CHOICE BASED CREDIT SYSTEM

School of Studies in Physics, Jiwaji University, Gwalior

B.Sc. Honors Physics SCHEME OF EXAMINATION SESSION 2021-24

SEMESTER I

Course Code	Course Name	Total Marks	Credit	End Sem. Exam		Sessional Marks	
				Max.	Min	Max	Min
CC-I-T	Mathematical Physics-I	100	4	60	21	40	14
CC-II-T	Mechanics	100	4	60	21	40	14
CC-I-P	Mathematical Physics-I Lab	100	2	60	21	40	14
CC-II-P	Mechanics Lab	100	2	60	21	40	14
GE-I	Computer fundamentals	100	4	60	21	40	14
AECC-I	English communication	100	4	60	21	40	14
	Total		20				

SEMESTER II

Course Code	Course Name	Total Marks	Credit	End Sem. Exam		Sessional Marks	
				Max.	Min	Max	Min
CC-III-T	Electricity and Magnetism	100	4	60	21	40	14
CC-IV-T	Waves and Optics	100	4	60	21	40	14
CC-III-P	Electricity and Magnetism Lab	100	2	60	21	40	14
CC-IV-P	Waves and Optics Lab	100	2	60	21	40	14
GE-II	Quantum Chemistry and Spectroscopy	100	4	60	21	40	14
AECC-II	Environmental Science	100	4	60	21	40	14
	Total		20				

SEMESTER III

Course Code	Course Name	Total Marks	Credit	End Sem. Exa		Sessional Marks	
				Max.	Min	Max	Min
CC-V-T	Mathematical Physics-II	100	4	60	21	40	14
CC-VI-T	Thermal Physics	100	4	60	21	40	14
CC-VII-T	Digital Systems and Applications	100	4	60	21	40	14
AEEC-I	Computational Physics Skill	100	4	60	21	40	14
GE-III	Introduction to Database System	100	4	60	21	40	14
CC-VI-P	Mathematical Physics-II Lab	100	2	60	21	40	14
CC-VI-P	Thermal Physics Lab	100	2	60	21	40	14
CC-VIII-P	Digital Systems & Applications Lab	100	2	60	21	40	14
			26				

SEMESTER IV

Course Code	Course Name	Total Marks	Credit	End Sem. Exa		Sessional Marks	
				Max.	Min	Max	Min
CC-VIII-T	Mathematical Physics III	100	4	60	21	40	14
CC-IX-T	Elements of Modern Physics	100	4	60	21	40	14
CC-X-T	Analog Systems and Applications	100	4	60	21	40	14
AEEC-II	Electrical Circuit Network Skills	100	4	60	21	40	14
GE-IV	Chemistry of main group elements, theories of acids and bases	100	4	60	21	40	14
CC-VIII-P	Mathematical Physics-III Lab	100	2	60	21	40	14
CC-IX-P	Elements of Modern Physics Lab	100	2	60	21	40	14
CC-X-P	Analog Systems & Applications Lab	100	2	60	21	40	14
			26				

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SEMESTER V

Course Code	Course Name	Total Marks	Credit	End Sem. Exa		Sessional Marks	
				Max.	Min	Max	Min
CC-XI-T	Quantum Mechanics & Applications	100	4	60	21	40	14
CC-XII-T	Solid State Physics	100	4	60	21	40	14
DSE-I-T	Experimental Techniques	100	4	60	21	40	14
DSE-II-T	Physics of Devices and Instrumentation	100	4	60	21	40	14
CC-XI-P	Quantum Mechanics Lab	100	2	60	21	40	14
CC-XII-P	Solid State Physics Lab	100	2	60	21	40	14
DSE-I-P	Experimental Techniques	100	2	60	21	40	14
DSE-II-P	Physics of Devices and Instrumentation	100	2	60	21	40	14
			24				

SEMESTER VI

Course Code	Course Name	Total Marks	Credit	End Sem. Exa		Sessional Marks	
				Max.	Min	Max	Min
CC-XIII-T	Electro-magnetic Theory	100	4	60	21	40	14
CC-XIV-T	Statistical Mechanics	100	4	60	21	40	14
DSE-III-T	Nuclear and Particle Physics	100	4	60	21	40	14
DSE-IV-T	Nano Materials and Applications	100	4	60	21	40	14
CC-XIII-P	Electro-magnetic Theory Lab	100	2	60	21	40	14
CC-XIV-P	Statistical Mechanics Lab	100	2	60	21	40	14
DSE-III-P	Nuclear and Particle Physics	100	2	60	21	40	14
DSE-IV-P	Nano Materials and Applications	100	2	60	21	40	14
			24				

Total Credits: 20+20+26+26+24+24 = 140

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Courses for SEMESTER I Duration July – December 2021

Core course-I theory	Mathematical Physics-I	4
Core course-II theory	Mechanics	4
General Elective – I GE - I	Computer Fundamentals	4
Ability Enhancement Compulsory Course -1 (AECC-1)	English Communication	4
Core course-I Practical/Tutorial	Mathematical Physics-I	2
Core course-II Practical/Tutorial	Mechanics	2

Semester I

PHYSICS-C I: MATHEMATICAL PHYSICS-I THEORY

Credits: 04 **40 Lectures**

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.

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series statements only. First Order Differential Equations and Integrating Factor. **6 Lectures**

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. **6 Lectures**

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **6 Lectures**

Vector Calculus:

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. **3Lectures**

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, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates. **6Lectures**

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. **8Lectures**

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **3 Lectures**

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. **2Lectures**

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7thEdn.,Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHIlearning
- Differential Equations, George F. Simmons, 2007, McGrawHill.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, VivaBook

B.Sc. Honors Physics syllabus

CHOICE BASED CREDIT SYSTEM

School of Studies in Physics, Jiwaji University, Gwalior

Complete Syllabus

SESSION 2021-24

PHYSICS LAB- C-I LAB: MATHEMATICAL PHYSICS-I

Credits: 02

20 Lectures

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 besolved*
- *Students can use any one operating system Linux or Microsoft Windows*

Topics Description with Applications

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 & overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods

Errors and error Analysis

Truncation and round off errors, Absolute and relative errors, Floating point computations.

Review of C & C++ Programming fundamentals Introduction to Programming, constants, variables and 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. TernaryOperator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops.* Arrays *1D & 2D* and strings, user defined functions,Structures and Unions, Idea of classes and objects

Programs:

Sum & 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

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods

Solution of linear and quadratic equation, solving $\alpha=\tan\alpha$; $I = Io\ [\sin\alpha/\alpha]^2$ in optics

Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation

Evaluation of trigonometric functions e.g. *sin θ, cos θ, tan θ, etc.*

Numerical differentiation Forward and Backward difference formula and Integration Trapezoidal and Simpsonrules, Monte Carlo method

Given Position with equidistant time data to calculate velocity and accelcration and vice versa. Find the area of B-H Hysteresis loop

Also attempt some problems on differential equations like:

1. Solve the coupled first order differential equations

$Dy/dx = y+x-x^3/3$ and $dy/dx = -x$ for four initial conditions $x0 = 0$, $y0 = -1, -2, -3, -4$. Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$.

2. The ordinary differential equation describing the motion of a pendulum is $\vartheta'' = -\sin\vartheta$.

The pendulum is released from rest at an angular displacement α i.e. $\vartheta(0) = \alpha$

Use the RK4 method to solve the equation for $\alpha = 0.1$, 0.5 and 1.0 and plot as a function of time in the range $0 \le t \le 8\pi$. Also, plot the analytic solution valid in the small , =

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn. , 2012, PHI Learning Pvt.Ltd.
- Numerical Computational Programming, P.B. Patil and U.P. Verma, Narosa Pub. New Delhi
- Schaum's Outline of Programming with C++. J. Hubbard,2000, McGraw---HillPub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Presscta1, 3rdEdn. , 2007, Cambridge University Press.

- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, WileyIndia.

PHYSICS-C II: MECHANICS

Credits: 02

THEORY
20 Lectures

1. Measurements of length or diameter using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate a Spring constant, b g and c Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method Poiseuille's method.
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Ba rPendulum.
12. 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 PublishingHouse
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann EducationalPublishers
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11thEdn, 2011, KitabMahal

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PHYSICS-C II: MECHANICS

THEORY
40 Lectures

Credits: 04

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket. **4Lectures**

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy **2Lectures**

Collisions: Elastic and inelastic collisions between particles. COM and Laboratory frames. **2Lectures**

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. **7Lectures**

Elasticity: RelationbetweenElasticconstants.TwistingtorqueonaCylinderorWire. 1Lectures

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **2Lectures**

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. **3Lectures**

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system GPS. Physiological effects on astronauts. **6Lectures**

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **4Lectures**

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. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. **3Lectures**

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. 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. Energy- Momentum Four Vector. **6Lectures**

Reference Books:

- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, TataMcGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008,Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, CengageLearning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, PearsonEducation
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley andSons.
- University Physics, Ronald Lane Reese, 2003, ThomsonBrooks/Cole.

Additional Books for Reference

- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, AddisonWesley Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGrawHill.

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AECC-1 : ENGLISH LANGUAGE

Credits: 04

40 Lectures

Structural Items

- Simple, compound and complex sentences.
- Co ordinate clauses (with but or Either-Or, Neither-Nor, Otherwise, Or else)
- Sub-ordinate clauses-noun clauses-as subject object and complement: Relative clouses (restrictive and non-restrictive clauses). Adverb clauses (open and hypothetical conditional, with because, though, here, so that, as long as, as soon as).
- Comparative Clauses (as+adjective/qdverb+as-to sooner that).

Tenses-

- Simple present, progressive and present perfect
- Simple past, progressive and past perfect.
- Indication of Futurity.

The passive (Simple present and past, present and past perfect and toinfinitive structure.

Reported Speech-

- Declarative sentences
- Imperatives
- Introgatives-wh-question, Yes/No Questions
- Exclamatory sentences.

Models (will, shall, should, would, ought to has to have to ought, can could, may/might and need.)

- Verb structures (infinitives and gerund)
- Linking devices-

Note: The above language items will be introduced to express the following communicative functions-

- Seeking and imparting information
- Expressing attitudes-intellectual and emotional
- Persuasion and dissuasion etc.

Note: Questions on all the units shall be asked from the prescribed text, which will comprise/specimens of popular creative writing and the following items:

- Indian Art : Meaning of Art, Features of Indian Art, Elementary knowledge of paintings, Music, Dancing, Sculpture Archaeology, Iconography and Other Social Arts.
- Indian Literature : Ancient Indian Literature, Elementary knowledge of Vedic Literature, Mahabharata, Ramayan and Other Main Granthas.
- Indian Freedom Struggle: Freedom Struggle of 1857, National Consciousness Non-Co-operation Movement. Civil Disobedient Movement Quit India Movement Contribution of revolutionaries in freedom struggle.
- Indian Constitution: Introduction, Main features of Constitution Fundamental Rights, Fundamental Duties.

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GE-1 COMPUTER FUNDAMENTALS **THEORY**
Credit : 04 **40 Lectures**

Introduction: Introduction to computer system, uses, types. **3 L**

Data Representation: Number systems and character representation, binary arithmetic **8 L**

Human Computer Interface: Types of software, Operating system as user interface, utility programs **4L**

Devices: Input and output devices (with connections and practical demo), keyboard, mouse, joystick, scanner, OCR, OMR, bar code reader, web camera, monitor, printer, plotter **6L**

Memory: Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks **5L**

Computer Organization and Architecture: C.P.U., registers, system bus, main memory unit, cache memory, Inside a computer, SMPS, Motherboard, Ports and Interfaces, expansion cards, ribbon cables, memory chips, processors. **8L**

Overview of Emerging Technologies: Bluetooth, cloud computing, big data, data mining, mobile computing and embeddedsystems. **6L**

Reference Books:

1. A. Goel, Computer Fundamentals, Pearson Education,2010.
2. P. Aksoy, L. DeNardis, Introduction to Information Technology, Cengage Learning,2006
3. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers,2007

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, TataMcGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-HillEducation
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, BenjaminCummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, PearsonEducation
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford UniversityPress.
- Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ.Press.

PHYSICS-C III: ELECTRICITY AND MAGNETISM LAB

Practical Credits: 02 **20 Lectures**

1. Use a Multimeter for measuring a Resistances, b AC and DC Voltages, c DC Current, d Capacitances, and e Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid determine dB/dx
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its a Resonant frequency, b Impedance at resonance, c Quality factor Q, and d Bandwidth.
11. To study the response curve of a parallel LCR circuit and determine its a Anti- resonant frequency and b Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

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 & 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, VaniPub.

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Courses for SEMESTER II Duration July – December 2022

Core course-III theory	Electricity and Magnetism	4
Core course-IV theory	Waves and Optics	4
Generic Elective -3 (GE-III)	Quantum Chemistry & Spectroscopy	4
Ability Enhancement Compulsory Course -II (AEEC-II)	Environmental Science	4
Core course-III Practical/Tutorial	Electricity and Magnetism	2
Core course-IV Practical/Tutorial	Waves and Optics	2

Semester II

PHYSICS-C III: ELECTRICITY AND MAGNETISM THEORY
Credits: 04 40 Lectures

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. **4 L**

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. **4L**

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. **5L**

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. **5L**

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment Analogy with Electric Dipole. Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. **6L**

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. **3L**

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. **4L**

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

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 circuits. **3 L**

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping.CDR. **2 L**

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PHYSICS-C IV: WAVES AND OPTICS

THEORY

Credits: Theory-04

40 Lectures

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies Beats. Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **4Lectures**

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures 1:1 and 1:2 and their uses. **2Lectures**

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive Travelling Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. **3Lectures**

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **4Lectures**

Superposition of Two Harmonic Waves: Standing Stationary Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. **4Lectures**

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **2Lectures**

Interference: Division of amplitude and wave front. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. 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. **7Lectures**

Interferometer: Michelson 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. **2Lectures**

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit. **2Lectures**

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **5Lectures**

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. **5Lectures**

ReferenceBooks

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, TataMcGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981,McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7thEdn., 1999, PergamonPress.
- Optics, AjoyGhatak, 2008, Tata McGrawHill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley andSons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGrawHill.

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PHYSICS LAB- C IV LAB WAVES AND OPTICS **LAB**
Credit Practical : 02 **20 Lectures**

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster's focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of 1 Na source and 2 spectral lines of Hg source using plane diffraction grating.
12. 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 & 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, VaniPub.

AECC-II: ENVIRONMENTAL SCIENCE

CREDIT : 04 **20 Lectures**

UNIT-I

The Environment: The Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecology, Ecosystem, Biogeochemical Cycle (Carbon Cycle, Nitrogen Cycle).

UNIT-II

Environment Pollution: Air Pollution, Water Pollution, Soil Pollution, Noise Pollution, Thermal Pollution, Radiation Pollution, Natural Disasters and their Management.

UNIT-III

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-IV

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

UNIT-V

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.

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GE 2 : QUANTUM CHEMISTRY and SPECTROSCOPY

Credits: 04 **Theory: 40 Lectures**

Quantum Chemistry

UNIT-I

Postulates of quantum mechanics, energy and momentum operators, Schrödinger equation and its application to free particle, Heisenberg Uncertainty principle; wavefunctions, probability distribution functions. Simple harmonic oscillator model of vibrational motion: Vibrational energy of diatomic molecules and zero-point energy.

UNIT II

Rigid rotator model of rotation of diatomic molecule.

Qualitative treatment of hydrogen atom: Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+.

UNIT-III

Molecular Spectroscopy:

Interaction of electromagnetic radiation with molecules and various types of spectra;

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations.

UNIT-IV

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference.

UNIT- V

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence. Larmor precession, chemical shift.

Reference Books:

- Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
- Kakkar, R. *Atomic & Molecular Spectroscopy: Concepts & Applications*, Cambridge University Press (2015).

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Courses for SEMESTER III **Duration** **July – December 2022**

Core course-V theory	Mathematical Physics-II	4
Core course-VI theory	Thermal Physics	4
Core course-VII theory	Digital Systems and Applications	4
Ability (Skill) Enhancement Elective Course -1 (AEEC-1)	Computational Physics Skill	4
Generic Elective -3 (GE-3)	Introduction to Database System	4
Core course-V Practical/Tutorial	Mathematical Physics-II Lab	2
Core course-VI Practical/Tutorial	Thermal Physics Lab	2
Core course-VII Practical/Tutorial	Digital Systems & Applications Lab	2

Semester III (three courses) Duration July-Dec. 2022

PHYSICS - C V: MATHEMATICAL PHYSICS-II THEORY

Credits: -04 **40 Lectures**

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.

Fourier Series: 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. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. **10 L**

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality. **16 L**

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function Probability Integral. **3 L**

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. **2 L**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. **9L**

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris,Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, TataMcGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, ThomsonBrooks/Cole.
- Differential Equations, George F. Simmons, 2006, TataMcGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, DoverPub.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, VivaBooks

PHYSICS -C V : MATHEMATICAL PHYSICS-II LAB

Credits: Practicals-02 **20 Lectures**

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 not on the programming but on the basis of formulating the problem

Topics in RED and Description with Applications IN BLACK

Introduction to Numerical computation software Scilab

Introduction to Scilab, Advantages and disadvantages, 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 & logical operators, the while loop, for loop, details of loop operations, break & 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 program2.

Curve fitting, Least square fit, Goodness of fit, standard deviation

Ohms law to calculate R, Hooke's law to calculatespring constant

Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method.

Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values 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 and Runge-Kutta second order methods Second order differential equation Fixed difference method

First order differential equation

- Radioactive decay
- Current in RC, LC circuits with DCsource
- Newton's law of cooling
- Classical equ. of motion II order Diff. Equ.
- Harmonic oscillator no friction
- Damped Harmonicoscillator
- Overdamped
- Critical damped
- Oscillatory
- Forced Harmonicoscillator
- Transientand
- Steady state solution Apply above to LCR circuits also

Using Scicos / xcos

- Generating square wave, sine wave, saw toothwave
- Solution to harmonic oscillator
- Study of beatphenomenon Phase space plots

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S.J.Bence, 3rd ed., 2006, Cambridge University Press
- Numerical Computational Programming, P.B. Patil and U.P. Verma, Narosa Pub. New Delhi

- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 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&Company
- Scilab Image Processing: Lambert M. Surhone. 2010 BetascriptPublishing

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PHYSICS-C VI: THERMAL PHYSICS

Theory
40 Lectures

Credits: -04

Include related problems for each topic

Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility andExpansionCo-efficient. **5 L**

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to PerfectGasScale. **6L**

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 Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **5L**

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation andEhrenfestequations **5L**

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, (1) ClausiusClapeyronequation, (2) Values of Cp-Cv, (3) Tds Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. **5L**

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy No proof required. Specific heats of Gases. **5L**

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 anditsSignificance. **4L**

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's 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- ThomsonCooling. **5L**

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981,McGraw-Hill.
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, TataMcGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009,Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988,Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford UniversityPress

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PHYSICS LAB- C VI THERMAL PHYSICS LAB

Credits: 02

Practicals
20 Lectures

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flowmethod.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle'sApparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom'sMethod.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's discmethod.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance ThermometerPRT.
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its TwoJunctions.
7. TocalibrateathermocoupletomeasuretemperatureinaspecifiedRangeusing (1) Null Method, (2)Direct measurement using Op-Amp difference amplifier and to determine NeutralTemperature.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann EducationalPublishers
- A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, VaniPub.

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PHYSICS-C VII: DIGITAL SYSTEMS AND APPLICATIONS THEORY
Credits: 04 **40 Lectures**

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: 1 Study of Waveform, 2 Measurement of Voltage, Current, Frequency, and Phase Difference. **3L**

Integrated Circuits Qualitative treatment only: Active & 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. **3L**

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. 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. **5L**

Boolean algebra: De Morgan's 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 (I) Sum of Products Method and (II) KarnaughMap. **3L**

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **2L**

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors. **3L**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked Level and Edge Triggered Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. **6L**

Timers: IC 555: block diagram and applications: Astablemultivibrator and Monostable multivibrator. **2L**

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers only up to4bits. **2L**

Counters4 bits: Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **2L**

Computer Organization: Input/Output Devices. Data storage idea of RAM and ROM. Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. **3L**

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. **4L**

Introduction to Assembly Language: 1 byte, 2 byte& 3 byte instructions. **2 L**

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, TataMcGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

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PHYSICS Practical - C VII: DIGITAL SYSTEMS & APPLICATIONS LAB: 20 Lectures
Credits: Practicals-02

1. To measure a Voltage, and b Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch NOT gate using atransistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified TruthTable.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logiccircuit.
8. Half Adder, Full Adder and 4-bit binaryAdder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full AdderI.C.
10. To build Flip-Flop RS, Clocked RS, D-type and JK circuits using NANDgates.
11. To build JK Master-slave flip-flop using Flip-FlopICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timingdiagram.
13. To make a 4-bit Shift Register serial and parallel using D-type/JK Flip-FlopICs.
14. To design an astablemultivibrator of given specifications using 555Timer.
15. To design a monostable multivibrator of given specifications using 555Timer.
16. Write the following programs using 8085Microprocessor
    a) Addition and subtraction of numbers using direct addressingmode
    b) Addition and subtraction of numbers using indirect addressingmode
    c) Multiplication by repeatedaddition.
    d) Division by repeatedsubtraction.
    e) Handling of 16-bitNumbers.
    f) Use of CALL and RETURNInstruction.
    g) Block datahandling.
    h) Other programs e.g. Parity Check, using interrupts,etc..

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, PrenticeHall.
- Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHILearning.

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Semester III **Duration July-Dec. 2022**

AEEC – 1 : COMPUTATIONAL PHYSICS SKILLS

Credits: 04 **Theory: 30 L**

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlighis the use of computational methods to solve physicalproblems*
- *Use of computer language as a tool in solving physics problemsapplications*
- *Course will consist of hands on training on the Problem solving onComputers.*

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution.

Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sinx as a series, algorithm for plotting 1 lissajous figures and 2 trajectory of a projectile thrown at an angle withthehorizontal. **4 L**

Scientific Programming: Some fundamental Linux Commands Internal and External commands. Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements unformatted/formatted, Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples fromphysicsproblems. **5 L**

Control Statements: Types of Logic Sequential, Selection, Repetition, Branching Statements Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements, Looping Statements DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops, Jumping Statements Unconditional GOTO, Computed GOTO, Assigned GOTO Subscripted Variables Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays, Functions and Subroutines Arithmetic Statement Function, Function Subprogram and Subroutine, RETURN, CALL, COMMON and EQUIVALENCE Statements, Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems. **6 L**

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment andcolors,errors. **6 L**

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot equations, building functions, user defined variables and functions, Understanding data with Gnuplot

Programming:

1. Exercises on syntax on usage ofFORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes inFORTRAN.
3. To print out all natural even/ odd numbers between givenlimits.
4. To find maximum, minimum and range of a given set ofnumbers.

Calculating Euler number using expx series evaluatedatx=1

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviationetc.
2. To evaluate sum of finite series and the area under acurve.
3. To find the product of twomatrices
4. To find a set of prime numbers and Fibonacciseries.
5. To write program to open a file and generate data for plotting usingGnuplot.
6. Plotting trajectory of a projectile projectedhorizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdffile.
9. To find the roots of a quadraticequation.
10. Motion of a projectile using simulation and plot the output forvisualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs forvisualization.
12. Motion of particle in a central force field and plot the output forvisualization.

9 L

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt.Ltd.
- Computer Programming in Fortran 77", V. Rajaraman Publisher:PHI.
- LaTeX–A Document Preparation System", Leslie Lamport Second Edition, Addison-Wesley,1994.
- Gnuplot in action: understanding data with graphs, Philip K Janert, Manning2010
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill BookCo.
- Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, NewDelhi1999
- AfirstcourseinNumericalMethods,U.M.AscherandC.Greif,2012,PHILearning
- Elementary Numerical Analysis, K.E. Atkinson, 3rdEdn., 2007, Wiley IndiaEdition.

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Semester III

GE 3 : Introduction to Database System

Credit: Theory 04 **Theory: 40 lectures**

Database: Introduction to database, relational data model, DBMS architecture, data independence, DBA, database users, end users, front end tools **08L**

E-R Modeling: Entity types, entity set, attribute and key, relationships, relation types, E- R diagrams, database design using ER diagrams **10L**

Relational Data Model: Relational model concepts, relational constraints, primary and foreign key, normalization: 1NF, 2NF, 3NF **10L**

Structured Query Language: SQL queries, create a database table, create relationships between database tables, modify and manage tables, queries, forms, reports, modify, filter and view data. **12L**

Reference Books :

1. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India,2008
2. R. Elmsasri,S.Navathe Fundamentals of Database Systems, Pearson Education, Fifth Edition,2007
3. MySQL : Reference Manual

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Courses for SEMESTER IV **Duration January – June 2023**

Core course-VIII theory	Mathematical Physics III	4
Core course-IX theory	Elements of Modern Physics	4
Core course-X theory	Analog Systems and Applications	4
Ability (Skill) Enhancement Elective Course -2 (AEEC-2)	Electrical Circuit Network Skills	4
Generic Elective -4 GE-4)	Chemistry of main group elements, theories of acids and bases	4
Core course-VIII Practical/Tutorial	Mathematical Physics-III Lab	2
Course-IX Practical/Tutorial	Elements of Modern Physics Lab	2
Course- X Practical/Tutorial	Analog Systems & Applications Lab	2

Semester IV (Three Courses)

PHYSICS-C VIII: MATHEMATICAL PHYSICS-III Theory

Credits: 04 **40 Lectures**

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's 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. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving DefiniteIntegrals. **20L**

Integrals Transforms:

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric,Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms translation, change of scale, complex conjugation, etc.. Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/HeatFlowEquations. **10L**

Laplace Transforms: Laplace Transform LT of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits. **10L**

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge UniversityPress
- Complex Variables, A.S.Fokas&M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ.Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, TataMcGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones &Bartlett

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PHYSICS PRACTICAL-C VIII : MATHEMATICAL PHYSICS-III

Credits: Laboratory-02 **LAB:** 20 Lectures

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:
   $dy/dx = e^{-x}$ with $y = 0$ for $x = 0$
   $dy/dx + e^{x}y = x^2$
   $d^2y/dt^2 + 2\ dy/dt = -y$
   $d^2y/dt^2 + e^{t}dy/dt = -y$

2. Dirac DeltaFunction:
   Evaluate =1, .1, .01 and show it tends to 5.

3. FourierSeries:
   Program to sum
   Evaluate the Fourier coefficients of a given periodic function square wave

4. Calculation of error for each data point of observations recorded in experiments done in previous semesters choose anytwo.

5. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computerprogram.

6. Evaluation of trigonometric functions e.g. *sin θ*, Given Bessel's function at N points find its value at anintermediate point. Complex analysis: Integrate $1/x^2+2$ numerically and check with computerintegration.
7. Integral transform: FFT of

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 A. Krzywicki, 1967, DoverPublications
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN:978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN:978-1479203444
- Scilab A free software to Matlab: H.Ramchandran, A.S.Nair. 2011 S.Chand&Company
- Scilab Image Processing: Lambert M. Surhone. 2010 BetascriptPublishing

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PHYSICS-C IX: ELEMENTS OF MODERN PHYSICS
Credits: 04

Theory
40 Lectures

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. **10 L**

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle Uncertainty relations involving Canonical pair of variables: Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of aninteraction. **4 L**

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativisticparticles;MomentumandEnergyoperators;stationarystates;physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities inonedimension. **6 L**

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. **6 L**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model andmagicnumbers. **4 L**

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity ofanucleus. **5 L**

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy brief qualitativediscussions. **2 L**

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser andHe-NeLaser. **3 L**

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002,McGraw-Hill.
- Introduction to Quantum Mechanics, David J. Griffith, 2005, PearsonEducation.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak&S.Lokanathan, 2004,Macmillan

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHILearning.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-HillCo.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rdEdn., Institute of PhysicsPub.
- Six Ideas that Shaped Physics: ParticleBehavelike Waves, T.A.Moore,2003, McGraw Hill

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PHYSICS PRACTICAL-C IX ELEMENTS OF MODERN PHYSICS

Credits: Practicals-02 **LAB 20 Lectures**

1. Measurement of Planck's constant using black body radiation andphoto-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency oflight
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 differentcolours.
5. To determine the wavelength of H-alpha emission line of Hydrogenatom.
6. To determine the ionization potential ofmercury.
7. To determine the absorption lines in the rotational spectrum of Iodinevapour.
8. To determine the value of e/m by a Magnetic focusing or b Barmagnet.
9. To setup the Millikan oil drop apparatus and determine the charge of anelectron.
10. To show the tunneling effect in tunnel diode using I-Vcharacteristics.
11. To determine the wavelength of laser source using diffraction of singleslit.
12. To determine the wavelength of laser source using diffraction of doubleslits.
13. To determine 1 wavelength and 2 angular spread of He-Ne laser using plane diffractiongrating

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann EducationalPublishers
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11thEdn, 2011,KitabMahal

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PHYSICS-C X: ANALOG SYSTEMS AND APPLICATIONS

Credits: 04 **Theory: 40 Lectures**

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 forStepJunction. **6 L**

Two-terminal Devices and their Applications: 1 Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, 2 Zener Diode and Voltage Regulation. Principle and structure of 1 LEDs, 2 Photodiode, 3SolarCell. **4 L**

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff andSaturationRegions. **4 L**

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage DividerBias.Transistoras2-portNetwork.h-parameterEquivalentCircuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. **6 L**

Coupled Amplifier: RC-coupled amplifier and its frequency response. **2 L**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, DistortionandNoise. **4 L**

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **3 L**

Operational Amplifiers Black Box approach: Characteristics of an Ideal and Practical Op-Amp. IC 741 Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept ofVirtual ground. **2 L**

Applications 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 Weinbridgeoscillator. **6 L**

Conversion: Resistive network Weighted and R-2R Ladder. Accuracy and Resolution. A/D Conversionsuccessiveapproximation **3 L**

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-GrawHill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, PrenticeHall.
- Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6th Edn.,2009, PHILearning
- Electronic Devices & circuits, S.Salivahanan&N.S.Kumar, 3rd Ed., 2012, Tata Mc-GrawHill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, PrenticeHall
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008,Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, WileyIndia
- Electronic Devices, 7/e Thomas L. Floyd, 2008, PearsonIndia

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PHYSICS PRACTICAL-C X : ANALOG SYSTEMS & APPLICATIONS

Credits: Practicals-02 **LAB: 40 Lectures**

1. To study V-I characteristics of PN junction diode, and Light emittingdiode.
2. To study the V-I characteristics of a Zener diode and its use as voltageregulator.
3. Study of V-I & power curves of solar cells, and find max. power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CEconfiguration.
5. To study the various biasing configurations of BJT for normal class Aoperation.
6. To design a CE transistor amplifier of a given gain mid-gain usingvoltage dividerbias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using anop-amp.
9. To design a phase shift oscillator of given specifications usingBJT.
10. To study the Colpitt`soscillator.
11. To design a digital to analog converter DAC of givenspecifications.
12. To study the analog to digital convertor ADCIC.
13. To design an inverting amplifier using Op-amp 741,351 for dc voltage of given gain
14. To design inverting amplifier using Op-amp 741,351 and study its frequencyresponse
15. To design non-inverting amplifier using Op-amp 741,351 & study its frequency response
16. To study the zero-crossing detector andcomparator
17. To add two dc voltages using Op-amp in inverting and non-invertingmode
18. To design a precision Differential amplifier of given I/O specification usingOp-amp.
19. To investigate the use of an op-amp as anIntegrator.
20. To investigate the use of an op-amp as aDifferentiator.

Reference Books:

- Basic Electronics: A text 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, PHI.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-GrawHill.
- Electronic Devices & circuit Theory, R.L. Boylestad& L.D. Nashelsky, 2009,Pearson

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Semester IV

GE 4 : CHEMISTRY OF MAIN GROUP ELEMENTS, THEORIES OF ACIDS AND BASES

Credits: Theory-04 **Theory: 40 Lectures**

Acids and Bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

(6 Lectures)

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents.

Hydrometallurgy with reference to cyanide process for gold and silver. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn, Au): electrolytic refining, zone refining, van Arkel-de Boer process, Parting Process, Mond's process and Kroll Process.

(5 Lectures)

***s*- and *p*-Block Elements**

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electronegativity (Pauling scale).

General characteristics of *s*-block metals like density, melting and boiling points, flame colour and reducing nature.

Oxidation states of *s*- and *p*-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S.

Complex forming tendency of *s* block elements and a preliminary idea of crown ethers and cryptates, structures of basic beryllium acetate, salicylaldehyde/ acetylacetonato complexes of Group 1 metals.

Solutions of alkali metals in liquid ammonia and their properties.

Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of *s*-block metals

(10 Lectures)

Structure, bonding and properties (acidic/ basic nature, oxidizing/ reducing nature and hydrolysis of the following compounds and their applications in industrial and environmental chemistry wherever applicable:

Diborane and concept of multicentre bonding, hydrides of Groups 13 (EH_3), 14, 15, 16 and 17.

Oxides of N and P, Oxoacids of P, S and Cl.

Halides and oxohalides of P and S (PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2) Interhalogen compounds.

A brief idea of pseudohalides

(12 Lectures)

Noble gases

Rationalization of inertness of noble gases,clathrates, preparation and properties of XeF_2, XeF_4 and XeF_6, bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory.

(3 Lectures)

Inorganic Polymers

Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones. Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in $(NPCl_2)_3$.

(4 Lectures)

Recommended texts:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inor.Chem.*, John Wiley & sons.
- Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010.
- Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

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Semester IV
AEEC - 2 ELECTRICAL CIRCUIT NETWORK SKILLS

Credits: 02 **Theory: 30 L**

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeterandammeter. **3 L**

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energyandmoney. **4 L**

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltagedrop. **4 L**

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operationoftransformers. **3 L**

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. **4 L**

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **3 L**

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements relay protection device **4 L**

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation ofextensionboard. **5 L**

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand &Co.
- A text book of Electrical Technology - A KTheraja
- Performance and design of AC machines - M G Say ELBSEdn.

Courses for SEMESTER V **Duration July – December 2023**

Core course-XI theory		Quantum Mechanics & Applications	4
Core course-XII theory		Solid State Physics	4
Discipline Specific Elective -1 theory	DSE-1	Experimental Techniques	4
Discipline Specific Elective -2 theory	DSE-2	Physics of Devices and Instrumentation	4
Core course-XI Practical/Tutorial		Quantum Mechanics Lab	2
Core course-VII Practical/Tutorial		Solid State Physics Lab	2
Discipline Specific Elective -1Practical	DSE-1 Lab	Experimental Techniques	2
Discipline Specific Elective- 2Practical	DSE-2 Lab	Physics of Devices and Instrumentation	2

Semester V (Two courses) Duration July-Dec. 2023

PHYSICS-C XI: QUANTUM MECHANICS AND APPLICATIONS

Credits: 04 **Theory: 40 Lectures**

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of aFreeParticle. **5 L**

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentumuncertaintyprinciple. **7 L**

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 eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **8 L**

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells. **6 L**

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **5 L**

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect QualitativeDiscussiononly. **3 L**

Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for

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Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali AtomsNaetc.. **6 L**

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGrawHill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002,Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGrawHill.
- Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning ofIndia.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and BartlettLearning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rdEdn., 1993,Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge UniversityPress

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons,Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, PearsonEducation
- Quantum Mechanics, Walter Greiner, 4thEdn., 2001,Springer

PHYSICS PRACTICAL-C XI Q. MECH. AND APPLICATIONS

Credits: Practicals-02 **LAB: 20 Lectures**

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:
   Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 eVÅ$^{1/2}$, ħc = 1973 eVÅ and m = 0.511x10^6 eV/c^2.
2. Solve the s-wave radial Schrodinger equation for another atom:
3. Solve the Schrodinger equation for harmonic osscilation.
4. Solve the Schrodinger equation for the vibrations of hydrogen molecule as an anharmonic oscillator.

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonancefrequency
6. Study of Zeeman effect: with external magnetic field; Hyperfinesplitting
7. To show the tunneling effect in tunnel diode using I-Vcharacteristics.
8. Quantum efficiency ofCCDs

Reference Books:

- Schaum's outline of Prog. with C++. J.Hubbard, 2000,McGraw---HillPublication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn., 2007, Cambridge UniversityPress.
- An introduction to comp.l Physics, T.Pang, 2ndEdn.,2006, Cambridge Univ.Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández.2014Springer.
- Scilab A Free Software to Matlab: H. Ramchandran, A.S. Nair. 2011 S. Chand &Co.
- Scilab Image Processing: L.M.Surhone.2010 Betascript PublishingISBN:978-6133459274

PHYSICS-C XII: SOLID STATE PHYSICS

Credits: 04 **Theory: 40 Lectures**

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic andGeometricalFactor. **8 L**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.T^3law **6 L**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. 6 L

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TOmodes. **5 L**

Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PEhysteresisloop. **5 L**

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor P and N type and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity 04 probe method &Hallcoefficient. **6 L**

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theoryNoderivation **4 L**

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt.Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-GrawHill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, CengageLearning
- Solid-state Physics, H. Ibach and H. Luth, 2009,Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, PearsonIndia
- Solid State Physics, M.A. Wahab, 2011, NarosaPublications

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PHYSICS PRACTICAL-C XII : SOLID STATE PHYSICS

Credits: Practicals-02 **LAB: 20Lectures**

1. Measurement of susceptibility of paramagnetic solution Quinck`s TubeMethod
2. To measure the Magnetic susceptibility ofSolids.
3. To determine the Coupling Coefficient of a Piezoelectriccrystal.
4. To measure the Dielectric Constant of a dielectric Materials withfrequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonanceSPR
6. To determine the refractive index of a dielectric layer usingSPR
7. To study the PE Hysteresis loop of a FerroelectricCrystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss fromHysteresis.
9. To measure the resistivity of a semiconductor Ge with temperature by four-probe method room temperature to 150 °C and to determine its bandgap.
10. To determine the Hall coefficient of a semiconductorsample.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann EducationalPublishers.
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall ofIndia.

Physics DSE - 1: EXPERIMENTAL TECHNIQUES

Credits: 04 **Theory: 40 Lectures**

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square and curve fitting.Guassiandistribution. **5 L**

Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise,1/fnoise **5L**

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding.ElectromagneticInterference. **2 L**

Transducers & industrial instrumentation working principle, efficiency, applications: Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors AD590, LM35, LM75 and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer LVDT, Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber,scintillationdetector. **15 L**

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement. **3 L**

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. DigitalLCRbridge. **2 L**

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges Pirani,Penning,ionization. **8 L**

Reference Books:

- Measurement, Instrumentation and Experiment Design in Physics andEngineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
- Experimental Methods for Engineers, J.P. Holman, McGrawHill
- Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt.Ltd.
- Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt.Ltd.
- Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGrawHill
- Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt.Ltd.
- Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk,Springer

PRACTICAL- DSE-1 LAB: EXPERIMENTAL TECHNIQUES

Credits: 02 **LAB : 20 Lectures**

1. Determine output characteristics of a LVDT & measure displacement usingLVDT
2. Measurement of Strain using StrainGauge.
3. Measurement of level using capacitivetransducer.
4. To study the characteristics of a Thermostat and determine itsparameters.
5. Study of distance measurement using ultrasonictransducer.
6. Calibrate Semiconductor type temperature sensor AD590, LM35, orLM75
7. To measure the change in temperature of ambient using Resistance Temperature DeviceRTD.
8. Create vacuum in a small chamber using a mechanical rotary pump and measure the chamber pressure using a pressuregauge.
9. Comparison of pickup of noise in cables of different types co-axial,single shielded, double shielded, without shielding of 2m length, understanding of importance of grounding using function generator of mV level & anoscilloscope.
10. To design and study the Sample and HoldCircuit.
11. Design and analyze the Clippers and Clampers circuits using junctiondiode
12. To plot the frequency response of amicrophone.
13. To measure Q of a coil and influence of frequency, using aQ-meter.

Reference Books:

- Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008,Springer
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill
- Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHILearning.

PHYSICS DSE- 2: PHYSICS OF DEVICES AND INSTRUMENTS

Credits: 04 **Theory: 40 Lectures**

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Metal oxide semiconductor MOS device. Ideal MOS and Flat Band voltage. SiO_2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode. **8 L**

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Shortcircuitprotection **2 L**

Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters. **2 L**

Multivibrators: Astable and Monostable Multivibratorsusingtransistors. **2 L**

Phase Locked LoopPLL: Basic Principles, Phase detectorXOR& edge triggered, Voltage Controlled Oscillator Basics, varactor. Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC 565or4046. **3 L**

Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion andimplantation. **8 L**

Digital Data Communication Standards:

Serial Communications: RS232, Handshaking, Implementation of RS232 on PC.

Universal Serial Bus USB: USB standards, Types and elements of USB transfers. Devices Basic idea of UART.

Parallel Communications: General Purpose Interface Bus GPIB, GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through aCOM port. **7 L**

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK,PSK,FSK. **8 L**

ReferenceBooks:

- Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, JW &Sons
- Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt.Ltd.
- Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt.Ltd.
- Electronic Communication systems, G. Kennedy, 1999, Tata McGrawHill.
- Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, PHI India

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PRACTICAL- DSE-2 LAB: PHYSICS OF DEVICES AND INSTRUMENTS

Credits: 02 **LAB : 20 Lectures**

1. To design a power supply using bridge rectifier and study effect ofC-filter.
2. To design the active Low pass and High pass filters of givenspecification.
3. To design the active filter wide band pass and band reject of givenspecification.
4. To study the output and transfer characteristics of aJFET.
5. To design a common source JFET Amplifier and study its frequencyresponse.
6. To study the output characteristics of aMOSFET.
7. To study the characteristics of a UJT and design a simple RelaxationOscillator.
8. To design an Amplitude Modulator usingTransistor.
9. To design PWM, PPM, PAM and Pulse code modulation usingICs.
10. To design an Astablemultivibrator of given specifications usingtransistor.
11. To study a PLL IC Lock and capturerange.
12. To study envelope detector for demodulation of AMsignal.
13. Study of ASK and FSKmodulator.
14. Glow an LED via USB port ofPC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USBport.

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1. To verify the Thevenin and NortonTheorems.
2. Design and analyze the series and parallel LCRcircuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of givengain
4. Design and Verification of op-amp as integrator anddifferentiator
5. Design the 1st order active low pass and high pass filters of given cutofffrequency
6. Design a Wein's Bridge oscillator of givenfrequency.
7. Design clocked SR and JK Flip-Flop's using NANDGates
8. Design 4-bit asynchronous counter using Flip-FlopICs
9. Design the CE amplifier of a given gain and its frequencyresponse.
10. Design an Astablemultivibrator using IC555 of given dutycycle.

Reference Books:

- Basic Electronics:A text lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller,1994, Mc-Graw Hill
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-GrawHill.
- Electronics : Fundamentals and Applications, J.D. Ryder, 2004, PrenticeHall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4thedn., 2000, PrenticeHall.
- Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHILearning.
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall ofIndia

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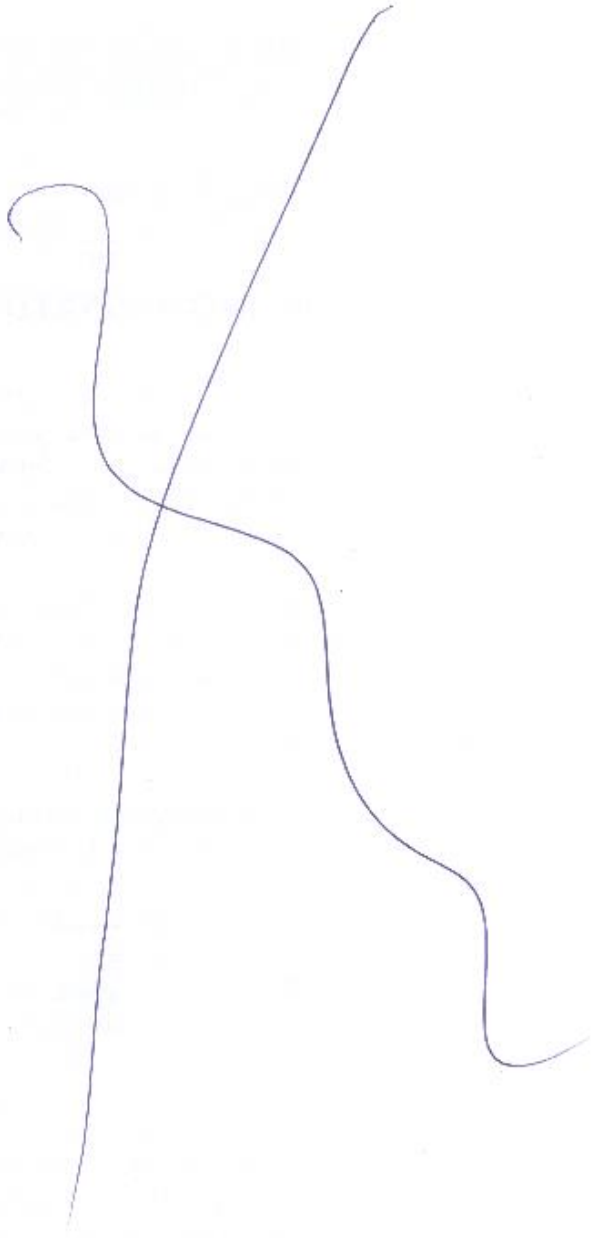

Courses for SEMESTER VI **Duration** **January – June 2024**

Core course-XIII theory	Electro-magnetic Theory	4
Core course-XIV theory	Statistical Mechanics	4
Discipline Specific Elective -3 Theory (DSE - 3)	Nuclear and Particle Physics	4
Discipline Specific Elective-4 Theory (DSE – 4)	Nano Materials and Applications	4
Core Course-XIII Practical	Electro-magnetic Theory Lab	2
Core Course-XIV Practical	Statistical Mechanics Lab	2
Discipline Specific Elective -3 Practical Tutorial	Nuclear and Particle Physics	2
Discipline Specific Elective -4 Practical DSE-4 Lab	Nano Materials and Applications	2

Semester VI (Two courses) Duration January-June 2024

PHYSICS-C XIII: ELECTROMAGNETIC THEORY

Credits: 04 **Theory: 40 Lectures**

Maxwell Equations: Review of 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. Electromagnetic EM Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and AngularMomentumDensity. **8 L**

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. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation throughionosphere. **6 L**

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection normalIncidence 6 L

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light **8 L**

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent'shalf-shadepolarimeter. **4 L**

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission. **6 L**

Optical Fibres:- Numerical Aperture. Step and Graded Indices Definitions Only. Single and Multiple Mode Fibres Concept andDefinitionOnly. **2 L**

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Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, BenjaminCummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford UniversityPress.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & BartlettLearning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGrawHill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, CengageLearning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010,Springer

Additional Books for Reference

- Electromagnetic Fields & Waves, P.Lorrain&D.Corson, 1970, W.H.Freeman&Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGrawHill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge UniversityPress

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PHYSICS PRACTICAL-C XIII: ELECTROMAGNETIC THEORY

Credits: Practicals-02 **LAB: 20 Lectures**

1. To verify the law of Malus for plane polarizedlight.
2. To determine the specific rotation of sugar solution usingPolarimeter.
3. To analyze elliptically polarized Light by using a Babinet'scompensator.
4. To study dependence of radiation on angle for a simple Dipoleantenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid Kerosene Oil, Xylene, etc. by studying the diffraction through ultrasonicgrating.
6. To study the reflection, refraction ofmicrowaves
7. To study Polarization and double slit interference inmicrowaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston'sair-film.
9. To determine the refractive Index of 1 glass and 2 a liquid by total internal reflection using a Gaussianeyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glassinterface.
11. To verify the Stefan`s law of radiation and to determine Stefan'sconstant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse.
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010,Springer

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PHYSICS-C XIV: STATISTICAL MECHANICS

Credits: 04 **Theory: 40 Lectures**

Classical Statistics: Macrostate& Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy with proof – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System,NegativeTemperature. **12 L**

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law.UltravioletCatastrophe. **6 L**

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of 1 Wien's Distribution Law, 2 Rayleigh-Jeans Law, 3 Stefan-Boltzmann Law, 4 Wien's Displacement law from Planck's law. **4 L**

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He qualitative description, Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation ofPlanck'slaw. **8 L**

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. **10 L**

Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford UniversityPress.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, TataMcGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, PrenticeHall
- 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
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ.Press

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PHYSICS PRACTICAL-C XIV: STATISTICAL MECHANICS

Credits:02 **LAB: 20 Lectures**

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature room temperature and lowtemperature.
2. 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 twocases
3. Plot Maxwell-Boltzmann distribution function versustemperature.
4. Plot Fermi-Dirac distribution function versustemperature.
5. Plot Bose-Einstein distribution function versustemperature.

Reference Books:

- Elementary Numerical Analysis, K.E.Atkinson, 3rdEdn. 2007, Wiley IndiaEdition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford UniversityPress.
- 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. VandeWouwer, P. Saucez, C. V. Fernández. 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

PHYSICS-DSE-3: Nuclear and Particle Physics
Credits: Theory-05, Tutorials-01 Theory: 40 Lectures

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, 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. **5 L**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model degenerate fermion gas, nuclear symmetry potential in Fermi gas, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **8 L**

Radioactivity decay:a Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. b β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. c Gamma decay: Gamma rays emission & kinematics, internal conversion. **4 L**

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering Rutherford scattering. **4 L**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization Bethe- Block formula, energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. **4 L**

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 photo-multiplier tube PMT. Semiconductor Detectors Si and Ge for charge particle and photon detection concept of charge carrier and mobility, neutron detector. **6 L**

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator Tandem accelerator, Linear accelerator,Cyclotron,Synchrotrons. **3 L**

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, concept of quark model, color quantum number and gluons. **6 L**

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane Wiley India Pvt. Ltd.,2008.
- Concepts of nuclear physics by Bernard L. Cohen. Tata Mcgraw Hill,1998.
- Introduction to the physics of nuclei & particles, R.A. Dunlap. Thomson Asia,2004.
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ.Press
- Introduction to Elementary Particles, D. Griffith, John Wiley &Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, NewDelhi
- Radiation detection and measurement, G.F. Knoll John Wiley & Sons,2000.
- Physics and Engineering of Radiation Detection, Syed Naeem AhmedAcademic Press, Elsevier, 2007.

PHYSICS-DSE-4 : Nano Materials and Applications

Credits: Theory-04 Theory: 40 L

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 nanostructures and its consequences. **6 L**

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition PVD: Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition CVD. Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth ofquantumdots. **5 L**

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning TunnelingMicroscopy. **5 L**

OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructuresandnanostructures. **8 L**

ELECTRON TRANSPORT: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level andsurfacedefects. **4 L**

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices LED, solar cells. Single electron devices no derivation. CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems MEMS, Nano ElectromechanicalSystemsNEMS. **12 L**

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology Wiley India Pvt.Ltd..
2. S.K. Kulkarni, Nanotechnology: Principles & Practices Capital PublishingCompany
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscienceand Technology PHI Learning PrivateLimited.
4. Richard Booker, Earl Boysen, Nanotechnology John Wiley andSons.
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook Elsevier,2007.
6. Bharat Bhushan, Springer Handbook of Nanotechnology Springer-Verlag, Berlin,2004.

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PRACTICALS-DSE-4 LAB: Nano Materials and Applications

Credits: 02 **LAB : 20 Lectures**

1. Synthesis of metal nanoparticles by chemicalroute.
2. Synthesis of semiconductornanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visiblespectrophotometer.
4. XRD pattern of nanomaterials and estimation of particlesize.
5. To study the effect of size on color ofnanomaterials.
6. To prepare composite of CNTs with othermaterials.
7. Growth of quantum dots by thermalevaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study itsXRD.
9. Fabricate a thin film of nanoparticles by spin coating or chemical routeand study transmittance spectra in UV-Visibleregion.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature orfrequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-Icharacteristic.

Reference Books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology Wiley India Pvt.Ltd..
2. S.K. Kulkarni, Nanotechnology: Principles & Practices Capital PublishingCompany.
3. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology PHI Learning PrivateLimited.
4. Richard Booker, Earl Boysen, Nanotechnology John Wiley andSons.

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