COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

DEPARTMENT OF PHYSICS

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-IA
	CORE-II				
II	CORE-III	AECC-II			GE-1B
	CORE -IV				
III	CORE-V		AEEC-I (SEC-I)		GE-2A
	CORE-VI				
	CORE-VII				
IV	CORE-VIII		AEEC-II (SEC-II)		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

Three-Year (6-Semester) CBCS Programme (B.Sc.Hons) (PhysicsDepartment)				
Yr.	Sl.No.	Course Structure	Code	Credit Points
FIRST YEAR		**SEMESTER-I**		
	1	Mathematical Physics-I	C-1.1	4+2
	2	Mechanics	C-1.2	4+2
	3	Mechanics and Properties of matter, Oscillation and Waves, Thermal Physics, Electricity and Magnetism and Electronics	GE-1.3	4+2
		SEMESTER-II		
	4	Electricity and Magnetism	C-2.1	4+2
	5	Waves and Optics	C-2.2	4+2
SECOND YEAR		**SEMESTER-III**		
	6	Mathematical Physics-II	C-3.1	4+2
	7	Thermal Physics	C-3.2	4+2
	8	Analog Systems and Applications	C-3.3	4+2
	9	Optics, Special Theory of Relativity, Atomic Physics, Quantum Mechanics and Nuclear Physics	GE-3.4	4+2
		SEMESTER-IV		
	10	Mathematical Physics-III	C-4.1	4+2
	11	Elements of Modern Physics	C-4.2	4+2
	12	Digital Systems and Applications	C-4.3	4+2
FINAL YEAR		**SEMESTER-V**		
	13	Quantum Mechanics & Applications	C-5.1	4+2
	14	Solid State Physics	C-5.2	4+2
	15	Classical Dynamics	DSE-5.3	6
	16	Nuclear and Particle Physics	DSE-5.4	6
		SEMESTER-VI		
	17	Electro-magnetic Theory	C-6.1	4+2
	18	Statistical Mechanics	C-6.2	4+2
	19	Nano Materials and Applications	DSE-6.3	6
	20	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
- AEEC- Ability Enhancement Elective Course (Skill Based)
- 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 (SrikrishnaPrakashan), 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 pointnumbers, 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, 3rdEdn. , 2007, Wiley India Edition.
- Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics,T.Pang, 2ndEdn., 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, McgrawHill.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, 11thEdn, 2011, KitabMahal

GE-1.3 :MECHANICS AND PROPERTIES OF MATTER, OSCILLATION AND WAVES, THERMALPHYSICS, ELECTRICITY AND MAGNETISM AND ELECTRONICS

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

THEORY

UNIT-I : Mechanics and Properties of Matter

Moment of Inertia Parallel axis and perpendicular axis theorem, M.I. of a Solid sphere and Solid cylinder, Gravitational potential and field due to a thin spherical shell and a solid sphere at external points and internal points, Relation among elastic constants, depression at free end of a light cantilever, Surface tension, pressure, difference across a curved membrane, viscous flow, Poiseulles formula.

UNIT-II :Oscillation and Waves

Simple harmonic motion, damped harmonic motion, under damped, over damped and critically damped motion, Forced vibration, Resonance, Wave equation in a medium, Velocity of Longitudinal waves in an elastic medium and velocity of transverse wave in a stretched string, Composition of SHM, Lissajous figures for superposition of two orthogonal simple harmonic vibrations (a) with same frequency, (b) frequency with 2:1.

UNIT-III : Thermal Physics

Entropy, change in entropy in reversible and irreversible process, Carnot engine and its efficiency. Carnot Theorem, Second law of thermodynamics, Kelvin-Planck, Clausius formula. Thermal conductivity, differential equation for heat flow in one dimension, Maxwell thermodynamic relation (statement only), ClausiusClapeyron equation, Black body radiation, Planck radiation formula (No derivation).

UNIT-IV : Electricity and Magnetism

Gauss law of electrostatics, use of Gauss law to compute electrostatic field due to a linear charge distribution, Magnetic induction B, Lorentz force law, BiotSavarts law, Magnetic induction due to long straight current carrying conductor, and in the axis of a current carrying circular coil, Amperes Circuital law,itsdifferentialform,Thelawofelectromagneticequations,itsdifferential and integral form, Maxwells electro-magnetic equations and their physical significance, Growth and decay of currents in LR and RC circuits, time constant, alternating currents in RC, RL and LCR circuits, impedance, power factor, resonance.

P-type and N-type semiconductors, PN-Junction as rectifier, Half wave and Full wave rectifiers (Bridge type), efficiency, ripple factor, use of RC, LC, and filters, working of PNP and NPN transistors, transistor configurations in CE and CB circuits and relation between α and β. JFET, its operation and characteristics of V-I curve.

Text Books:

1. Elements of Properties of Matter D.S. Mathur (S. Chand Publication)-2010
2. Heat and Thermodynamics A.B. Gupta and H.B. Ray (New Central Book Agency)-2010
3. A Text Books book of oscillations, waves and acoustics (5thed.) M. Ghosh and D. Bhattacharya (S. Chand Publication)-2018
4. Electricity and magnetism- R. Murugeshan (S. Chand publishing)-2017
5. Fundamentals of Electronics-Raskhit and Chattopadhyay (New age International Publication)-2018

Reference Books:

❖ Physics of Degree students Vol.I M. Das, P.K. Jena etal (Sri Krishna Prakashan)-2006
❖ Physics of Degree students Vol.II M. Das, P.K. Jena etal (Sri Krishna Prakashan)-2006
❖ Waves and Oscillations (2nd ed) N. Subramaniyam and BrijLal (Vikas Publications)-1994
❖ A Text Books book of Sound (2nd ed) - N. Subramaniyam and BrijLal (S. Chand Publications)-1999

PRACTICAL

(Minimum 6 experiments are to be done)

1. To determine the moment of inertia of a fly wheel.
2. To determine the Young's modulus Y of a wire by Searl's method.
3. To determine the modulus of rigidity of a wire by Maxwell's needle/Torsion Pendulum (Dynamic method).
4. To determine g by bar pendulum.
5. To determine the value of Y of a rubber by using travelling microscope.
6. To determine the Rigidity of modulus by static method.
7. To determine the frequency of a telescope by using Sonometer.
8. Verification of Laws of Vibration of a string by using Sonometer.
9. To compare capacitances using De Sauty bridge.
10. To determine the Law of resistance by using Foster bridge.
11. Compare the specific heat of two liquids by method of Cooling.

Reference Books:

❖ Advanced Practical Physics for students, B.L. Flintand H.T. Worsnop, 1971, Asia Publishing House
❖ A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal (1985), Vani Publication
❖ A Text Books of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition (2011), KitabMahal, New Delhi

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 tocharge distributions with spherical, cylindrical and planar symmetry,Conservative nature of Electrostatic Field. Electrostatic Potential, Potential andElectric 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) PlaneInfinite Sheet and (2) Sphere.

Electrostatic energy of system of charges, Electrostatic energy of a chargedsphere, Conductors in an electrostatic Field, Surface charge and force on aconductor.

UNIT-II

Magnetic Field: Magnetic Force, Lorentz Force, BiotSavarts Law, CurrentLoop as a Magnetic Dipole and its Dipole Moment (analogy with ElectricDipole), Amperes Circuital Law and its application to (1) Solenoid (2) Toroid(3) Helmhotz coil, Properties of B: curl and divergence, Vector Potential, BallisticGalvanometer: 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 vectorD, Relations between E, P and D, Gauss Law in dielectrics. Magnetic Propertiesof Matter: Magnetization vector (M), Magnetic Intensity (H), MagneticSusceptibility and permeability, Relation between B, H, M, Ferromagnetism, B-Hcurve and hysteresis.

Electromagnetic Induction: Faradays Law, Lenzs Law, Self Inductance andMutual 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 andImpedance, 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, NetworkTheorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocitytheorem, 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 andChoudhury (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)DCCurrent, (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 FostersBridge.
4. And compare capacitances using DeSautysbridge.
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, 11thEd., 2011, KitabMahal
- 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 anoptical system, Idea of dispersion, Application to thick Lens and thin Lens, Ramsdenand Huygens eyepiece. Wave Optics : Electromagnetic nature of light. Definition andproperties 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 ofWave. Superposition of two perpendicular Harmonic Oscillations : Graphical andAnalytical Methods, Lissajous Figures (1:1 and 1:2) and their uses, Superposition ofN 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 equalinclination (Haidinger Fringes), Fringes of equal thickness (Fizeau Fringes), Newton'sRings: Measurement of wavelength and refractive index. Interferometer :MichelsonsInterferometer-(1) Idea of form of fringes (No theory required), (2) Determination ofWavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility ofFringes, Fabry-Perot interferometer.

UNIT - IV

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

Text Books:

1. OpticsP.K.Chakrabarty, New Central Agency 3rd Edition 2012
2. 2.Optics - AjoyGhatak (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 BrijLal (S.Chand Publishing),2006
- The Physics of Vibrations and Waves- H.J. Pain (JohnWiley)-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 experimentand 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 thematerial 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 Hgsource using plane diffraction grating.
7. To determine dispersive power and resolving power of a plane diffractiongrating.

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, 11thEd., 2011, KitabMahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn,4thEdition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D. P.Khandelwal, 1985, Vani

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 tophysicists. Students are to be examined on the basis of problems, seen andunseen.

UNIT-I

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

UNIT-II

Frobenius Method and Special Functions: Singular Points of Second OrderLinear Differential Equations and their importance, Singularities of Bessel's andLaguerre Equations, Frobenius method and its applications to

differentialequations:LegendreandHermiteDifferentialEquations,LegendreandHermitePolynomials: 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 LegendreDifferential 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 (ProbabilityIntegral).

UNIT-IV

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

Text Books:

1. MathematicalMethodsforPhysicists,G.B.Arfken,H.J.Weber,F.E.Harris(2013, 7thEdn., Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) 9th Edition2011

Reference Books:

- Mathematical Physics and Special Relativity, M. Das, P.K. Jena andB.K. Dash (SrikrishnaPrakashan)-2009
- Mathematical Physics–H. K. Dass, Dr. Rama Verma (S. ChandPublishing) -2011
- Mathematical Physics C. Harper (Prentice Hall India)-1978
- Schaum's Outlines Series M. Spiegel (2ndEdition, 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 (4thedition, 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 doneon the basis of formulating the problem but not on the programming

Topics

Introduction to Numerical computation software Scilab: Introduction toScilab, Advantages and disadvantages, Scilab computation software Scilabenvironment, 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 ofoperations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2),Branching Statements and program design, Relational and logical operators, the whileloop, for loop, details of loop operations, break and continue statements, nested loops,logical arrays and vectorization (2) User defined functions, Introduction to Scilabfunctions, Variable passing in Scilab, optional arguments, preserving data betweencalls to a function, Complex and Character data, string function, Multidimensionalarrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods anddeveloping 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 Solutionmethod and Gauss Seidal method. Diagonalization matrices, Inverse of amatrix, 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- Kuttamethods, 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.20Bence, 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 andP.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.2011S.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 ofthermodynamics,

Second Law of Thermodynamics: Reversible and Irreversible process withexamples, Kelvin-Planck and Clausius Statements and their Equivalence, CarnotsTheorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale ofTemperature and its Equivalence to Perfect Gas Scale.

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Lawof Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle ofincrease of Entropy, Entropy Changes in Reversible and Irreversible processes withexamples, Entropy of the Principle of Increase of Entropy, Temperature Entropydiagrams for Carnot's Cycle, Third Law of Thermodynamics, Unattainability ofAbsolute 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 Filmsand Variation of Surface Tension with Temperature, Magnetic Work, Coolingdue to adiabatic demagnetization

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

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell'sRelations, Maxwell's Relations: (1) ClausiusClapeyron equation (2) Relationbetween *Cp*and *Cv*(3) TdS Equations,(4)Joule-Kelvin coefficient for Ideal andVan der Waal Gases (5) Energy equations (6) Change of Temperature during AdiabaticProcess.

UNIT-III

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities inan Ideal Gas and its Experimental Verification, Sterns Experiment, Mean, RMS andMost Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (Noproof required), Specific heats of Gases.

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

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

UNIT-IV

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation, TheVirial Equation, Andrews Experiments on CO2 Gas. Critical Constants, Continuity ofLiquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van der WaalsEquation of State for Real Gases, Values of Critical Constants, Law of CorrespondingStates, 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 ofInversion, 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 (Newcentral book agency limited)-2017
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics-Sears and Salinger(Narosa)-1988
- A Treatise on Heat- MeghnadSaha and B.N.Srivastava (The IndianPress) Heat, Thermodynamics and Statistical Physics, N.Subrahmanyamand BrijLal (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 Barnesconstant flow method.
2. To determine the Coefficient of Thermal Conductivity of a badconductor by Lee and Charltons disc method.
3. To determine the Temperature Coefficient of Resistance by PlatinumResistance Thermometer (PRT).
4. To study the variation of Thermo-emf of a Thermocouple with Difference ofTemperature 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, KitabMahal
- 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 (simpleidea), 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-waveRectifiers.center-tappedandbridgetypeFull-waveRectifiers,Calculation ofRipple Factor and Rectification Efficiency, L and C Filters (2) Zener Diode andVoltage Regulation, Principle and structure of LEDS, (2) Photo diode(3) SolarCell.

UNIT II

Bipolar Junction Transistors: n-p-n and p-n-p transistors, Characteristics ofCB, 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 ofcurrent flow, Active, Cut-off and Saturation Regions.

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

Amplifiers: Transistors as 2-port network h-parameter Equivalent Circuit, Analysisof 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- putImpedance, Output Impedance, Gain Stability, Distortion and Noise. SinusoidalOscillations: Barkhausen'sGaterian for self-sustained oscillations. RC Phase shiftoscillator, determination of Frequency, Hartley and Colpitt's oscillators.

UNIT-IV

Operational Amplifiers (Black Box approach): Characteristics of an Ideal andPractical OP-AMP (IC741). Open-loop and Closed loop Gain. FrequencyResponse. 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) Zerocrossing 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 voltageregulator.
2. Study of V-I and power curves of solar cells, and find maximum powerpoint and efficiency.
3. To study the characteristics of a Bipolar Junction Transistor in CEconfiguration and draw load line
4. To study the various biasing configurations of BJT for normal class Aoperation.
5. To study the frequency response of voltage gain of a RC-coupled transistoramplifier.
6. To design and study OP Amp-IC (741/351) as inverting and non invertingamplifier
7. To design and study OP Amp-IC (741/351) as integrator and differentiation andstudy 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 McGrawHill.
- 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 :OPTICS, SPECIAL THEORY OF RELATIVITY, ATOMIC PHYSICS, QUANTUM MECHANICS AND NUCLEAR PHYSICS

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

THEORY

UNIT-I

Optics-I: Elementary ideas of monochromatic aberrations and their minimization,chromatic aberration, achromatic combination, Theory of formation of primary andsecondary rainbow, condition of interference, coherent sources, Youngs double slitexperiment, biprism and measurement of wave length of light of by it, color of thinfilms and Newton's rings, Fresnel and Fraunhoffer diffraction, diffraction by singleslit plane transmission grating.

Optics-II : Electromagnetic nature of light, polarized and unpolarized light,polarization by reflection and refraction, Brewster's Law, Mauls Law, Doublerefraction, Ordinary and extraordinary rays.

UNIT-II Atomic Physics

Inadequacy of classical physics, brief outline of Rayleigh Jeans theory and Planck'squantum theory of radiation, particle nature of electromagnetic radiation photoelectric effect, Compton effect, dual nature of radiation, wave nature of particles, de-Broglie hypothesis, matter wave, wave-particle duality, Davisson- Germerexperiment.Bohr's theory of Hydrogen atom, explanation of Hydrogen Spectra, correction forfinite mass of the nucleus, Bohrs correspondence principle, limitations of Bohr'stheory, Discrete energy, exchange by atom Frank Hertz experiment.

UNIT-III

Quantum Mechanics : Heisenberg's Uncertainty relation, Time dependentSchrodinger's wave equation in one dimension and three dimensions, The physicalinterpretation of the wave function, Probability density and probability currentdensity, Equation of continuity, Normalization of the Wave function, Expectationvalue of an observable, Ehrenfest's theorem. Time independent Schrodinger's waveequation in one dimension particle in a box, energy eigen values and eigen functions.

UNIT-IV

Nuclear Physics : Properties of the nucleus Charge, Size, Spin, MagneticMoment, Mass, Mass defect, Binding energy, Packing fraction, Nuclear force andits characteristics features, Radioactive decay laws, average life, half life, nuclearfission, nuclear fusion, Linear accelerators, and cyclotron.

Relativity: Galilean transformation, Newtonian relativity and its limitation,Michelson Morley experiment and it's consequence, postulates of special theoryof relativity. Lorentz transformation, length contraction, time dilation, relativisticmass and momentum, mass energy relation.

Text Books:

1. University Physics, H. D. Young, R. A. Freedman (Person)-2017
2. Fundamentals of Physics, Resnick, Halliday, Walker (WIley)-2015

Reference Books:

- A Text Books book of Optics N. Subrahmanyam and BrijLal (S.ChandPublishing)-2006
- Introduction to Special Relativity-R. Resnick (John Wiley)-2007

- Concepts of Modern Physics Arthur Beiser (McGraw Hill)-2017
- Modern Physics H.S. Mani and G.K.Mehta-2018.

PRACTICAL

(Minimum 6 experiments are to be done):

1. Determination of E.C.E. of a Copper by taking 3readings.
2. Determination of Refractive index of the material of a prism usingSodium light.
3. To determine the wavelength of light using plane diffraction grating.
4. To determine the wavelength of light using Newton's ring.
5. Determination of refractive index of (a) glass and (b) liquid by usingtravelling microscope.
6. To plot the I-D curve and to determine the refractive index of a prism
7. Determination of radius of curvature of a convex/concave mirror by usingKohlrausch's method.
8. T o determine the magnifying power of a given telescope.
9. To Obtain the static characteristics of a P-N-P/N-P-N transistor/Triode Valve.
10. To determine the reduction factor of a tangent Galvanometer.
11. To study the Variation of magnetic field along the axis of a circular coilcarrying current.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint and H.T. Worsnop,(1971), Asia Publishing House
- A Laboratory Manual of Physics for Undergraduate Classes,D.P.Khandelwal (1985), Vani Publication
- A Text Books of Practical Physics, Indu Prakash andRamakrishna, 11th Edition (2011), KitabMahal, New Delhi

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 tophysicists. Students are to be examined on the basis of problems; known or unknown.

UNIT-I

Complex Analysis: Brief Revision of Complex Numbers and their GraphicalRepresentation 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 ofsingularity, branch cuts, Integration of a function of a complex variable, CauchysInequality, Cauchys Integral formula, Simply and multiply connected region, Laurentand Taylors expansion, Residues and Residue Theorem, Application in solvingsimple Definite Integrals.

UNIT-II

Integral Transforms-I: Fourier Transforms: Fourier Integral theorem, FourierTransform,Examples,FourierTransformoftrigonometric,Gaussian,finitewave trainand 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 Fouriertransforms 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 DifferentialEquations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Text Books:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris(2013,7thEdn., Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) 10thEdition 2014

Reference Books:

- ❖ Mathematical Physics and Special Relativity–M.Das, P.K. Jena and B.K. Dash(SrikrishnaPrakashan)-2009
- ❖ Mathematical Physics–H. K. Das, Dr. Rama Verma (S. Chand Publishing)2011
- ❖ Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition , Mc- GrawHill 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 clasees (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 UniversityPress
- ❖ Mathematics for Physicists, P.Dennery and .Krzywicki,1967,DoverPublications
- ❖ Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB:Scientific and Engineering Applications: A. VandeWouwer, 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 ofBlack body Radiation, Photoelectric effect, Compton Effect, dual nature ofradiation wave nature of particles, Atomic spectra, Line spectra of hydrogenatom, Ritz Rydberg combination principle, Alpha Particle Scattering, RutherfordScattering 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, limitationsof 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, WaveParticle Duality, Complemntarity.

Wave Particle Duality: de Broglie hypothesis, Experimental confirmation ofmatter wave, Davisson Germer Experiment, velocity of deBroglie wave, waveparticle duality, Complementarity.

Uncertainty Principle: Heisenberg Uncertainty Principle, Illustration of thePrinciplethroughthoughtExperimentsofGammaraymicroscopeandelectrondiffraction through a slit, Estimation of ground state energy of harmonic oscillator
and hydrogen atom, non existence of electron in the nucleus, Uncertainty andcomplementarities.

UNIT- III

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

UNIT- IV

Nuclear Physics- II: Radioactivity, stability of the nucleus, Law of radioactivedecay, Mean life and Half life Alpha decay, Beta decay-energy released, spectrum andPaulis 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 offragments and emission of neutrons, Nuclear reactor: slow neutron interacting withUranium 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:

❖ QuantumMechanics:TheoryandApplications,A.K.GhatakandS.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 (PearsonIndia)-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 doubleslits.
4. To determine (1) wavelength and (2) angular spread of He-Ne laser usingplane diffraction grating.
5. To determine the Plancks constant using LEDs of at least 4 differentcolours.
6. To determine the value of e/m by (a) Magnetic focusing or (b) Barmagnet.
7. To setup the Millikan oil drop apparatus and determine the charge of anelectron.

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,4thEdition, reprinted 1985, Heinemann Educational Publishers
- ❖ A Text Books Book of Practical Physics, I. Prakashand Ramakrishna,11thEdn, 2011,KitabMahal

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 ofIntegration: SSI, MSI, LSI and VLSI (basic idea and definitions only), Classificationof ICs, Examples of Linear and Digital ICs.

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

UNIT-II

Boolean algebra: De Morgans Theorems: Boolean Laws, Simplification of LogicCircuit using Boolean Algebra, Fundamental Products, Idea of Minterms andMaxterms, 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 systemand 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. Halfand Full Adders. Half and Full Subtractors, 4 bit binary Adder/Subtractor.

Timers: IC 555: block diagram and application is Astablemultivibrator andMonostablemultivibrator.

UNIT-IV

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

Shift registers: Serial-in-serial-out, Serial-in-Parallel-out, Parallel-in-Serial- outand 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-RakshitChattopadhaya (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 ,CambridgeUniversity -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 ofa periodic waveform using CRO and to test a Diode and Transistorusing 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 AdderI.C.
6. To build Flip-Flop(RS,Clocked RS,D- type and JK) circuits usingNAND gates.
7. To design an stable multivibrator of given specifications using 555Timer.
8. To design a monostablemultivibrator of given specifications using 555Timer.

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

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 ofWave Function, Interpretation of wave function, Probability and probability currentdensities in three dimensions, Conditions for Physical Acceptability of WaveFunction, Normalization, Linearity and Superposition Principles. Wave function of afree particle ,Wave Packet, Fourier Transform and momemtum space Wave function,Spread of Gaussian Wave packet, Evolution with time, Position and MomentumUncertainty.

UNIT-II

Operators: Operators, Commutator Algebra, Position, Momentum AngularMomentum and Energy operators, Hermitian Operators, Expectation values ofposition and momentum, Ehrenfest Theorem, Eigenvalues and Eigen functions ofHermitian Operator, Energy Eigen Spectrum, Degeneracy, Orthonormality ofEigen 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 arbitrarywave function as a linear combination of energy eigen functions, General solution ofthe time dependent Schrodinger equation in terms of linear combinations of stationarystates. General Discussion of Bound states in an arbitrary potential: Continuity ofwave function, Boundary condition and emergence of discrete energy levels,Application to one dimensional problem-Square well potential, Quantum mechanicsof simple Harmonic Oscillator-Energy Levels and energy eigen functions, groundstate, zero point energy and uncertainty principle, One dimensional infinitely rigidbox energy eigen values and eigen functions, normalization, quantum dot as example,Quantum mechanical scattering and tunnelling in one dimension across a steppotential and rectangular potential barrier.

UNIT-IV

Atoms in Electric and Magnetic Fields: Electron angular momentum. Spacequantization, Electron Spin and Spin Angular Momentum, Larmors Theorem,Spin Magnetic Moment, Stern Gerlach Experiment,Vector Atom Model, L-S andJ-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 KrishnaPublication)-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 $m = 0940MeV/c^2, k = 100MeV/fm^2, b = 0{,}10{,}30\ MeV/fm^3$. 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$V(r) = D(e^{-2\alpha r} - e^{-\alpha r})$, 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. $m = 940x10^6 eV/c^2, D = 0.755501eV, \alpha = 1.44, r_0 = 0.131349\ °A$
   b. $m = 940x106eV/c^2, D = 0.755501eV, \alpha = 1.44, r_0 = 0.131349\ °A$

Laboratory Based Experiments : (to be taken up depending on availability ofequipment)

1. Study of Electron spin resonance- determine magnetic field as a functionof 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.,3rdEdition, 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. VandeWouwer, 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 PublishingISBN: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 translationVectors, Lattice with a Basis. Central and Non-Central Elements. Unit Cell, MillerIndices, Types of Lattices, Reciprocal Lattice, Brillouin zones, DiffractionofXraysbycrystals,BraggLaw,AtomicandGeometricalFactor

UNIT-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear, Monotomicand Diatomic Chains, Acoustical and Optical Phonons, Qualitative Description of thephonon spectrum in solids, Dulong and Petits Law, Einstein and Debye theories ofspecific heat of solids, *T* 3 Law

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

UNIT-III

Dielectric Properties of Materials: Polarization Local Electrical Field at anAtom, Depolarization Field, Electric Susceptibility, Polari ability, ClausiusMosotti Equation, Classical theory of Electronic Polarizability.

Lasers: Einsteins A and B coefficients, Meta stable States, Spontaneous andStimulated emissions, Optical Pumping and population Inversion, Three Level andFour 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 HallCoefficient.

Superconductivity: Experimental Results, Critical Temperature, Criticalmagnetic field, Meissner effect, Type I and type II Superconductors, LondonsEquation and Penetration Depth, Isotope effect, Idea of BCS theory (Noderivation)

Text Books:

1. Introduction to Solid State Physics- Charles Kittel (Wiley India) 8th Edition2012
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 variationwith 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 energyloss from Hysteresis
6. To measure the resistivity and band gap of a given semiconductor by fourproblemmethod.
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, KitabMahal
- 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 tophysicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

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

UNIT-II

Hamiltons Principle, Calculus of Variation and derivation of Euler-Lagrangesequation, Langranges Equations derived from Hamiltons Principles, Hamiltoian andits applications to Shortest Distance between two points in a plane, GeodesicProblem, minimum surface of revolution, Brachistochrone problem, The Equations ofmotion and first integrals, The equivalent one-dimensional problem and classificationof orbits, canonical momenta, Hamiltions equations of motion, Motion of chargedparticles in external electric and magnetic fields, Applications to central force motionand coupled oscillators.

UNIT- III

Special theory of Relativity (Postulates of special theory of relativity), Lorentztransformations, Minkowski space, The invariant interval, light cone and worldlines, 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 vectorperspective, Concept of four-force, Conservation of four momentum, Application totwo 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 (OxfordPress)(2010)
3. Classical Mechanics-M. Das, P.K. Jena, M. Bhuyan, R.N. Mishra (SrikrishnaPrakashan)-2009
4. Mathematical Physics with Classical Mechanics-Satya Prakash (SultanChand and sons)-2014
5. Introduction to classical dynamics R.K.Takwale and S.Puranik (TataMcGraw 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 intrinsicproperties, Quantitative facts about mass, radius, charge density (matter density),binding energy, average binding energy and its variation with mass number, mainfeatures of binding energy versus mass number curve, N/A plot, angularmomentum, parity, magnetic moment electric moments, nuclear excites states.

Radioactivity decays: (a) Alpha decay: basics of alpha- decay processes, theoryof alpha-emission, Gamow factor, Geiger Nuttall law (b) beta-decay: energykinematics 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 andsignificance of its various terms, conditions of nuclear stability, two nucleonseparation energies, evidence for nuclear shell structure, nuclear magic number, basicassumption of shell models.

UNIT-III

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

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

UNIT-IV

Particle Physics: Particle interactions, basic features, types of particles and itsfamilies,

Symmetries and conservation laws: Energy and momentum, angularmomentum, parity, baryon number, Lepton number, Isospin, strangeness andcharm, 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, BrijLal and JivanSeshan (S. Chand Publishing)-2007

Reference Books:

- Introduction to Modern Physics- H.S.Mani and G.K. Mehta(Affilatedeast 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 andScalar 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 ElectromagneticField Energy Density

UNIT-II

EM Wave Propagation in Unbounded Media: Plane EM waves throughvacuum and isotropic dielectric medium, transverse nature of plane EM waves,refractive index and dielectric constant, wave impedance, Propagation throughconducting media, relaxation time, skin depth, Electrical conductivity of ionizedgases, plasma frequency, refractive index, skin depth, application to propagationthrough ionosphere.

UNIT-III

EM Wave in Bounded Media: Boundary conditions at a plane interface betweentwo media, Reflection and Refraction of plane waves at plane interface betweentwo dielectric media, Laws of Reflection and Refraction, Fresnel's Formulae forperpendicular and parallel polarization cases, Brewster's law, Reflection andTransmission coefficients, Total internal reflection, evanescent waves, Metallicreflection (normal Incidence)

UNIT IV

Polarization of Electromagnetic Waves: Description of Linear, Circular andElliptical Polarization, Uniaxial and Biaxial Crystals, Light Propagation inUniaxial Crystal, Double Refraction, Polarization by Double Refraction, NicolPrism, Ordinary and extraordinary refractive indices, Production and detection ofPlane, Circularly and Elliptically Polarized Light,**Phase Retardation Plates:** Quarter-Wave and Half- Wave Plates. BabinetsCompensator 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, Experimentalverification of Fresnels theory, Specific rotation, Laurents half-shadepolarimeter.

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 usingWollastonsair-film.
5. To determine the refractive Index of (1) glass and (2) a liquid by totalinternal reflection using a Gaussian eye piece.
6. To study the polarization of light by reflection and determine the polarizingangle 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 PNjunction 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, 11thEd., 2011, KitabMahal Electromagnetic Field Theory for Engineers andPhysicists, 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, Entropyand Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, PartitionFunction.

UNIT- II

Classical Statistics-II : Thermodynamic Functions of an Ideal Gas, classicalEntropy Expression, Gibbs Paradox, SackurTetrode equation, Law of equi partitionof 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 andBosons, Bose Einstein distribution function and Fermi- Dirac distribution function.Bose- Einstein Condensation, Bose deviation from Plancks law, Effect oftemperature on Fermi-Dirac distribution function, degenerate Fermi gas, Density ofStates Fermi energy.

UNIT-IV

Radiation: Properties of Thermal Radiation, Blackbody Radiation, Pure Temperaturedependence, Kirchhoffs law, Stefan Boltzmann law: Thermodynamic proof,Radiation Pressure, Weins Displacement law, Wiens distribution Law, SahasIonization 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

ReferenceBooks:

- Statistical Mechanics, B.K.Agarwal and Melvin Eisner (New Age International)-2013
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics: FrancisW.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 Mechanicslike

1. Plot Plancks law for Black Body radiation and compare it with Weins law andfind Wein's constant and Stefan constant
2. plot Raleigh-Jeans Law at high temperature (room temperature) and lowtemperature.
3. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b)Einstein distribution function, (c) Debye distribution function for hightemperature (room temperature) and low temperature and compare themfor 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, 3rdEdn. 2007, WileyIndia Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Edition, 1996, Oxford University Press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, FrancisW. 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. VandeWouwer, 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 3Dnanostructures (nanodots, thin films, nanowires, nanorods), Band structure anddensity of states of materials at nanoscale, size effects in nano systems, Quantumconfinement Applications of Schrodinger equation-infinite potential well, potentialstep, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructure andits 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-GelElectrodeposition,Spray pyrolysis,Hydrothermalsynthesis,Preparationthroughcolloidal methods, MBE growth of quantum dots.

UNIT-III

Characterization: X-Ray Diffraction, Optical Microscopy, Scanning ElectronMicroscopy, Transmission Electron Microscopy, Atomic Force Microscopy, ScanningTunneling Microscopy

UNIT-IV

Applications: Applications of nano particles, quantum dots, nanowires and thinfilms 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 dotsmagneticdata storage. Micro Electromechanical Systems (MEMS), NanoElectromechanical Systems (NEMS)

Text Books:

1. S.K. Kulkarni, Nanotechnology: Principles and Practices (CapitalPublishing Company)-3rd Edition 2014
2. Nano science and nano technology, K.K. Choudhary (Narosa)-2016

Reference Books:

- Nano Science and nano technology, Sundar Singh (PragatiPrakashan)-2017
- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (WileyIndia Pvt. Ltd.)-2007
- Richard Booker, Earl Boysen, Nanotechnology(John Wiley and Sons)-2005
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle TechnologyHandbook (Elsevier, 2007)
- K.K. Chattopadhya and A. N. Banerjee, Introduction to Nanoscienceand Technology (PHI Learning Private Limited)-2009

DSE-6.4 :DISSERTATION / PROJECT WORK

Full Marks – 100
End SemProject– 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, resolutionrange etc. Errors in measurements and loading effects.

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

Electronic Voltmeter: Advantage over conventional multimeter for voltagemeasurement with respect to input impedance and sensitivity. Principles ofvoltage, measurement (block diagramonly).Specifications of an electronicVoltmeter/ Multimeter and their significance.

AC mill voltmeter: Type of AC mill voltmeters: Amplifier- rectifier, and rectifieramplifier.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 nomathematical treatment), brief discussion on screen phosphor, visual persistence andchemical 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. Digitalstorage Oscilloscope: Block diagram and principle ofworking.

UNIT-III

Signal Generators and Analytical Instruments: Block diagram, explanation andspecifications 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 ofanalog and digital instruments, Characteristics of a digital meter, Workingprinciples of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter,Working principle of time interval, frequency and period measurement usinguniversalcounter/frequencycounter,time-basestability,accuracyandresolution.

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-SubrataGhoshal (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 voltageacross a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequencyvoltage 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 usingCRO.
5. Measurement of time period, frequency, average period using universalcounter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. MeasurementofdistortionofaRFsignalgeneratorusingdistortionfactormeter.
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, RakshitCentral-2013
- Practical Physics-B.B.Swain (KitabMahal)-2014
- Advanced practical Physics-B.Ghosh and KG Majumdar (Vol. I and II)-Shreedhar Publication-2004
- ALaboratoryManualofPhysicsforUndergraduateClasses,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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