

Evaluate $\int_{-3}^{3} dx \ \frac{(x+3)}{\sqrt{2\pi\sigma^2}} \ e^{-\frac{(x-2)^2}{2\sigma^2}}$, for $\sigma = 0.1, 0.01, 0.001$ and show that it tends to 5.

- Fourier Series :
  Program to sum
  Evaluate the Fourier coefficients of a given periodic function (square wave)

- Frobenius method and Special functions :

$$\int_{-1}^{1} d\mu \; P_n(\mu) \, P_m(\mu) = \frac{2}{2n+1} \delta_{m,n}$$

  Plot $P_n(x)$, Legendre polynomial of degree n, and $J_n(x)$, Bessel function of first kind.

  Show recursion relation

- Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

- Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

- Evaluation of trigonometric functions e.g. sin, Given Bessels function at N points find its value at an intermediate point.
  Complex analysis : Calculate $\int \frac{dx}{(x^2+2)}$ and check it with computer integration.

- Integral transform : FFT of e^{-x^2}

Reference Books:
- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and Krzywicki,1967,DoverPublications
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernndez. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab (A free software to math lab): H. Ramchandran, A.S. Nair. 2011 S. Chand and Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Beta script Publishing

C-4.2 : ELEMENTS OF MODERN PHYSICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT- I
Atomic Spectra and Models: Inadequacy of classical physics, Brief Review of Black body Radiation, Photoelectric effect, Compton Effect, dual nature of radiation wave nature of particles, Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle, Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations. **Atomic Model:** Bohrs Model of Hydrogen atom, explanation of atomic spec- tra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Experiment, Sommerfelds modification of Bohr's Theory.

UNIT- II
Wave Packet: superposition of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time, Time development of a wave packet, Wave Particle Duality, Complemntarity.
Wave Particle Duality: de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of deBroglie wave, wave particle duality, Complementarity.
Uncertainty Principle: Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiments of Gamma ray microscope and electron diffraction through a slit, Estimation of ground state energy of harmonic oscillator
and hydrogen atom, non existence of electron in the nucleus, Uncertainty and complementarities.

UNIT- III
Nuclear Physics- I: Size and structure of atomic nucleus and its relation with atomic weight, Impossibility of an electron being in the nucleus as a con- sequence of the uncertainty principle, Nature of the nuclear force, NZ graph, Liquid Drop model: semi empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

UNIT- IV
Nuclear Physics- II: Radioactivity, stability of the nucleus, Law of radioactive decay, Mean life and Half life Alpha decay, Beta decay-energy released, spectrum and Paulis prediction of neutrino, Gamma ray emission energy-

momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus, Fission and fusion mass deficit, relativity and generation of energy, Fission- nature of fragments and emission of neutrons, Nuclear reactor: slow neutron interacting with Uranium 235, Fusion and thermo nuclear reactions driving stellar energy (brief

qualitative discussion).

Text Books:
1. Concepts of Modern Physics Arthur Beiser (McGraw Hill)-2002
2. Modern Physics Murugeshan and Sivaprasad (S. Chand) 18th Edition 2016

Reference Books:
❖ Quantum Mechanics: Theory and Applications, A.K. Ghatak and S. Lokanathan, (Macmillan)-2004
❖ Introduction to Quantum Theory, David Park (Dover Publications)-1974
❖ Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin- (Tata McGraw-Hill) 2nd Edition
❖ Physics for scientists and engineer with Modern Physics-Jewell and Serway -(CENGAGE Learnings) 2010.
❖ Modern Physics of Atoms and Molecules Bransden and Joachim (Pearson India)-2003
❖ Atomic and Nuclear Physics-A.B. Gupta (New Central)-2009
❖ Theoretical Nuclear Physics, J.M. Blatt and V.F. Weisskof (Springer)-2003

PRACTICAL

(Minimum 4 experiments are to be done):
1. To show the tunneling effect in tunnel diode using I-V characteristics.
2. To determine the wavelength of laser source using diffraction of single slit.
3. To determine the wavelength of laser source using diffraction of double slits.
4. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.
5. To determine the Plancks constant using LEDs of at least 4 different colours.
6. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
7. To setup the Millikan oil drop apparatus and determine the charge of an electron.

Reference Books:
❖ Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
❖ Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
❖ A Text Books Book of Practical Physics, I. Prakashand Ramakrishna, 11th Edn, 2011, Kitab Mahal

C-4.3 : DIGITAL SYSTEMS AND APPLICATIONS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I

Integrated Circuits (Qualitative treatment only): Active and Passive Components, Discrete components, Wafer Chip, Advantages and Drawbacks of ICs, Scale of Integration: SSI, MSI, LSI and VLSI (basic idea and definitions only), Classification of ICs, Examples of Linear and Digital ICs.

Digital Circuits: Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversation, BCD, Octal and Hexadecimal numbers, AND, OR and NOT. Gates (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates and application as Parity Checkers.

UNIT-II

Boolean algebra: De Morgans Theorems: Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Idea of Minterms and Maxterms, Conversion of a Truth table into Equivalent Logic Circuit by

(1) Sum of Products Method and (2) Karnaugh Map.

Introduction to CRO: Block Diagram of CRO, Electron Gun, Deflection system and Time Base, Deflection Sensitivity,

Applications of CRO: (1) Study of Wave Form, (2) Measurement of Volt- age, Current, Frequency and Phase Difference.

UNIT-III

Data Processing Circuits: Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2s complement. Half and Full Adders. Half and Full Subtractors, 4 bit binary Adder/Subtractor.

Timers: IC 555: block diagram and application is Astable multivibrator and Monostable multivibrator.

UNIT-IV

Introduction to Computer Organization: Input/output Devices, Data storage (idea of RAM and ROM), Computer memory, Memory organization and addressing, Memory Interfacing, Memory Map.

Shift registers: Serial-in-serial-out, Serial-in-Parallel-out, Parallel-in-Serial- out and Parallel-in-Parallel-out. Shift Registers (only up to 4 bits)

Counters (4 bits): Ring Counter, Asynchronous counters, Decade Counter. Synchronous Counter.

Text Books:
1. Foundation of Electronics-Rakshit Chattopadhaya (New Age) -2015
2. Digital Circuits and Logic design: Samuel C. Lee (Printice Hall)-1976
3. Digital Principles and Applications - A.P. Malvino, D.P. Leach and Saha (Tata McGraw)- 7th Edition 2011

Reference Books:
❖ The Art of Electronics by Paul Horowitz and Wilfield Hill, Cambridge University -2006
❖ Electronics by Allan R. Hambley, Prentice Hall - 1994
❖ Digital Logic and Computer design M. Morris Mano (Pearson) -2016
❖ Concepts of Electronics D.C. Tayal (Himalaya Publishing house) -2018

PRACTICAL

(Minimum 6 experiments are to be done):
1. Student should know how to measure (a) Voltage, and (b) Time period of a periodic waveform using CRO and to test a Diode and Transistor using a Millimeter.
2. To design a switch (NOT gate) using a transistor.
3. To verify and design AND, OR, NOT and XOR gates using NAND gates.
4. Half Adder, Full Adder and 4-bit binary Adder.
5. Half Subtractor, Full Subtractor, Adder- Subtractor using Full Adder I.C.
6. To build Flip-Flop (RS, Clocked RS, D- type and JK) circuits using NAND gates.
7. To design an stable multivibrator of given specifications using 555Timer.
8. To design a monostable multivibrator of given specifications using 555 Timer.

Reference Books:
❖ Basic Electronics: A Text Books lab manual, P.B. Zbar, A.P. Malvino,
❖ M.A. Miller, 1994, Mc-Graw Hill.
❖ OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
❖ Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill. Electronic Devices and circuit Theory, R.L. Boylestad and L.D. Nashelsky, 2009, Pearson

GE-4.4 : ALGEBRA

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Objective: This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The basics of linear algebra i.e. vector spaces, matrices are introduced here.

Expected Outcomes: The acquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc.

UNIT-I

Sets, relations, Equivalence relations, partial ordering, well ordering, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments

UNIT-II

Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

UNIT-III

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems.

UNIT-IV

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples, Introduction to linear transformations, matrix representation of a linear transformation, Eigen values, Eigen vectors of a matrix.

Books Recommended :

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
2. V Krishna Murthy, V P Mainra, J L Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd.

Reference Books :

❖ David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
❖ B S Vatsa and Suchi Vatsa Theory of Matrices New age International third edition 2010.
❖ Ward Cheney, David kincaid. Linear algebra theory and applications, Jones and Bartlett, 2010.

SECC-I-4.5 : COMMUNICATIVE ENGLISH

(Enriching Linguistic Knowledge & Communication Proficiency)

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

UNIT-I : BUSINESS COMMUNICATION AND GRAMMAR

Why English Communication is Essential and How to Improve the Skill?

Introduction to Voice and Accent, Why do we have such different accents?, Accent Training-Consequences, Voice and accent in the Enterprise Industry, Globally Comprehensible Accent, Introduction to Phonetics, International Phonetic Alphabet

Consonant Sounds

Vowels

Diphthongs

A Few Phonic Rules

Word Stress: Syllables

Intonation : Intonation and Stress

Pacing and Chunking : Common Patterns of Pacing, Importance of Chunking

Fluency

Indianisms : Errors relating to Grammar, Vocabulary

UNIT-II : GRAMMAR

English: Spoken Versus Written Communication

Nouns : Kinds of Nouns, Activity 3: Noun Ping-pong, Nouns-Number, Noun-Gender, Countable and Uncountable Nouns

Pronouns : Reflexive Pronouns, Relative Pronouns, Demonstrative Pronouns, Interrogative Pronouns, Indefinite pronouns, Activity 4: Sentence Auction

Adjectives : Activity 5 : Picture perfect, Positioning of adjectives, Comparative Degrees of Adjectives, Order of Adjectives

Adverbs : Kinds of Adverb, Degree of Comparison, Word Order with Adverbs, Activity 6: Relay Race

Prepositions : Activity 7: Treasure Hunt, Activity 8: Route Map, Prepositions with Adjectives, Nouns and Verbs

Conjunctions : Coordinating conjunctions, Subordinating Conjunctions, Correlative Conjunctions, Connecting Adverbs, Activity 9: The Socks Story

Verbs : Verb Classification, List of irregular verbs, Activity 10: Word Search

Subject and verb agreement, Activity 11: Tossed Word Salad, Activity 12: The Sentence Pageant Determiners and Modifiers : Kinds of determiners, The Definite and the Indefinite Article, Definite Article: The, Activity 13: Proof Reading

Tenses : Reference Table, Present Tense, Activity 14: Instruction Manual, Activity 15: Commentary, Past Tense, Activity 16: The Chain List, Activity 17: Transcription, Future Tense, Activity 18: This Week for You, Activity 19: Verb Grand Prix
Punctuation : Forms of Punctuation

UNIT-III : READING COMPREHENSION

Reading – A 7 Step Process, Techniques to enhance students' reading skills, Types of reading skills, Skimming, Scanning, Extensive reading, Intensive reading, Three levels of Reading, Improving your reading speed, Reading Comprehension Practice Exercises

Text Books:
1.   Communicative English – Odisha State Higher Education Council, Bhubaneswar

SEMESTER-V

C-5.1 : QUANTUM MECHANICS AND APPLICATIONS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT- I
Schrodinger equation: Time dependent Schrodinger equation , Properties of Wave Function, Interpretation of wave function, Probability and probability current densities in three dimensions, Conditions for Physical Acceptability of Wave Function, Normalization, Linearity and Superposition Principles. Wave function of a free particle ,Wave Packet, Fourier Transform and momemtum space Wave function ,Spread of Gaussian Wave packet, Evolution with time, Position and Momentum Uncertainty.

UNIT-II
Operators: Operators, Commutator Algebra, Position, Momentum Angular Momentum and Energy operators, Hermitian Operators, Expectation values of position and momentum, Ehrenfest Theorem, Eigenvalues and Eigen functions of Hermitian Operator, Energy Eigen Spectrum, Degeneracy, Orthonormality of Eigen functions, Linear Dependance. Orthogonalisation.

UNIT-III
Time Independent Schrodinger equation in one dimension (1d), 2d and 3d, Hamiltonian, stationary states and energy eigen values, expansion of an arbitrary wave function as a linear combination of energy eigen functions, General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states. General Discussion of Bound states in an arbitrary potential: Continuity of wave function, Boundary condition and emergence of discrete energy levels, Application to one dimensional problem-Square well potential, Quantum mechanics of simple Harmonic Oscillator-Energy Levels and energy eigen functions, ground state, zero point energy and uncertainty principle, One dimensional infinitely rigid box energy eigen values and eigen functions, normalization, quantum dot as example, Quantum mechanical scattering and tunnelling in one dimension across a step potential and rectangular potential barrier.

UNIT-IV
Atoms in Electric and Magnetic Fields: Electron angular momentum. Space quantization, Electron Spin and Spin Angular Momentum, Larmors Theorem, Spin Magnetic Moment, Stern Gerlach Experiment, Vector Atom Model, L-S and J-J coupling, Zeeman Effect, Electron Magnetic Moment and Magnetic Energy, Gyro magnetic Ratio and Bohr Magnet on Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect, Paschenback and Stark Effect (qualitative Discussion only)

Text Books:
1.   Introduction to Quantum Theory, D. J. Griffiths (Pearson)-2015
2.   Introduction to Quantum Theory David Park (Dover Publications)-1974

Reference Books :
❖   Quantum Mechanics, Theory and applications A. Ghatak and S. Lokanathan (McMillan India)-2004
❖   Quantum Mechanics-G. Aruldhas (Printice Hall of India)-2008
❖   Quantum Physics–S. Gasiorowicz (Wiley)-2007
❖   Quantum Mechanics -J.L. Powell and B. Craseman (Narosa)-1998
❖   Introduction to Quantum Mechanics M.Das and P.K. Jena (Shri Krishna Publication)-2006

PRACTICAL

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like (Use finite difference method, matrix method, ODE solver method in all cases)

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:
$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E], V(r) = -\frac{e^2}{r} \ ,$$
where m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is $\sim -13.6 \, eV$. Take $e = 3.795\sqrt{(eV \, °A)}, \hbar c = 1973 (eV \, °A)$ and $m = 0.511 \times 10^6 eV/c^2$

2. Solve the s-wave radial Schrodinger equation for an atom :
$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E],$$ where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential : $V(r) = -\frac{e^2}{r}e^{-r/a}$
Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take $e = 3.795\sqrt{eV \, °A}, \hbar c = 1973 (eV \, °A)$ and $m = 0.511 \times 10^6 \, eV/c^2$, and $a = 3 \, °A, 5 \, °A, 7 \, °A$. The ground state energy is expected to be above – 12eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m : $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E],$
for the anharmonic oscillator potential : $V(r) = \frac{kr^2}{2} + \frac{br^3}{3}$.
Find the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m = 0940 MeV/c^2, k = 100 MeV/fm^2, b = 0,10,30 \, MeV/fm^3$. In these Units, $c = 197.3 \, MeV \, fm$. [The ground state energy is expected to lie between 90 and 110 MeV for all three cases.]

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule: $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$, where m is the reduced mass of the two-atom system for the Morse potential $V(r) = D(e^{-2\alpha r} - e^{-\alpha})$, where $r = r - r_0$. Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave functions for the choices give below:
   a. $m = 940 x10^6 eV/c^2, D = 0.755501 eV, \alpha = 1.44, r_0 = 0.131349 \, °A$
   b. $m = 940 x106 eV/c^2, D = 0.755501 eV, \alpha = 1.44, r_0 = 0.131349 \, °A$

Laboratory Based Experiments : (to be taken up depending on availability of equipment)
1. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
2. Study of Zeeman effect: with external magnetic field; Hyper fine splitting
3. To show the tunneling effect in tunnel diode using I-V characteristics.
4. Quantum efficiency of CCDs

Reference Books:
- Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw– Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edition, 2007, Cambridge University Press.
- An introduction to computational Physics, T. Pang, 2nd Edn.,2006, Cam- bridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernndez. 2014 Springer.
- Scilab (A Free Software to Math lab): H. Ramchandran, A.S. Nair. 2011, S. Chand and Co.
- Scilab Image Processing: L.M. Surhone. 2010 Beta script Publishing ISBN:9786133459274

C-5.2 : SOLID STATE PHYSICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I
   Crystal Structure: Solids, Amorphous and Crystalline Materials, Lattice translation Vectors, Lattice with a Basis. Central and Non-Central Elements. Unit Cell, Miller Indices, Types of Lattices, Reciprocal Lattice, Brillouin zones, Diffraction of Xrays by crystals, Bragg Law, Atomic and Geometrical Factor

UNIT-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear, Monotomic and Diatomic Chains, Acoustical and Optical Phonons, Qualitative Description of the phonon spectrum in solids, Dulong and Petits Law, Einstein and Debye theories of specific heat of solids, $T3$ Law

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials, Classical Langevins theory of dia and Paramagnetic Domains, Curies law, Weiss Theory of Ferro magnetism and Ferro magnetic Domains, Discussion of B-H Curve, Hysteresis and Energy Loss.

UNIT-III

Dielectric Properties of Materials: Polarization Local Electrical Field at an Atom, Depolarization Field, Electric Susceptibility, Polari ability, Clausius Mosotti Equation, Classical theory of Electronic Polarizability.

Lasers: Einsteins A and B coefficients, Meta stable States, Spontaneous and Stimulated emissions, Optical Pumping and population Inversion, Three Level and Four Level Lasers, Ruby Laser and He-Ne Laser.

UNIT-IV

Elementary band theory: Kronig-Penny model of band Gap, Conductor, Semiconductor (P and N type) and insulator, Conductivity of Semiconductor, mobility, Hall Effect, Measurement of conductivity (04 problem method) and Hall Coefficient.

Superconductivity: Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, Londons Equation and Penetration Depth, Isotope effect, Idea of BCS theory (No derivation)

Text Books:
1.	Introduction to Solid State Physics- Charles Kittel (Wiley India) 8th Edition 2012
2.	LASERS: Fundamentals and Applications-Thyagarajan and Ghatak (McMillan India)-2011

Reference Books:
❖	Solid State Physics-N. W. Ashcroft and N.D. Mermin (Cengage)-2003
❖	Solid State Physics- R.K.Puri and V.K. Babbar (S.Chand Publication)-2010
❖	Solid State Physics S. O. Pillai (New Age Publication)-2008
❖	Lasers and Non linear Optics B.B.Laud (Wiley Eastern)-2011
❖	Elements of Solid State Physics-J.P. Srivastava (Prentice Hall of India)-2014
❖	Elementary Solid State Physics-Ali Omar (Addison Wiley)-2002

PRACTICAL

(Minimum 4 experiments are to be done)

1.	Measurement of susceptibility of paramagnetic solution (Quinck's Tube-Method)
2.	To measure the Magnetic susceptibility of Solids.
3.	To measure the Dielectric Constant of a dielectric Materials and variation with frequency
4.	To determine the Hall coefficient of a semiconductor sample.
5.	To draw the BH curve of Fe using solenoid and to determine the energy loss from Hysteresis
6.	To measure the resistivity and band gap of a given semiconductor by four problem method.
7.	To study PE hysteresis loop of a ferroelectric crystal

Reference Books:
❖	Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
❖	Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
❖	A Text Books Book of Practical Physics, I. Prakashand Ramakrishna, 11 Ed., 2011, Kitab Mahal
❖	Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice- Hall of India.

DSE-5.3 : CLASSICAL DYNAMICS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Generalised co-ordinates and Velocities, Generalised Force, Principle of virtual work Derivation of Lagranges equation of motion from D Alemberts Principles, Lagrangian and its Application to Simple, Compound and Double Pendulums, Single Particle in Space, At woods Machine, Dumbbell, Linear harmonic oscillator.

UNIT-II

Hamiltons Principle, Calculus of Variation and derivation of Euler-Lagranges equation, Langranges Equations derived from Hamiltons Principles, Hamiltoian and its applications to Shortest Distance between two points in a plane, Geodesic Problem, minimum surface of revolution, Brachistochrone problem, The Equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, canonical momenta, Hamiltions equations of motion, Motion of charged particles in external electric and magnetic fields, Applications to central force motion and coupled oscillators.

UNIT- III

Special theory of Relativity (Postulates of special theory of relativity), Lorentz transformations, Minkowski space, The invariant interval, light cone and world lines, space time diagrams, Times-dilation, length contraction and Twin paradox, Variation of mass with velocity mass energy relation

UNIT- IV

Four Vectors: Space Like, Time-like and light-like. Four velocity and acceleration, Four momentum and energy-momentum relation. Doppler effects from a four vector perspective, Concept of four-force, Conservation of four momentum, Application to two body decay of anun stable particle

Text Books:

1. Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko (Pearson) -20112.Classical Mechanics N C Rana and P S Joag.-2017

Reference Books:

1. Mechanics-D.S. Mathur (Sultan Chand)-2000
2. Solved problems in Classical Mechanics, O.L. Delange and J. Pierrus (Oxford Press) (2010)
3. Classical Mechanics-M. Das, P.K. Jena, M. Bhuyan, R.N. Mishra (Srikrishna Prakashan)-2009
4. Mathematical Physics with Classical Mechanics-Satya Prakash (Sultan Chand and sons)-2014
5. Introduction to classical dynamics R.K. Takwale and S. Puranik (Tata McGraw Hill)-2017
6. Classical Mechanics J.C. Upadhyay (Himalayan Publisher)-2017
7. Classical Dynamics of particles and systems -S.T. Thorton and Marion (Cengage publication)-2012

DSE-5.4 : NUCLEAR AND PARTICLE PHYSICS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

UNIT-I

General properties of Nuclei: Constituents of nucleus and their intrinsic properties, Quantitative facts about mass, radius, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment electric moments, nuclear excites states.

Radioactivity decays: (a) Alpha decay: basics of alpha- decay processes, theory of alpha-emission, Gamow factor, Geiger Nuttall law (b) beta-decay: energy kinematics for beta-decay, positron emission, electron capture, neutrino hypothesis. (c) Elementary idea of Gamma decay.

UNIT-II

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, conditions of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic number, basic assumption of shell models.

UNIT-III

Detector for nuclear radiations: Detector for nuclear radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic Principle of Scintillation Detectors and Construction of photomultiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge Particle and photo detection (Concept of charge carrier and mobility), neutron detector.

Particle Accelerators: Van-de Graff generator (Tandem Accelerator), Linear accelerator, Cyclotron, Synchrotrons

UNIT-IV

Particle Physics: Particle interactions, basic features, types of particles and its families,

Symmetries and conservation laws: Energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, strangeness and charm, Elementary ideas of quarks and gluons.

Text Books:

1. Introduction to Nuclear Physics by Roy and Nigam-2014
2. Atomic and Nuclear Physics- N. Subramanyam, Brij Lal and Jivan Seshan (S. Chand Publishing)-2007

Reference Books:
❖ Introduction to Modern Physics- H.S. Mani and G.K. Mehta (Affilated east and west) -2018
❖ Introductory nuclear Physics-Kenneth S. Krane (Wiley India Pvt. Ltd)-1987
❖ Introduction to Elementary Particles-D. Griffith (John Wiley and Sons)-2008
❖ Concepts of Nuclear Physics - Bernard L. Cohen. (Tata Mcgraw Hill). -2017
❖ Concepts of Modern Physics-Arthur Beiser (McGraw Hill)-2017

SEMESTER-VI

C-6.1 : ELECTROMAGNETIC THEORY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I
Maxwell Equations: Maxwell's equations, Displacement Current, Vector and Scalar Potentials, Gauge Transformations: Lorentz and Coulomb Gauge, Boundary Conditions at Interface between Different Media, Wave Equations, Plane Waves in Dielectric Media, Poynting Theorem and Poynting Vector, Electro- magnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density

UNIT-II
EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance, Propagation through conducting media, relaxation time, skin depth, Electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

UNIT-III
EM Wave in Bounded Media: Boundary conditions at a plane interface between two media, Reflection and Refraction of plane waves at plane interface between two dielectric media, Laws of Reflection and Refraction, Fresnel's Formulae for perpendicular and parallel polarization cases, Brewster's law, Reflection and Transmission coefficients, Total internal reflection, evanescent waves, Metallic reflection (normal Incidence)

UNIT IV
Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization, Uniaxial and Biaxial Crystals, Light Propagation in Uniaxial Crystal, Double Refraction, Polarization by Double Refraction, Nicol Prism, Ordinary and extraordinary refractive indices, Production and detection of Plane, Circularly and Elliptically Polarized Light, **Phase Retardation Plates:** Quarter-Wave and Half- Wave Plates. Babinets Compensator and its Uses, Analysis of Polarized Light.
Rotatory Polarization: Optical Rotation, Biots Laws for Rotatory Polarization, Fresnels Theory of optical rotation, Calculation of angle of rotation, Experimental verification of Fresnels theory, Specific rotation, Laurents half-shade polarimeter.

Text Books:
1. Introduction to Electrodynamics, D.J. Griffiths (Pearson)-2015
2. Principles of Optics- Max Born and E. Wolf- Cambridge University Press-1999
Reference Books:
❖ Classical Electrodynamics by J.D. Jackson (Willey)-2007
❖ Foundation of electromagnetic theory: Ritz and Milford (Pearson)-2008
❖ Electricity and Magnetism : D C Tayal (Himalaya Publication)-2014
❖ Optics : A.K. Ghatak (McGraw Hill Education)- 2017
❖ Electricity and Magnetism: Chattopadhyaya, Rakhit (New Central)-2018

PRACTICAL

(Minimum 4 experiments are to be done):
1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinets compensator.
4. To determine the refractive index of liquid by total internal reflection using Wollastonsair-film.

5. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eye piece.
6. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
7. To verify the Stefan's law of radiation and to determine Stefan's constant.
8. To determine the Boltzmann constant using V-I characteristics of PN junction diode.
9. To determine wavelength and velocity of ultrasonic wave in liquid.

Reference Books:
❖ Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
❖ Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
❖ A Text Books Book of Practical Physics, I.Prakashand Ramakrishna, 11th Ed., 2011, Kitab Mahal Electromagnetic Field Theory for Engineers and Physicists, G. Lehner, 2010, Springer

C-6.2 : STATISTICAL MECHANICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT- I
   Classical Statistics-I: Macrostate and Microstate, Elementary Concept of Ensemble, Micro canonical, Canonical and Grand Canonical ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function.

UNIT- II
   Classical Statistics-II : Thermodynamic Functions of an Ideal Gas, classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of equi partition of Energy (with proof)- Applications to Specific Heat and its Limitations, Thermodynamic Functions of a two energy levels system, Negative Temperature.

UNIT-III
   Quantum Statistics: Identical particles, macrostates and microstates, Fermions and Bosons, Bose Einstein distribution function and Fermi- Dirac distribution function. Bose- Einstein Condensation, Bose deviation from Plancks law, Effect of temperature on Fermi-Dirac distribution function, degenerate Fermi gas, Density of States Fermi energy.

UNIT-IV
   Radiation: Properties of Thermal Radiation, Blackbody Radiation, Pure Temperature dependence, Kirchhoffs law, Stefan Boltzmann law: Thermodynamic proof, Radiation Pressure, Weins Displacement law, Wiens distribution Law, Sahas Ionization Formula, Rayleigh Jeans Law, Ultra Violet catastrophe.
   Plancks Law of Black body Radiation: Experimental verification, Deduction of (1) Wiens Distribution Law, (2) Rayleigh Jeans Law, (3) Stefan Boltzmann Law, (4) Weins Displacement Law from Plancks Law.

Text Books:
1. Introduction to Statistical Physics by Kerson Huang (Wiley).-2008
2. Statistical Physics, Berkeley Physics Course, F.Reif (Tata McGraw-Hill)-2017

Reference Books:
❖ Statistical Mechanics, B.K. Agarwal and Melvin Eisner (New Age International)-2013
❖ Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Francis W. Sears and Gerhard L. Salinger (Narosa) 1998
❖ Statistical Mechanics: R.K. Pathria and Paul D. Beale (Academic Press)-2011

PRACTICAL

Use C/C++/ Sci lab for solving the problems based on Statistical Mechanics like
1. Plot Plancks law for Black Body radiation and compare it with Weins law and find Wein's constant and Stefan constant
2. plot Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
3. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
4. Plot Maxwell-Boltzmann distribution function

5.	Plot Fermi-Dirac distribution function
6.	Plot Bose-Einstein distribution function.

Reference Books:
❖	Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition
❖	Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Edition, 1996, Oxford University Press.
❖	Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
❖	Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
❖	Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernndez. 2014 Springer ISBN: 978-3319067896
❖	Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
❖	Scilab Image Processing: L. M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

DSE-6.3 : NANO MATERIALS AND APPLICATIONS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

UNIT-I
Nanoscale Systems: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, size effects in nano systems, Quantum confinement Applications of Schrodinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructure and its consequences.
UNIT-II
Synthesis of Nanostructure Materials: Top down and bottoms up approach, Photo lithography Ball milling. Gas phase condensation, Vacuum deposition, Physical vapour deposition (PVT): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapour deposition (CVD), Sol-Gel Electro deposition, Spray pyrolysis, Hydrothermal synthesis, Preparation through colloidal methods, MBE growth of quantum dots.
UNIT-III
Characterization: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy
UNIT-IV
Applications: Applications of nano particles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nonmaterial Devices: Quantum dots hetero structure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS)

Text Books:
1.	S.K. Kulkarni, Nanotechnology: Principles and Practices (Capital Publishing Company)-3rd Edition 2014
2.	Nano science and nano technology, K.K. Choudhary (Narosa)-2016
Reference Books:
❖	Nano Science and nano technology, Sundar Singh (Pragati Prakashan)-2017
❖	C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)-2007
❖	Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons)-2005
❖	M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007)
❖	K.K. Chattopadhya and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited)-2009

DSE-6.4 : DISSERTATION / PROJECT WORK

Full Marks – 100
End Sem Project– 100

Topics to be announced by the HOD.

OR

DSE-6.4 : BASIC INSTRUMENTATION

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac volt- age, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

AC mill voltmeter: Type of AC mill voltmeters: Amplifier- rectifier, and rectifier amplifier. Block diagram ac mill voltmeter, specifications and their significance.

UNIT-II

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only no mathematical treatment), brief discussion on screen phosphor, visual persistence and chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

UNIT-III

Signal Generators and Analytical Instruments: Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator, Brief idea for testing, specifications, Distortion factor meter, wave analysis.

UNIT-IV

Digital Instruments: Principle and working of digital meters, Comparison of analog and digital instruments, Characteristics of a digital meter, Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter, Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time-base stability, accuracy and resolution.

Text Books :
1.   A Text Books book of electrical technology-B.L. Theraja and A.K. Theraja (S. Chand Publishing)-2014
2.   Digital circuits and systems Venugopal (Tata McGraw Hill)-2011

Reference Books :
❖   Digital Electronics-Subrata Ghoshal (Cengage Learning)-2017
❖   Electronic Devices and circuits - S. Salivahanan and N. S. Kumar (Tata Mc-Graw Hill)-2012
❖   Electronic Devices-Thomas L. Floyd (Pearson)-2015

PRACTICAL

The test of lab skills will be of the following test items:
* Use of an oscilloscope.
* CRO as a versatile measuring device.
* Circuit tracing of Laboratory electronic equipment,
* Use of Digital multimeter /VTVM for measuring voltages
* Circuit tracing of Laboratory electronic equipment,
* Winding a coil /transformer.
* Study the layout of receiver circuit.
* Trouble shooting a circuit
* Balancing of bridges

Laboratory Exercises:
1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q-meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurementofdistortionofa RF signalgeneratorusingdistortionfactor meter.
8. Measurement of R, L and Cusinga LCR bridge/universal bridge.

Open Ended Experiments:
1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)
   More emphasis should be given on hands-on experiments.

Reference Books:
❖ An advanced course in Practical Physics- Chattopadhayay, Rakshit Central-2013
❖ Practical Physics-B.B. Swain (Kitab Mahal)-2014
❖ Advanced practical Physics-B. Ghosh and KG Majumdar (Vol. I and II)-Shreedhar Publication-2004
❖ A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal (Vani Publication)-1985
❖ B.Sc. Practical Physics- C.L. Arora (S. Chand Publishing)-2010
❖ B.Sc. Practical Physics H. Singh and P.S. Hemne (S. Chand Publishing)-2002

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