

B.Sc. Physics (Honours) Syllabus (CBCS)

*The syllabus is approved in the Academic Council meeting held on XXXX**

September, 2020



Physics Department, Gauhati University
WEB : <https://gauhati.ac.in>
GUWEB : <http://web.gauhati.ac.in/syllabus>

The syllabus is subject to modifications as deem fit by the Gauhati University

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9	Fifth Semester	98
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Course Structure for B.Sc. in Physics (Honours) under CBCS

Type→	Core	AECC	SEC	DSE	GE	
Credits→	14 × 6 = 84	2 × 4 = 8	2 × 4 = 8	4 × 6 = 24	4 × 6 = 24	
Semester I	PHY-HC-1016	ENG-AE-1014			AAA-HG-1016	
	PHY-HC-1026					
Semester II	PHY-HC-2016	ENV-AE-2014			BBB-HG-2016	
	PHY-HC-2026					
Semester III	PHY-HC-3016		PHY-SE-3XX4		CCC-HG-3016	
	PHY-HC-3026					
	PHY-HC-3036					
Semester IV	PHY-HC-4016		PHY-SE-4XX4		DDD-HG-4016	
	PHY-HC-4026					
	PHY-HC-4036					
Semester V	PHY-HC-5016				PHY-HE-5XX6	
	PHY-HC-5026				PHY-HE-5YY6	
Semester VI	PHY-HC-6016				PHY-HE-6XX6	
	PHY-HC-6026				PHY-HE-6YY6	

Legends

HC : Core Papers

HE : Discipline Specific Elective Papers

SE : Skill Enhancement Papers

HG : Generic Elective Papers

Directives & Advisory

- (a) A student majoring (honours) in Physics MAY take GE papers from any available discipline in the college, except Physics.
- (b) It is advisable that a student majoring (honours) in Physics take at least one GE paper from Mathematics

B.Sc. Honours Physics
Semester Wise Credit Distribution

Semester	Core Papers	AECC	SEC	DSE	Generic Elective	Total Credit
First	2×6	1×4			1×6	22
Second	2×6	1×4			1×6	22
Third	3×6		1×4		1×6	28
Fourth	3×6		1×4		1×6	28
Fifth	2×6			2×6		24
Sixth	2×6			2×6		24
Total	84	8	8	24	24	148

List of Papers

Honours Core Papers

1. PHY-HC-1016 : Mathematical Physics I
2. PHY-HC-1026 : Mechanics
3. PHY-HC-2016 : Electricity & Magnetism
4. PHY-HC-2026 : Waves & Optics
5. PHY-HC-3016 : Mathematical Physics II
6. PHY-HC-3026 : Thermal Physics
7. PHY-HC-3036 : Digital Systems & Applications
8. PHY-HC-4016 : Mathematical Physics III
9. PHY-HC-4026 : Elements of Modern Physics
10. PHY-HC-4036 : Analog Systems & Applications
11. PHY-HC-5016 : Quantum Mechanics & Applications
12. PHY-HC-5026 : Solid State Physics
13. PHY-HC-6016 : Electromagnetic Theory
14. PHY-HC-6026 : Statistical Mechanics

Discipline Specific Elective (DSE) Papers

1. PHY-HE-5016 : Experimental Techniques (PHY-RE-5016)
2. PHY-HE-5026 : Embedded Sys: Introduction to Microcontrollers (PHY-RE-5026)
3. PHY-HE-5036 : Advanced Mathematical Physics I (PHY-RE-5036)
4. PHY-HE-5046 : Physics of Devices and Instruments (PHY-RE-5046)
5. PHY-HE-5056 : Particle and Nuclear Physics (PHY-RE-5056)
6. PHY-HE-6016 : Communication Electronics (PHY-RE-6016)
7. PHY-HE-6026 : Digital Signal Processing (PHY-RE-6026)
8. PHY-HE-6036 : Advanced Mathematical Physics II (PHY-RE-6036)
9. PHY-HE-6046 : Astronomy and Astrophysics (PHY-RE-6046)
10. PHY-HE-6056 : Classical Dynamics (PHY-RE-6056)

Generic Elective (GE) Papers for other Disciplines

1. PHY-HG-1016 : Mechanics (PHY-RC-1016)
2. PHY-HG-2016 : Electricity & Magnetism (PHY-RC-2016)
3. PHY-HG-3016 : Thermal Physics & Statistical Mechanics (PHY-RC-3016)
4. PHY-HG-4016 : Waves & Optics (PHY-RC-4016)

Skill Enhancement (SE) Papers

1. PHY-SE-3014 : Physics Workshop Skills
2. PHY-SE-3024 : Computational Physics Skills
3. PHY-SE-3034 : Computer Assembling and Networking
4. PHY-SE-3044 : Digital Photography and editing
5. PHY-SE-3054 : Video editing for social media

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| 6. | PHY-SE-3064 | : Weather Forecast |
| 7. | PHY-SE-3074 | : Applied Optics |
| 8. | PHY-SE-3084 | : Technical Drawing |
| 9. | PHY-SE-3094 | : PageMaker |
| | | |
| 10. | PHY-SE-4014 | : Basic Instruments Skills |
| 11. | PHY-SE-4024 | : Research & Technical Writing |
| 12. | PHY-SE-4034 | : Domestic and industrial wiring |
| 13. | PHY-SE-4044 | : Photoshop |
| 14. | PHY-SE-4054 | : Motion graphics for advertising and films |
| 15. | PHY-SE-4064 | : Radiation Safety |
| 16. | PHY-SE-4074 | : Renewable energy |
| 17. | PHY-SE-4084 | : Introduction to CorelDraw |
| 18. | PHY-SE-4094 | : Graphic design for digital advertising |

Note:

- (a) *The courses given in Red colour are equivalent in content to the corresponding courses given alongside.*
- (b) *In the Lab classes, wherever applicable, students and instructors can use either of C, C++, FORTRAN 90/95, Matlab, Scilab, or Python environment.*
- (c) *Marks in questions papers must appear approximately, if not exactly, in the proportion of number of lectures assigned to various modules of a particular paper. However, marks in the question paper should not exceed 1.25 times the number of assigned lectures of a module under any circumstances.*

Course Pre-Requisites

1. Physics Honours Course : Physics and Mathematics in Class XII (or equivalent)

Paper Pre-Requisites

- | | | |
|-------------------------------|---|---|
| 1. PHY-HG-1016 | } | Physics in Class XII (or equivalent) |
| 2. PHY-HG-2016 | | |
| 3. PHY-HG-3016 | | |
| 4. PHY-HG-4016 | | |
| 5. PHY-HE-5016 / PHY-RE-5016 | } | PHY-HG-1016, 2016, 3016, 4016 or
PHY-RC-1016, 2016, 3016, 4016 |
| 6. PHY-HE-5026 / PHY-RE-5026 | | |
| 7. PHY-HE-5036 / PHY-RE-5036 | | |
| 8. PHY-HE-5046 / PHY-RE-5046 | | |
| 9. PHY-HE-6016 / PHY-RE-6016 | } | All earlier Pre-Requisites &
PHY-HE-5016, 5016, 5016, 5016 or
PHY-RE-5016, 5016, 5016, 5016 |
| 10. PHY-HE-6026 / PHY-RE-6026 | | |
| 11. PHY-HE-6036 / PHY-RE-6036 | | |
| 12. PHY-HE-6046 / PHY-RE-6046 | | |

First Semester

Honours Core Papers

PHY-HC-1016

Mathematical Physics I

Total Lectures: 60

Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: Successful students should be able to understand vector and its applications in various fields, differential equations and its applications, different coordinate systems, concept of probability and error.

Theory

Unit I: Vector Calculus (Lectures 25)

Revision: 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.

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

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

Unit II: First and Second order Differential Equations (Lectures 17)

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration.

Unit III: Orthogonal Curvilinear Coordinates (Lectures 06)

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

Unit IV: Dirac Delta function and its Properties (Lectures 02)

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Unit V: Introduction to Probability (Lectures 04)

Independent random variables: Probability distribution functions; binomial, Gaussian and Poisson, with examples. Mean and variance.

Unit VI: Theory of Errors (Lectures 06)

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit.

Lab

Aim

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

- Highlights the use of computational methods to solve physical problems
- The course will consist of lectures (both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- Students can use any one operating system Linux or Microsoft Windows

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

Basics of scientific computing Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods

Review of C & C++/Python/ Matlab/ Mathematica 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. Ternary Operator. 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 pi (π)

Solution of Algebraic and Transcendental equations by Newton Raphson methods Solution of linear and quadratic equation, solving $\alpha = \tan \alpha$, $I = I_0 (\sin \alpha / \alpha)^2$ in optics

Interpolation by Newton Gregory Forward and Backward difference formula Evaluation of trigonometric functions e.g. $\sin \theta$, $\cos \theta$, $\tan \theta$ etc.

Numerical Integration (Trapezoidal and Simpson rules), Monte Carlo method Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop

Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods First order differential equation

(a) Radioactive decay (b) Newton's law of cooling.

Reference Books

- [1] Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, and F. E. Harris, 2013, 7th Edn., Elsevier.
- [2] An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI
- [3] Learning Differential Equations, George F. Simmons, 2007, McGraw Hill.
- [4] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- [5] Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book
- [6] Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- [7] Mathematical Physics, Goswami, 1st edition, Cengage Learning
- [8] Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press
- [9] Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India
- [10] Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge University Press

PHY-HC-1026

Mechanics

Total Lectures: 60

Credits: 6 (Theory: 04, Lab: 02)

***Course Outcome:** On successful completion of the course students should be able to understand Inertial and non inertial reference frames, Newtonian motion, Galilean transformations, projectile motion, work and energy, Elastic and inelastic collisions, motion under central force, simple harmonic oscillations, special theory of relativity.*

Theory

Unit I: Fundamentals of Dynamics (Lectures 06)

Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

Unit II: Work and Energy (Lectures 04)

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.

Unit III: Collisions (Lectures 03)

Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit IV: Rotational Dynamics (Lectures 12)

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.

Unit V: Elasticity (Lectures 03)

Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Cantilever.

Unit VI: Fluid Motion (Lectures 02)

Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit VII: Gravitation and Central Force Motion (Lectures 08)

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws.

Unit VIII: Oscillations (Lectures 08)

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. Compound Pendulum.

Unit IX: Non-Inertial Systems (Lectures 04)

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

Unit X: Special Theory of Relativity (Lectures 10)

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.

Lab

A minimum of seven experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge, Spherometer and travelling micro- scope.
2. To study the Motion of Spring and calculate (a) Spring constant and (b) Rigidity modulus.
3. To determine the Moment of Inertia of a cylinder about two different axes of symmetry by torsional oscillation method.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
6. To determine the Modulus of Rigidity of a Wire Static method.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum.
9. To determine the height of a building using a Sextant.
10. To determine g and velocity for a freely falling body using Digital Timing Technique.

Reference Books

- [1] An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- [2] Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- [3] Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- [4] Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.
- [5] Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
- [6] Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- [7] University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- [8] Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000
- [9] University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley
- [10] Physics for Scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway, 2010, Cengage Learning
- [11] Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill.

Honours Generic Paper

PHY-HG-1016 (PHY-RC-1016)

Mechanics

Total Lectures: 60 Credits : 6 (Theory : 04, Lab : 02)

***Course outcome:** Upon completion of this course, students are expected to understand the role of vectors and coordinate systems in Physics, solve Ordinary Differential Equations, laws of motion and their application to various dynamical situations, Inertial reference frames their transformations, concept of conservation of energy, momentum, angular momentum and apply them to basic problems, phenomenon of simple harmonic motion, motion under central force, concept of time dilation, Length contraction using special theory of relativity. In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, Vernier calipers, travelling microscope) student shall embark on verifying various principles and associated measurable parameters.*

Theory

Unit I : Vectors (Lectures 06)

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

Unit II : Laws of Motion (Lectures 10)

Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

Unit III : Momentum and Energy (Lectures 06)

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

Unit IV : Rotational Motion (Lectures 05)

Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Unit V : Gravitation (Lectures 07)

Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only).

Unit VI : Oscillations (Lectures 07)

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Compound pendulum.

Unit VII : Elasticity (Lectures 08)

Hooke's law - Stress-strain diagram – Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder – Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia – η and σ by Searles method.

Unit VIII : Special Theory of Relativity (Lectures 07)

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Lab

A minimum of five experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge and Spherometer.
2. To determine the Moment of Inertia of a Symmetrical body about an axis by torsional oscillation method.
3. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
4. To determine the Modulus of Rigidity of a Wire Static method.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant and (b) value of g .

Reference Books

- [1] An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- [2] Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- [3] Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- [4] Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.
- [5] Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
- [6] Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- [7] University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- [8] Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000
- [9] University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley
- [10] Physics for Scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway, 2010, Cengage Learning
- [11] Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill.

Second Semester

Honours Core Papers

PHY-HC-2016

Electricity & Magnetism

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

***Course Outcome:** After successful completion of this course, students will be able to Understand electric and magnetic fields in matter, Dielectric properties of matter magnetic properties of matter, electromagnetic induction, applications of Kirchhoff's law in different circuits, applications of network theorem in circuits.*

Theory

Unit I: Electric Field and Electric Potential (Lectures 26)

Electric field; Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. 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.

Unit II: Dielectric Properties of Matter (Lectures 08)

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector $\vec{D}$. Relations between $\vec{E}$, $\vec{P}$ and $\vec{D}$ Gauss' Law in dielectrics.

Unit III: Magnetic Field (Lectures 09)

Magnetic Force on a point charge, definition and properties of magnetic field $\vec{B}$. Curl and Divergence. Vector potential $\vec{A}$. Magnetic Force on (1) a current carrying wire (2) between current elements. Torque on a current loop in a uniform magnetic field. Biot-Savart's law and its simple application : 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 (2) Torus.

Unit IV: Magnetic Properties of Matter (Lectures 04)

Magnetization vector ($\vec{M}$). Magnetic Intensity ($\vec{H}$). Magnetic Susceptibility and permeability. Relation between $\vec{B}$, $\vec{H}$, $\vec{M}$. Ferromagnetism. B-H curve and hysteresis.

Unit V: Electromagnetic Induction (Lectures 06)

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.

Unit VI: Electrical Circuits (Lectures 04)

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.

Unit VII: Network Theorems (Lectures 03)

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.

Unit VIII: Ballistic Galvanometer (Lectures 03)

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

Lab

A minimum of seven experiments to be done.

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 $\vec{B}$ and its variation in a solenoid (determine $\frac{dB}{dx}$).
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) Band width.
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

- [1] Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- [2] Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- [3] Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- [4] Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
- [5] Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.
- [6] Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

PHY-HC-2026

Waves & Optics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

***Course Outcome:** After successful completion of this course, students will be able to Understand superposition of harmonic oscillations, different types of wave motions, superposition of harmonic waves, interference and interferometer, diffraction, holography.*

Theory

Unit I: Superposition of Collinear Harmonic Oscillations (Lectures 05)

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.

Unit II: Superposition of Two Perpendicular Harmonic Oscillations (Lectures 02)

Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequency and their uses.

Unit III: Wave Motion (Lectures 04)

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.

Unit IV: Velocity of Waves (Lectures 06)

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.

Unit V: Superposition of Two Harmonic Waves (Lectures 07)

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.

Unit VI: Wave Optics (Lectures 03)

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Unit VII: Interference (Lectures 09)

Division of amplitude and wavefront. 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.

Unit VIII: Interferometer (Lectures 04)

Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, (5) Visibility of fringes. Fabry-Perot interferometer.

Unit IX: Diffraction (Lectures 09)

Fresnel and Fraunhofer diffraction. 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 diffraction pattern of a straight edge and at a circular aperture . Resolving Power of a telescope.

Unit X: Fraunhofer Diffraction (Lectures 08)

Single slit. Double slit. Multiple slits. Diffraction grating . Resolving power of grating.

Unit XI: Holography (Lectures 03)

Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Lab

A minimum of seven experiments to be done.

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

Reference Books

- [1] Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- [2] Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill
- [3] Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- [4] Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- [5] The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- [6] The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- [7] Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.

Honours Generic Paper

PHY-HG-2016 (PHY-RC-2016)

Electricity & Magnetism

Total Lectures: 60

Credits : 6 (Theory : 04, Lab : 02)

***Course outcome:** Upon completion of this course, students are expected to apply Gauss's law of electrostatics to solve a variety of problems, calculate the magnetic forces that act on moving charges and the magnetic fields due to currents, have brief idea of magnetic materials, understand the concepts of induction, and apply them to solve variety of problems. In the Lab course, students will be able to measure resistance (high and low), Voltage, Current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different circuits RC, LCR etc.*

Theory

Unit I : Vector Analysis (Lectures 12)

Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Unit II : Electrostatics (Lectures 22)

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem – Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Unit III : Magnetism (Lectures 10)

Magnetostatics: Biot-Savart's law & its applications – straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia, para, and ferro-magnetic materials.

Unit IV : Electromagnetic Induction (Lectures 06)

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Unit V : Maxwell's Equations and EM Wave (Lectures 10)

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

Lab

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer
 - (a) Measurement of charge and current sensitivity
 - (b) Measurement of CDR
 - (c) Determine a high resistance by Leakage Method
 - (d) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q .
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem.
10. To verify the Superposition, and Maximum Power Transfer Theorem.

Reference Books

- [1] Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- [2] Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- [3] Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- [4] Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
- [5] Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.
- [6] Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

Third Semester

Honours Core Papers

PHY-HC-3016

Mathematical Physics II

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

***Course Outcome:** After successful completion of the course, students will be able to solve differential equation using power series solution method, solve differential equation using separation of variables method, special integrals, different properties of matrix, Fourier series.*

Theory

Unit I: Frobenius Method and Special Functions (Lectures 18)

Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, 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.

Unit II: Partial Differential Equations (Lectures 14)

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. Diffusion Equation.

Unit III: Some Special Integrals (Lectures 04)

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Unit IV: Matrix (Lectures 15)

Matrix algebra using index notation, Properties of matrices, Special matrix with their properties: Transpose matrix, complex conjugate matrix, Hermitian matrix, Anti-Hermitian matrix, special square matrix, unit matrix, diagonal matrix, co-factor matrix, adjoint of a matrix, self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix. Determinant, Rank, Eigen value, Eigen vector and diagonalisation of matrix.

Unit V: Fourier Series (Lectures 09)

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. Application to square and triangular waves.

Lab

Aim

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.

Introduction to Numerical computation softwares Introduction to Scilab/Mathematica/Matlab/Python, Advantages and disadvantages, Scilab / Mathematica / Matlab/ Python environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab / Mathematica / Matlab/ Python, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab / Mathematica / Matlab/Python functions, Introduction to plotting, 2D and 3D plotting.

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

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

Generation of Special functions Generation of Special functions using User defined functions in Scilab / Mathematica / Matlab. Generating and plotting Legendre Polynomials Generating and plotting Hermite function.

First order ODE Solution of first order Differential equation Euler, modified Euler and Runge-Kutta second order methods. First order differential equation (a) Current in RC, LC circuits with DC source (b) Classical equations of motion.

Second order ODE Second order differential equation. Fixed difference method. Second order Differential Equation (a) Harmonic oscillator (no friction) (b) Damped Harmonic oscillator (c) Over damped (d) Critical damped.

Partial Differential Equation (PDE) Solution of Partial Differential Equation: (a) Wave equation (b) Heat equation.

Reference Books

- [1] Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, and F. E. Harris, 2013, 7th Edn., Elsevier.
- [2] An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI
- [3] Learning Differential Equations, George F. Simmons, 2007, McGraw Hill.
- [4] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- [5] Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book
- [6] Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- [7] Mathematical Physics, Goswami, 1st edition, Cengage Learning
- [8] Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press
- [9] Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India
- [10] Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge University Press

PHY-HC-3026

Thermal Physics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: Upon successful completion, students will have the knowledge and skills to identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, Thermodynamics potentials, Free energies, Maxwell's relations in thermodynamics, behaviour of real gases.

Theory

Introduction to Thermodynamics

Unit I: Zeroth and First Law of Thermodynamics (Lectures 08)

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 and Expansion Coefficient.

Unit II: Second Law of Thermodynamics (Lectures 10)

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 Perfect Gas Scale.

Unit III: Entropy (Lectures 07)

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.

Unit IV: Thermodynamic Potentials (Lectures 07)

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Unit V: Maxwell's Thermodynamic Relations (Lectures 07)

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

Kinetic Theory of Gases

Unit VI: Distribution of Velocities (Lectures 07)

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.

Unit VII: Molecular Collisions (Lectures 04)

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Unit VIII: *Real Gases* (Lectures 10)

Behaviour of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 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-Thomson Cooling.

Lab

1. To determine Mechanical Equivalent of Heat, J , by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books

- [1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- [2] A Treatise on Heat, Meghnad Saha, and B. N.Srivastava, 1958, Indian Press
- [3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- [4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- [5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- [6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- [7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

PHY-HC-3036

Digital Systems & Applications

Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

***Course Outcome:** After successful completion of the course student will be able to understand the working principle of CRO, develop a digital logic and apply it to solve real life problems, Analyze, design and implement combinational logic circuits, Classify different semiconductor memories, Analyze, design and implement sequential logic circuits, Analyze digital system design using PLD, Simulate and implement combinational and sequential circuits.*

Theory

Unit I: Introduction to CRO (Lectures 03)

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.

Unit II: Integrated Circuits (qualitative treatment only) (Lectures 03)

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.

Unit III: Digital Circuits (Lectures 06)

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.

Unit IV: Boolean Algebra (Lectures 06)

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

Unit V: Data Processing Circuits (Lectures 04)

Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Unit VI: Arithmetic Circuits (Lectures 05)

Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Unit VII: Sequential Circuits (Lectures 06)

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.

Unit VIII: Timers: IC 555 (Lectures 03)

Block diagram and applications: Astable multivibrator and Monostable multivibrator.

Unit IX: Shift Registers (Lectures 02)

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

Unit X: Counters (4 bits) (Lectures 04)

Ring Counter, Asynchronous counters, Decade Counter. Synchronous Counter.

Unit XI: Computer Organization (Lectures 06)

Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing.

Unit XII: Intel 8085 Microprocessor Architecture (Lectures 08)

Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry.

Unit XIII: Introduction to Assembly Language (Lectures 04)

1 byte, 2 byte, & 3 byte instructions.

Lab

A minimum of eight experiments to be done.

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 a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. Half Adder, Full Adder and 4-bit binary Adder.
8. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder IC.
9. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
10. To build JK Master-slave flip-flop using Flip-Flop ICs .
11. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
12. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
13. To design an astable multivibrator of given specifications using 555 Timer.
14. To design a monostable multivibrator of given specifications using 555 Timer.
15. Write the following programs using 8085 Microprocessor
 - (a) Addition and subtraction of numbers using direct addressingmode
 - (b) Addition and subtraction of numbers using indirect addressin gmode
 - (c) Multiplication by repeated addition
 - (d) Division by repeated subtraction
 - (e) Handling of 16-bit Numbers
 - (f) Use of CALL and RETURN Instruction (g) Block data handling

Reference Books

- [1] Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- [2] Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- [3] Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- [4] Digital Electronics G. K. Kharate ,2010, Oxford University Press
- [5] Digital Systems: Principles & Applications, R. J. Tocci, N. S. Widmer, 2001, PHI Learning
- [6] Logic circuit design, Shimon P. Vingron, 2012, Springer.
- [7] Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- [8] Digital Electronics, S. K. Mandal, 2010, 1st edition, McGraw Hill
- [9] Microprocessor Architecture Programming & applications with 8085, 2002, R. S. Goankar, Prentice Hall.

Honours Generic Paper

PHY-HG-3016 (PHY-RC-3016)

Thermal Physics & Statistical Mechanics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab : 02)

***Course outcome:** Upon completion of this course, students are expected learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations, Maxwell's thermodynamic relations, fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion, black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances, quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics. In the laboratory course, the students will be able to Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo emf across two junctions of a thermocouple with temperature etc.*

Theory

Unit I : Laws of Thermodynamics (Lectures 22)

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP & CV , Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit II : Thermodynamic Potentials (Lectures 10)

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP — CV), CP/CV , T dS equations.

Unit III : Kinetic Theory of Gases (Lectures 10)

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Unit IV : Theory of Radiation (Lectures 06)

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Unit V : Statistical Mechanics (Lectures 12)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity – Quantum statistics – Fermi-Dirac distribution law – electron gas – Bose-Einstein distribution law – photon gas – comparison of three statistics.

Lab

1. To determine Mechanical Equivalent of Heat, J , by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Reference Books

- [1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- [2] A Treatise on Heat, Meghnad Saha, and B. N. Srivastava, 1958, Indian Press
- [3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- [4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- [5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- [6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- [7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
- [8] Statistical Mechanics, R. K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- [9] Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- [10] Statistical and Thermal Physics, S. Lokanathan and R. S. Gambhir. 1991, Prentice Hall

Skill Enhancement Papers

[Choose One]

PHY-SE-3014

Physics Workshop Skills

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics or a B.E/B.Tech in Mechanical Engineering

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode

Unit I: Introduction (4 Lectures)

Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

Unit II: Mechanical Skill (10 Lectures)

Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothing of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.

Unit III : Electrical and Electronic Skill (10 Lectures)

Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay.

Unit III : Introduction to prime movers: (6 Lectures)

Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment.

Lab

1. Study the use of meter scale, Vernier caliper, Screw Gauge.
2. To measure dimension of solid block, volume of cylindrical beaker/ glass, diameter of thin wire, thickness of metal sheet.
3. To measure height of building, mountain using Sextant
4. To join metals using welding.
5. To prepare nut, bolts etc. using lathe machine and other tools.
6. To Cut a metal sheet and smoothing of the cutting edge using file.
7. Study the use of multimeter and Oscilloscope.
8. To use soldering of electrical circuit having discrete components on PCB.
9. To construct a regulated power supply
10. Demonstration of lifting of heavy weight using lever

Reference Books:

- [1] A text book in Electrical Technology-B L Theraja – S. Chand and Company.
- [2] Performance and design of AC machines – M.G. Say, ELBS Edn.
- [3] Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
- [4] Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
- [5] New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

PHY-SE-3024
COMPUTATIONAL PHYSICS SKILLS
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with adequate knowledge on computer programming/An MCA/M.Sc. with DCA.

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.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*
- *Course will consist of hands on training on the Problem solving on Computers.*

Theory

Unit I: Introduction (Lectures 3)

Importance of computers in Physics, paradigm for solving physics problems for solution. Introduction to various OS, Linux OS such as RedHat, Ubuntu, Scientific Linux, Usage of Basic linux commands. Text editors such as vi and Emacs.

Unit II: Basics of Scientific Programming (Lectures 4)

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 $\sin(x)$ as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Unit III: Scientific Programming (Lectures 18)

Variables and Formatting: Introduction to HLL, Concepts of a Compiler. 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. I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of a Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Control Statements, Functions, and Subroutines: 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.

Unit V: Visualization (Lectures 5)

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, curve fitting – straight line, polynomials, user defined function. Physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor.
2. To print out all natural even/ odd numbers between given limits.
3. To find maximum, minimum and range of a given set of numbers.
4. Calculating Euler number using $\exp(x)$ series evaluated at $x=1$
5. To compile a frequency distribution and evaluate mean, standard deviation etc.
6. To evaluate sum of finite series and the area under a curve.
7. To find the product of two matrices
8. To find a set of prime numbers and Fibonacci series.
9. To write program to open a file and generate data for plotting using Gnuplot.
10. Plotting trajectory of a projectile projected horizontally.
11. Plotting trajectory of a projectile projected making an angle with the horizontally.
12. 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 pdf file.
13. To find the roots of a quadratic equation.
14. Motion of a projectile using simulation and plot the output for visualization.
15. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
16. Motion of particle in a central force field and plot the output for visualization.

Reference Books:

- [1] Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- [2] Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
- [3] LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
- [4] Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- [5] Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- [6] Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
- [7] A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

PHY-SE-3034

Computer Assembling and Networking

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate course on Computer Assembling and Networking, B.E./B.Tech. in Computer Science/ MCA/First class or Second class govt registered contractor with a Bachelor Degree in Science/ B.Sc. with DCA.

The aim of the course is give overview of the different components in a computer and their assembling and disassembling and handling of installation of operating system in computer. It will also give overview of the networking, different hardware and components of networking.

Course Outcome: After successfully completing the course students will be able to Identify Computer Hardware Components, Network Components and Peripherals, assemble and disassemble a computer, Identify the different types of network topologies and protocols. Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer, Identify the different types of network devices and their functions within a network, Understand and building the skills of subnetting and routing mechanisms., Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Unit I: Components of Computer (Lectures 10)

Specifications of processors (Intel Celeron, P4family, Xeon dual core, quad core, core2 duo, i3, i5, i7 and AMD).

Memory devices, types, principle of storing. Data organization 4bit, 8-bit, word. Semiconductor memories, RAM, ROM, PROM, EPROM, EEPROM, Static and dynamic. Example of memory chips, pin diagram, pin function.

Concept of track, sector, cylinder. FD Drive components read write head, head actuator, spindle motor, sensors, PCB.

Precaution and care to be taken while dismantling Drives. Drive bay, sizes, types of drives that can be fitted. Precautions to be taken while removing drive bay from PC.

HDD, advantages, Principle of working of Hard disk drive, cylinder and cluster, types, capacity, popular brands, standards, interface, jumper setting. Drive components- hard disk platters, and recording media, air filter, read write head, head actuator, spindle motor, circuit board, sensor, features like head parking, head positioning, reliability, performances, shock mounting capacity. HDD interface IDE, SCSI-I/2/3 comparative study. Latest trends in interface technology in PC and server HDD interface. Concept of SATA and SAS.

Precautions to be taken while fitting drives into bays and bay inside PC cabinet. CMOS setting. (restrict to drive settings only). Meaning and need for Using Scan disk and defrag. Basic blocks of SMPS, description of sample circuit. Vendor/sources of PC hardware components.

Unit II: Operating System Basics & Installation (Lectures 4)

Introduction to OS, Types of Operating systems, System files FAT and NTFS DOS, Windows XP, Windows Vista, Windows 7 and Windows 8, Windows 10 and RedHat Linux and Multi Boot Operating System

Unit III: Overview of Networking (Lectures 2)

Introduction to networks and networking, LAN, VLAN, CAN, MAN, WAN, Internet and Intranet etc. Uses and benefits of Network, Server-client based network, peer to peer networks.

Unit IV: Network Hardware and Components (Lectures 4)

Concept of Server, client, node, segment, backbone, host etc. Analog and Digital transmission, Network Interface Card, Crimping tools and Color standards for Straight crimping and Cross crimping Functions of NIC, Repeaters, Hub, Switches, Routers, Bridges, Router etc.

Unit V: Transmission Media and Topologies (Lectures 4)

Media types: STP cable, UTP cable, Coaxial cable, Fiber cable, Base band and Broadband transmission, Cables and

Connectors, Physical and logical topologies, Bus, Star, Ring and Mesh topologies

Unit VI: Protocols and Services (Lectures 3)

HTTP, FTP and other Different types of protocols, OSI Model, Media Access Method, DNS services, DHCP services, WINS services and RAS services, Web services, Proxy Services etc.

Unit VII: TCP/IP and Sub-netting (Lectures 3)

Introduction about TCP/IP and Sub-nettings, configuring IP address and subnettings with different Routers and Network, TCP/IP Errors and Solutions,

Lab

(i) Computer Assembling and Operating System Installations

1. Installation of different Operating Systems Windows XP, Windows 7, Windows 10, RedHat, Linux,
2. Installation Dual Operating System like: Windows XP and Windows 7, Ubuntu, Linux
3. Troubleshooting and Repair Operating System : Windows XP, Windows 7, Windows 10, RedHat, Linux
4. Tacking Data Backup and System Formatting and OS Installation
5. Check various front panel connections on motherboard (power switch, reset switch and HDD Led). Check power and reset switch connection. Replace faulty power switch from cabinet and assemble a new one.
6. Check DDR3 and DDR4 RAM's FSB. Insert it on memory slot. Test and understand various beep sounds in case of trouble.
7. Find the CMOS/ROM BIOS chip on mother board.
8. Install a Hard Drive. Identify and check data and power cable and SATA and SACH ports in motherboards.
9. Install internal and external DVD ROM Drive.
10. Troubleshoot defects related to SMPS, its cable, connector and servicing procedure. Removing a Power Supply. Installing a Power Supply. Use SMPS tester.
11. Install a Graphic and sound cards. Remove them safely.
12. Install and removing cooling Fans on pc cabinet.
13. Removing the Motherboard carefully and Install it again.
14. Removing the Processor, Installing the Processor. Understand and identify various different processor sockets.
15. Installing different type of CPU Cooler.
16. Find the CMOS Battery. Test it with multimeter. Replace it.

(ii) Networking

1. Installing and Configuring Windows 2003 and 2008 Server or latest server
2. Cable Crimping using Different Color Codes (Straight and Cross Cable)
3. Installation and configuring Peer to Peer and Server-Client Network
4. Installation and Configuring Active Directory Services
5. Installation and Configuring DNS & DHCP Services
6. Installation and Configuring FTP, HTTP Services
7. Backup and Restoration for ADS, DHCP and User Data
8. FAT and NTFS Sharing Permission
9. Configuring & Implementing Unmanageable Network Switch
10. Configuring & Implementing Manageable Network Switch
11. Configuring a Local Security Policies & Domain Security Policies
12. Installing Printer in Windows XP, Windows 7, Windows 2003 & 2008 Server
13. Configuring Gateway Service for Internet Connectivity
14. Configuring ADSL+2 Router for BSNL/other Internet Connectivity
15. Configuring Wireless Access Point
16. Installation and Configuring Wire Network
17. Installation and Configuring Wireless Network
18. Installation of AD-hoc Wireless Network
19. Installation and Configure Different Antivirus Software and Admin Console
20. Remote Desktop, Remote Assistance, Telnet, HyperTerminal, TeamViewer

Reference Books:

- [1] Fundamentals of Computer by V Rajaraman; Prentice Hall of India Pvt. Ltd., New Delhi
- [2] Information Technology for Management by Henery Lucas, Tata McGraw Hills, New Delhi
- [3] Computers Fundamentals Architecture and Organisation by B Ram, revised Edition, New Age International Publishers, New Delhi
- [4] Computer Networking A Top-Down Approach, Kurose James F., Ross Keith W., Sixth Edition By Pearson

PHY-SE-3044

Digital Photography & Editing

Credits: 4 (Theory: 02, Lab: 02)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with a certificate on digital photography/Professional Photographer with degree or diploma in photography with adequate knowledge on digital editing and a Bachelor degree in Science.

This course will give you the basic understanding of photography, Physics behind working of camera, various composition techniques that will help you to take superior photos. Various composition techniques those will help the students to improve the photos. This course will give the students an overview and explanation of what good overflow in photography look like.

***Course Outcome:** On successful completion of the course students will be able to indentify cameras according to formats and view finder systems, identify types of lenses and state what type of lenses to be used for different purposes, apply settings of shutter speed, control depth of field via aperture settings, apply suitable focal length, Use the light metering mechanism of the camera to take photographs.*

Theory

Unit I: Theory of Basic Photography (Lectures 2)

History of Photography, Introduction to Digital Photography, Digital Camera, dSLR, Advantages and Disadvantages of Digital Photography

Unit II: The Camera- Components and Concepts (Lectures 2)

Lens, Focal Length, Lens type, Aperture, Depth of Field, Shutter, Shutter Speed, Image sensor, Memory cards, External Flash, File types

Unit III: Capturing an Image, Hands-on Basics (Lectures 3)

Elements of Composition: Pattern, Symmetry, Texture, Depth of Field, Lines; Law of Thirds, Camera Shake, Red eye, Lighting, Digital Noise

Unit IV: Exposure Modes (Lectures 5)

Automatic mode, Manual mode, aperture mode, shutter mode, Scene mode, Portrait mode, landscape mode, close up mode, sports mode, Twilight mode, Night Mode, Black and white, sepia, Panoramic **mode**.

Unit V: Conditions in Digital Photography (Lectures 7)

Lighting, Importance of Natural Light, Best Time of Day to Take Photos, Disable Flash Indoors, Disable Flash in Low Light, Use Flash to Balance Bright Light, Get Closer to the Subject, Crop Your Photo, Choose Better Backgrounds, Pick Proper Orientation, Use Point of View, Frame your Subject, Experiment with Abstract Photography, Holding your DSLR

Unit VI: Digital Videography (Lectures 4)

Various Parts, Contrl and Features of Video Camera, Types of daylight applications, Three points lighting- (a) The key light, (b) The fill light and the back light, (c) Bounce and diffuse light, Framing and shots, Camera angle and camera movements

Unit VII: Post Production (Lectures 7)

The Digital Workflow: Capturing the Image, Storing the Photo, Cataloging the Image Files, Editing the Photo,

Sharing, Archiving and Backing Up the Photograph

Reference Books

- [1] Beginner's Guide to Digital Photography
- [2] Complete Idiot's Guide to Digital Photography – Steve Greenberg
- [3] Complete Digital Photography Third Edition – Ben Long
- [4] The Textbook of Digital Photography Second Edition – Dennis P. Curtin

PHY-SE-3054
VIDEO EDITING FOR SOCIAL MEDIA
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on video editing/ B.E./B.Tech. in Computer Science/ MCA/B.Sc with DCA.

This course will give you the skills to edit innovative videos for news, events, food, travel or blogging to be promoted on Social Media platforms. You will learn to create & edit these videos on the most popular and industry relevant video editing software, Adobe Premiere Pro.

Course Outcome: On successful completion of the course students will be able to learn to Edit impactful video content which appeals to target audience, Add or Edit Music, Soundtrack or Audio to your videos, Learn to customize your videos by using Text (fonts), Learn to use transitions and effects to create impactful videos.

Tools: Adobe Premiere CC

Unit I: What's New in Premiere Pro CC 7.0 (Lectures 2)

New Features: Summary, Workspace

Unit II: Workflow and Project Setup (Lectures 2)

Basic Workflow, Preferences

Unit III: Importing Footage (Lectures 2)

Transferring and Importing Files, Supported File Format, Importing Sequences, Clip Lists, Compositions, Still Images, and Digital Videos

Unit IV: Working Sequences (Lectures 3)

Creating and Changing Sequences, Adding, Rearranging, and Working with Clips in a Sequences, Rendering and Previewing Sequences

Unit V: Editing Audio (Lectures 4)

Overview of Audio and Audio Track Mixer, Working with Clips, Channels, and Tracks, Editing Audio in a Timeline Panel, Adjusting Volume Levels

Unit VI: Titling and the Titler (Lectures 4)

Creating and Editing Titles, Creating and Formatting Text in Titles, Working with Text and Objects in Titles

Unit VII: Effects (Lectures 5)

About Effects - Applying, Removing, Finding, and Organizing Effects, Viewing and Adjusting Effects, Keyframes, and Effects Presets, Masking and Tracking, Applying Transitions, Adjustment Layers, Color Correction and Adjustments, Three-way Color Corrector Effect, Audio Effects and Transitions

Unit VIII: Compositing and Exporting (Lectures 4)

Compositing, Alpha Channels, and Adjusting Clip Opacity, Blending Modes, Workflow and Overview for Exporting, Exporting Projects for Other Applications, Exporting Still Images

Unit IX: Patching of Rough Cuts (Lectures 4)

Working with Rough Cut, Editing Rough Cuts, The Prelude Workspace, Exporting Still Images

PHY-SE-3064
WEATHER FORECASTING
Credits: 4 (Theory: 02, Lab: 02)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Atmospheric Physics.

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques

Theory

Unit I: Introduction to atmosphere (Lectures 9)

Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; atmospheric pressure: its measurement; atmospheric boundary layer and its characteristics; atmospheric convection and inversion; introduction to numerical weather prediction systems.

Unit II: Measuring the weather (Lectures 4)

Wind; forces acting to produce wind; measurement of wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

Unit III: Weather systems (Lectures 3)

Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes, Indian summer monsoon.

Unit IV: Climate and Climate Change (Lectures 6)

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

Unit V: Basics of weather forecasting (Lectures 8)

Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

Lab

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data
 - (a) To calculate the sunniest time of the year.
 - (b) To study the variation of rainfall amount and intensity by wind direction.
 - (c) To observe the sunniest/driest day of the week.
 - (d) To examine the maximum and minimum temperature throughout the year.
 - (e) To evaluate the relative humidity of the day.
 - (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non aviation)

Reference books

- [1] Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
- [2] The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
- [3] Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
- [4] Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
- [5] Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
- [6] Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

PHY-SE-3074
APPLIED OPTICS
Credits: 4 (Theory: 2, Lab: 2)
THEORY: 30 Lectures

Preferred minimum qualification of the teacher/instructor: Asst. Professor of Physics with PhD in Experimental Spectroscopy/Optics.

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

Theory

Unit I: Sources and Detectors (Lectures 10)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Experiments on Lasers:

- (b) Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
- (c) To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
- (d) To find the polarization angle of laser light using polarizer and analyzer

Experiments on Semiconductor Sources and Detectors:

- (a) V-I characteristics of LED
- (b) Study the characteristics of solid state laser
- (c) Study the characteristics of LDR
- (d) Photovoltaic Cell

Unit II: Holography (Lectures 8)

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition.

Experiments on Holography and interferometry:

- (a) Recording and reconstructing holograms
- (b) Constructing a Michelson interferometer or a Fabry Perot interferometer
- (c) Measuring the refractive index of air
- (d) White light Hologram

Unit III: Photonics: Fibre Optics (Lectures 12)

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments on Photonics: Fibre Optics

- (a) To measure the numerical aperture of an optical fibre
- (b) To study the variation of the bending loss in a multimode fibre

Reference Books:

- [1] Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- [2] LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
- [3] Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- [4] Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- [5] Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- [6] Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- [7] Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- [8] Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

PHY-SE-3084
TECHNICAL DRAWING
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with a certificate on Technical Drawing/B.E./B.Tech. in Mechanical Engineering.

The subject is aimed at developing basic graphic skills in the students so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation. The emphasis, while imparting instructions, should be to develop conceptual skills in the students.

Course Outcome: After successfully completing the course students will be able to draw free hand sketches of various kinds of objects, apply different dimensioning methods on drawing of objects, different types of scales and their utilization in reading and reproducing drawings of objects and maps, Draw 2 - dimensional view of different objects viewed from different angles, Generate isometric (3D) drawing from different 2D (orthographic) views/sketches, use basic commands of Auto CAD.

Theory

Unit I: Introduction (Lectures 4)

Drafting Instruments and their uses. lettering: construction and uses of various scales: dimensioning as per I.S.I. 696-1972. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, involute: spiral: helix and loci of points of simple moving mechanism. 2D geometrical construction. Representation of 3D objects. Principles of projections.

Unit II: Projections (Lectures 6)

Straight lines, planes and solids. Development of surfaces of right and oblique solids. Section of solids.

Unit III: Object Projections (Lectures 4)

Orthographic projection. Interpenetration and intersection of solids. Isometric and oblique parallel projection of solids.

Unit IV: CAD Drawing (Lectures 16)

Introduction to CAD and Auto CAD, precision drawing and drawing aids, Geometric shapes, Demonstrating CAD-specific skills (graphical user interface. Create, retrieve, edit, and use symbol libraries. Use inquiry commands to extract drawing data). Control entity properties. Demonstrating basic skills to produce 2-D and 3-D drawings. 3D modeling with Auto CAD (surfaces and solids), 3D modeling with sketch up, annotating in Auto CAD with text and hatching, layers, templates & design center, advanced plotting (layouts, viewports), office standards, dimensioning, internet and collaboration, Blocks, Drafting symbols, attributes, extracting data. basic printing, editing tools, Plot/Print drawing to appropriate scale.

Reference Books

- [1] K. Venugopal, and V. Raja Prabhu. Engineering Graphic, New Age International
- [2] AutoCAD 2014 & AutoCAD 2014/Donnie Gladfelter/Sybex/ISBN:978-1-118-57510-9
- [3] Architectural Design with Sketchup/Alexander Schreyer/John Wiley & Sons/ISBN: 978-1-118-12309-6

PHY-SE-3094

PAGEMAKER

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on PageMaker/B.E./B.Tech. in Computer Science / MCA/ B.Sc. with DCA.

This course prepares students for proficiency in electronic publishing with the Adobe PageMaker publishing and graphics software application. The course topics include: skills using the PageMaker software; creating simple single-page publications; creating multiple page publications; working with text; working with graphics; formatting; and publishing publications electronically.

Course Outcome: *On successful completion of the course students will be able to Create Documents and Templates, add text into documents using various methods, and apply different formatting styles to characters and paragraphs, Import graphics, create objects using various tools, add effects to objects, Create a book and export it into PDF, Multipage Layout Design.*

Theory

Unit I: Pagemaker Basics (4 Lectures)

Starting PageMaker, PageMaker Window Elements, Viewing the Page, Floating Palettes, Toolbox, Using the Zoom Tool, Using the Rulers, Displaying the Rulers, Using the Revert Feature. Opening a Publication, Creating a New Document, Setting the Margins, Setting the Page Size, Setting the Page Orientation, The Page Icons, Displaying Master Pages and Master Page Items, Inserting and Removing Pages, Inserting a Page, Removing a Page, Setting Page Numbers, Saving a New Document, Saving an Existing Document, Saving a Document as Another Document, Closing a Document.

Unit II: The text and drawing tool (4 Lectures)

Introduction, Using the Text Tool, Creating Text From Scratch, The Manual Text Icon, The Autoflow Text Icon, Text Blocks, Sizing and Positioning Text Blocks, Editing and Manipulating Text, Threading and Unthreading Text, Threading Additional Text, Threading Text to a Different Page, Unthreading Text Blocks, Rethreading Text Blocks.

The Line Tool, The Oval Tool, Rectangle Tool, Polygon Tool, Changing the Shape of Rectangle, Changing Strokes and Fills, Deleting an Object, Duplicating an Object.

Unit III: Importing Graphics (2 Lectures)

Introduction, Placing Graphics, Placing in-Line Graphics, Converting an Independent Graphic to an In-Line Graphic, Aligning In-Line Graphics, Sizing Graphics, Cropping Graphics, Object Linking and Embedding (OLE), Setting Up an OLE Liked Object, Embedding an OLE Object, Text Wrap.

Unit IV: Transformations (3 Lectures)

Introduction, Using the Control Palette, Control Palette Basics, Modifying Objects by Adjusting Values, Using the Reference-Point Proxy, Setting Measurement and Nudge Preferences, Moving Objects, Rotating an Object, Reflecting an Object, Skewing an Object, Removing Transformation, Aligning and Distributing Objects, Grouping and Ungrouping, Rules for Grouping Objects, Changing the Staking Order of Objects, Locking Objects.

Unit V: Utilities (3 Lectures)

Creating PDF Files with Acrobat, Creating an Adobe Acrobat File, Font Issues, Managing Automatic Hypertext Links, Using the Tables Editor, Setting Adobe Table Defaults, Adobe Table Preferences, Typing, Editing and Formatting Text in Adobe Table, Formatting Text in a Table, Exporting and Saving Adobe Tables, Exporting Tables from Adobe Table, Exporting a Table as Text, Exporting a Table as a Graphic, Saving Adobe Tables, Importing and Updating Table, Sorting Pages, Balancing Columns, Create Keyline, Bullets and Numbering, Add

Continued Line.

Unit VI: Master Pages (3 Lectures)

Creating Master Pages, Setting Up Pages, Numbering Pages, Adding Page Numbers, Adding a Prefix to Page Numbers, Numbering pages within a book, Setting Margins, Setting Print-related Document Setup Options, Resizing 1-bit Bitmap Images, Column Guides, Setting Up Ruler Guides, Revising, Deleting and Renaming Masters, Removing Master Page Formatting, Displaying Master Pages and Master Page Items, Showing Master Pages, About the Adjust Layout Option.

Unit VII: Working with large amount of texts (2 Lectures)

Introduction, Character Specifications, Paragraph Specifications, Changing Indents, Paragraph Spaces, Alignment, Adding Lines Above or Below Your Paragraphs, Indent/Tabs, Hyphenation, Grid Manager.

Unit VIII: The story editor (3 Lectures)

Introduction, Using the Story Editor, Starting at a Particular Spot in a Story, Placing the Story, Returning to an Open Story Window, Creating and Editing Text in Story Editor, Managing Story Editor Windows, Story Editor Preferences, Navigating through Text, Using the Key Board, Selecting Text, Cutting, Copying, Deleting and Pasting Text, Using the Spelling Checker, Starting the Speller, Adding Words to Dictionaries, Using Find and Change, The Find Feature, Searching with Wildcard Characters, Searching for Phrases, Searching for Special Attributes, Positioning the Find Dialog Box, Using the Change Feature, Replacing Text, Replacing Special Attributes, Story Editor and Layout Views.

Unit IX: Pagemaker style Sheets (3 Lectures)

Introduction, Defining Styles, Creating New Styles, Editing Styles, Removing Styles, Copying Styles, Applying Styles to Text, Changing Styles, Modifying Styles Text.

Unit X: Long documents features (3 Lectures)

Compiling Chapters into a Book, Preparing the Book, Combining the Chapters, Numbering Pages, Restarting Page Numbering, Creating a Table of Contents.

Practical / Lab work to be performed

1. Letter Head Design
2. Business Card Design
3. Sign Board Design
4. Cash Memo Design
5. Logo Design
6. Certificate Design
7. Newspaper Advertisement Design
8. Build Booklet, Page Numbering
9. Type a Doc Using Story Editor
10. Newsletter Design (Page Layout Design)

Fourth Semester

Honours Core Papers

PHY-HC-4016

Mathematical Physics III

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: On successful completion of the course students will be able to solve complex integrals using residue theorem, apply Fourier and Laplace transforms in solving differential equations, understand properties of Tensor like Transformation of coordinates, contravariant and co-variant tensors, indices rules for combining tensors.

Theory

Unit I: Complex Analysis (Lectures 10)

Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity.

Unit II: Complex Integration (Lectures 10)

Integration of a function of a complex variable. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem with numerical application.

Unit III: Fourier Transforms (Lectures 15)

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian functions Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem (Statement only). Properties of Fourier transforms (translation, change of scale, complex conjugation).

Unit IV: Laplace Transforms (Lectures 15)

Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem (Statement only). Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator.

Unit V: Tensor Algebra (Lectures 10)

Introduction to tensor, Transformation of co-ordinates, Einstein's summation convention. contravariant and co-variant tensor, tensorial character of physical quantities, symmetric and antisymmetric tensors, Kronecker delta, Levi-Civita tensor. Quotient law of tensors, Raising and lowering of indices Rules for combination of tensors- addition, subtraction, outer multiplication, contraction and inner multiplications.

Lab

1. Solve differential equations

$$\frac{dy}{dx} = e^x \text{ with } y = 0 \text{ for } x = 0$$

$$\frac{dy}{dx} + e^{-x}y = x^2$$

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} = -y$$

$$\frac{d^2y}{dt^2} + e^{-t}\frac{dy}{dt} = -y$$

2. Dirac Delta Function

Evaluate the integral I

$$I = \frac{1}{\sqrt{2\pi\sigma^2}} \int \exp\left[-\frac{(x-2)^2}{2\sigma^2}\right] (x+3) dx \text{ for } \sigma = 1.0, 0.1, 0.01 \text{ and show the } I \rightarrow 5$$

3. Fourier Series

Make a program to evaluate

$$\sum_{n=1}^{\infty} (0.2)^n$$

Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special Functions

Evaluate

$$\int_{-1}^1 P_n(x) P_m(x) dx = \delta_{n,m}$$

Plot $P_n(x)$, $J_\theta(x)$ and show the recursion relation.

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

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

7. Evaluation of trigonometric functions e.g. $\sin\theta$, given Bessel's function at N points find its value at an intermediate point.

8. Integrate

$$\frac{1}{(x^2 + 2)}$$

Numerically in a given interval.

9. Compute the n th roots of unity for $n=2, 3$, and 4 .

10. Find the two square roots of $5+12j$.

11. Integral transform

Evaluate FFT of e^{-x^2}

12. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.

Reference Books

- [1] Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, and F. E. Harris, 2013, 7th Edn., Elsevier.
- [2] An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI
- [3] Learning Differential Equations, George F. Simmons, 2007, McGraw Hill.
- [4] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- [5] Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book
- [6] Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- [7] Mathematical Physics, Goswami, 1st edition, Cengage Learning
- [8] Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press
- [9] Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India
- [10] Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge University Press

PHY-HC-4026

Elements of Modern Physics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

***Course Outcome:** On completion of the course students will be able to understand modern development in Physics, Starting from Planck's law, its development of the idea of probability interpretation and the formulation of Schrodinger equation. Students will also get preliminary idea of structure of nucleus, radioactivity Fission and Fusion and Laser*

Theory

Unit I: Quantum Theory and Blackbody Radiation (Lecture 12)

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.

Unit II: Uncertainty and Wave-Particle Duality (Lecture 05)

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 an interaction.

Unit III: Schrödinger Equation (Lecture 8)

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrödinger equation for non- relativistic particles; expectation value, momentum and energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; probability and probability current densities in one dimension.

Unit IV: One-dimensional Box and Step Barrier (Lecture 9)

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 and rectangular potential barrier.

Unit V: Structure of the Atomic Nucleus (Lecture 06)

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. Atomic Mass Unit. Nature of nuclear force, $N - Z$ graph, liquid drop model: semi-empirical mass formula and binding energy, nuclear shell model (qualitative discussions) and magic numbers.

Unit VI: Radioactivity (Lecture 08)

Stability curve and stability of nuclei, Law of radioactive decay, disintegration constant, half life and mean life. Activity unit. Alpha decay – Range energy relation, Fine structure of alpha energy spectrum. Beta decay energy released, continuous beta spectrum and Pauli's prediction of neutrino. Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Unit VII : Detection of nuclear radiation (Lecture 04)

Method of energy loss by charged particles and gamma photons. Photoelectric, Compton and Pair-production processes Gas filled detectors – principle and construction of a gas filled detector, Ionization, proportional, GM and spark region.

Unit VIII: Fission and Fusion (Lecture 04)

Energy consideration in Nuclear Reaction, Q-value of nuclear reaction, Mass deficit, Einstein's mass-energy equivalence principle and generation of nuclear 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 qualitative discussions).

Unit IX: Lasers (Lecture 04)

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 and He-Ne Laser. Basic lasing.

Lab

A minimum of six experiments to be done.

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect
Photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
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 different colours.
5. To determine the wavelength of $H - \alpha$ emission line of hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of iodine vapour.
8. To determine the value of e/m by (a) magnetic focusing or (b) bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using $I - V$ characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.

Reference Books

- [1] Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- [2] Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- [3] Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- [4] Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- [5] Modern Physics, G. Kaur and G. R. Pickrell, 2014, McGraw Hill
- [6] Quantum Mechanics: Theory & Applications, A. K. Ghatak & S. Lokanathan, 2004, Macmillan

PHY-HC-4036

Analog Systems & Applications

Total Lectures: 60

Credits: 6 (Theory: 04, Lab:02)

***Course Outcome:** On successful completion of the course students will be able to understand about the physics of semiconductor p-n junction and devices such as rectifier diodes, zener diode, photodiode etc. and bipolar junction transistors, transistor biasing and stabilization circuits, the concept of feedback in amplifiers and the oscillator circuits, students will also have an understanding of operational amplifiers and their applications.*

Theory

Unit I: Semiconductor Diodes (Lectures 10)

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 for Step Junction. Current flow mechanism in Forward and Reverse Biased Diode.

Unit II: Two-terminal Devices and their Applications (Lectures 06)

(1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

Unit III: Bipolar Junction Transistors (Lectures 06)

$n-p-n$ 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 and Saturation Regions.

Unit IV: Amplifiers (Lectures 10)

Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h -parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.

Unit V: Coupled Amplifier (Lectures 04)

Two stage RC -coupled amplifier and its frequency response.

Unit VI: Feedback in Amplifiers (Lectures 04)

Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Unit VII: Sinusoidal Oscillators (Lectures 04)

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

Unit VIII: Operational Amplifiers (Black Box approach) (Lectures 04)

Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Unit IX: Applications of Op-Amps (Lectures 09)

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

Unit X: Conversion (Lectures 03)

Resistive network (Weighted and $R-2R$ Ladder). Accuracy and Resolution. A/D Conversion (successive approximation).

Lab

A minimum of eight experiments to be done.

1. To study $V - I$ characteristics of PN junction diode, and Light emitting diode.
2. To study the $V - I$ characteristics of a Zener diode and its use as voltage regulator.
3. Study of $V - I$ & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
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 an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt's oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
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 frequency response.
15. To design non-inverting amplifier using Op-amp (741/351) & study its frequency response.
16. To study the zero-crossing detector and comparator.
17. To add two dc voltages using Op-amp in inverting and non-inverting mode.
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.

Reference Books

- [1] Integrated Electronics, J. Millman and C. C. Halkias, 1991, Tata Mc-Graw Hill.
- [2] Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.
- [3] Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn., 2009, PHI Learning
- [4] Electronic Devices & circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- [5] OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- [6] Microelectronic circuits, A. S. Sedra, K.C. Smith, A. N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- [7] Electronic circuits: Handbook of design & applications, U. Tietze, C. Schenk, 2008, Springer
- [8] Semiconductor Devices: Physics and Technology, S. M. Sze, 2nd Ed., 2002, Wiley India
- [9] Microelectronic Circuits, M. H. Rashid, 2nd Edition, Cengage Learning
- [10] Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Honours Generic Paper

PHY-HG-4016 (PHY-RC-4016)

Waves & Optics

Total Lectures: 60

Credits: 6 (Theory: 04, Lab:02)

***Course outcome:** Upon completion of this course, students are expected to understand Simple harmonic oscillation and superposition principle, importance of classical wave equation in transverse and longitudinal waves and solving a range of physical systems on its basis, concept of normal modes in transverse and longitudinal waves: their frequencies and configurations, interference as superposition of waves from coherent sources derived from same parent source, Demonstrate understanding of Interference and diffraction experiments, Polarization. In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment, the motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves.*

Theory

Unit I: Superposition of Two Collinear Harmonic Oscillations (Lectures 04)

Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

Unit II: Superposition of Two Perpendicular Harmonic Oscillations (Lectures 02)

Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequency and their uses.

Unit III: Waves Motion (Lectures 07)

General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

Unit IV: Fluids (Lectures 06)

Surface Tension: Synclastic and anticlastic surface – Excess of pressure – Application to spherical and cylindrical drops and bubbles – variation of surface tension with temperature – Jaeger's method. Viscosity – Rate flow of liquid in a capillary tube – Poiseuille's formula – Determination of coefficient of viscosity of a liquid – Variations of viscosity of liquid with temperature – lubrication.

Unit V : Sound (Lectures 06)

Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

Unit VI : Wave Optics (Lectures 03)

Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

Unit VII : Interference (Lectures 10)

Division of amplitude and division of wavefront. 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 and Fringes of equal thickness. Newton's Rings: measurement of wavelength. Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index Visibility of fringes.

Unit VIII : Michelson Interferometer (Lectures 03)

(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Refractive Index. (4) Visibility of fringes.

Unit IX : Diffraction (Lectures 14)

Fresnel and Fraunhofer diffraction . 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 diffraction pattern of a straight edge and at a circular aperture . Resolving Power of a telescope. Fraunhofer diffraction due to a Single slit , Diffraction grating . Resolving power of grating.

Unit X : Polarization (Lectures 05)

Transverse nature of light waves. Double Refraction, Plane, circular and elliptically polarized light , Production and analysis of polarized light. Retarding plates.

Lab

A minimum of five experiments to be done.

1. To study the variation in liquid column height with diameter of capillary tube and determine the surface tension of the liquid.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $Z^2 \propto T$ Law.
3. To determine the coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method)
4. To determine the focal length of a convex mirror with the help of convex lens .
5. To determine the refractive index of a liquid by using plane mirror and convex lens.
6. To determine the focal length of two lenses and their combination by displacement method .
7. Familiarization with Schuster's focussing; determination of angle of prism.
8. To determine the Refractive Index of the Material of a Prism using Sodium Light.
9. To determine wavelength of sodium light using Newton's Rings.

Reference Books

- [1] Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- [2] Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill
- [3] Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- [4] Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- [5] The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- [6] The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- [7] Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.

Skill Enhancement Papers

[Choose One]

PHY-SE-4014

BASIC INSTRUMENTATION SKILLS

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics/B.E./B.Tech in Instrumentation/Mechanical Engineering.

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Theory

Unit I: Basic of Measurement (Lectures 4)

Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Unit II: Electronic Voltmeter (Lectures 4)

Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

Unit III: Cathode Ray Oscilloscope (Lectures 6)

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

Unit IV: (Lectures 3)

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

Unit V: Signal Generators and Analysis Instruments (Lectures 4)

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

Unit VI: Impedance Bridges & Q-Meters (Lectures 3)

Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

Unit VII: Digital Instruments (Lectures 3)

Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Unit VIII: Digital Multimeter (Lectures 3)

Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period

measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Lab

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

Open Ended Experiments:

2. Using a Dual Trace Oscilloscope
3. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books

- [1] Electronic Measurements and Instrumentation, K. Lal Kishore, Pearson India
- [2] Electrical and Electronics Measurements and Instrumentation, Prithwiraj Purkait, Budhaditya Biswas, Santanu Das, Chiranjib Koley, McGraw Hill India.
- [3] A text book in Electrical Technology - B L Theraja - S Chand and Co.
- [4] Performance and design of AC machines - M G Say ELBS Edn.
- [5] Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- [6] Logic circuit design, Shimon P. Vingron, 2012, Springer.
- [7] Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- [8] Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- [9] Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- [10] Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

PHY-SE-4024

Research & Technical Writing

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with adequate knowledge on Latex/ B.E./B.Tech. in Computer Science/ MCA.

This aim of the course is to make the students aware about importance of research and technical writing. This course provides students with an introduction to technical writing, graphing and data analysis, and computer presentation with LaTeX, Origin and Microsoft excel.

Course Outcome: *On successful completion of the course students will be able to identify and write different parts of technical reports, write article, thesis, and presentation in latex, create chart in Microsoft excel, use different format of chart based on need, plot data from different sources using Origin plot.*

Theory

Introduction (Lectures 4)

Structure and components of scientific reports - Types of report – Technical reports and thesis– Different steps in the preparation – Layout – Illustrations and tables - Bibliography, referencing and footnotes. Need of scientific word processor, examples of scientific word processors.

Unit II: Technical Writing in LaTeX (Lectures 12)

Introduction to LaTeX, advantages of using 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 and colors, errors. Applications of LaTeX in article, thesis, slide preparation.

Unit III: Scientific graphing and data analysis (Lectures 14)

Creating chart in Microsoft excel, Types of chart- Column chart, line chart, Pie chart, Doughnut chart, bar chart, area chart, scatter chart, surface chart; Chart elements- Chart style, Chart filter, fine tune of chart; Chart design tools- Design and format.

The Origin Workspace, Multi-sheet Workbooks, Managing Data and Metadata, Importing Data from different sources, Working with Excel and Origin, Basic Data Manipulation, Creating and Customizing Graphs, Custom Graph Templates and Themes, Publishing Graphs, Basic Data Analysis, Customizing Data Import, Post Processing of Imported Data, Creating and Customizing Multi-layer Graphs, Data Exploration and Pre-selection, Advanced Nonlinear Fitting, including Creating Custom Fitting Functions, Analysis Themes, Customizing Reports and Creating Custom Tables in Graphs, Recalculating/Updating Results, Analysis Templates and Custom Reports, Peaks and Baseline.

PHY-SE-4034

Domestic and Industrial Electrical Wiring

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: B.E./B.Tech. in electrical engineering/First class or Second class govt. registered contractor with a Bachelor Degree in Science.

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. This course will enable the students to read, understand and interpret engineering drawing and communicate through sketches and drawings. Students will be able to prepare working drawings of panels, transmission and distribution and install and commission electrical wiring in domestic as well as industrial buildings.

Course Outcome: After successfully completion of the course students will be able to recognize various electrical devices and their symbols, Recognize various electrical devices placed on the panels/distribution boards and to design the panels, Read schematic and wiring diagrams of electrical devices, Read and interpret electrical installation plan, Practice and execute any type of wiring , Estimate and determine the cost of wiring installation

Theory

Unit I: Understanding Electrical Circuits (Lectures 3)

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.

Unit II: Electrical Drawing and Symbols (Lectures 10)

Various electrical symbols used in domestic and industrial installation and power system as per BIS code. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. Wiring diagram of light, fan, bell and alarm circuit, staircase and godown wiring, schematic diagram of lighting system of conference room, theatre, sports stadium etc. Design and drawing of panels, distribution board using MCB, ELCB, main switches and change over switches for domestic, industrial and commercial installations.

Unit III: Types of wiring (Lectures 5)

Basics of wiring- star and delta wiring; Cleat, Batten, casing-capping and conduit wiring, comparison of different types of wiring systems; selection and design of wiring schemes for particular situation (domestic and industrial), selection of wire, cables, wiring accessories and use of protective devices i.e., MCB, ELCB etc.; rating and current carrying capacity of wires, cables, fuse, switches, socket, MCBs, ELCBs and other electrical accessories.

Unit IV: Earthing (Lectures 2)

Concept and purpose of earthing, different types and procedure of earthing, drawing of plate and pipe earthing, test material and costing and estimating.

Unit V: Estimating and costing (Lectures 10)

- (i) Domestic Installations: Standard practices as per IS and IE rules. Planning of circuits, sub circuits and position of different accessories, electrical layouts, preparing estimates including costs as per schedule rate pattern and actual market rate (single storey and multi storey buildings having similar electrical load)
- (ii) Industrial Installations: Standard practices as per IS and IE rules; planning, designing and estimation of installation of single phase motors of different ratings, electrical circuit diagram, starters, preparation of list of materials,

estimating and costing on workshop with single phase , 3-phase motor load and the light load

(iii) Service line connections: Estimate for domestic and industrial load from pole to energy meter.

Lab

1. Safety use in electricity, shock treatment methods, safety precautions.
2. To study & find the specifications of various types of wires and cables.
3. To measure the gauge of a given wire with the help of wire gauge.
4. To connect the wires with different electrical accessories.
5. Skinning the cable and joint practice on single and multi strand wire.
6. To measure the power of an electric motor by wattmeter.
7. To make a main switch board for house wiring
8. Installation of common electrical accessories such as switch, holder, plug on board.
9. Installation and wiring connection of ceiling fan, exhaust fan, geyser, water purifier.
10. Preparation of extension board.
11. Demonstrate electrical circuit diagrams related to electrical equipment
12. Calculate/ interpret electrical power rating of electrical circuits installed in the equipments
13. Carry out the earthing of the installed electrical circuit as per standard practice
14. Practice on different types of House Wiring installation and testing
15. Designing of light and fan scheme for a institutional or commercial building
16. House wiring circuits using fuse, switches, sockets, ceiling fan etc. in batten or P.V.C. casing-caping.
17. Prepare one estimate of materials required for CTS wiring for small domestic installation of one room and one verandah within 25 m² with given light, fan & plug points.
18. Prepare one estimate of materials required for conduit wiring for small domestic installation of one room and one verandha within 25 m² with given light, fan & plug points.
19. Prepare one estimate of materials required for concealed wiring for domestic installation of two rooms and one latrine, bath, kitchen & verandah within 80m² with given light, fan & plug points.
20. Prepare one estimate of materials required for erection of conduct wiring to a small workshop installation about 30m²

Reference Books:

- [1] Electrical Installation and Estimating- Surjit Singh, Dhanpatrai and sons
- [2] A course in Electrical Installation, Estimating and costing- J B Gupta, S K Kataria and Sons
- [3] A text book in Electrical Technology - B L Theraja - S Chand & Co.
- [4] A text book of Electrical Technology - A K Theraja
- [5] Performance and design of AC machines - M G Say ELBS Edn.

PHY-SE-4044

Photoshop

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on Photoshop/B.E./B.Tech. in Computer Science/MCA/ B.Sc. with DCA.

This course will give you skill to prepare creative effect to design stunning text style, design icons, business cards, illustrations and characters. You will learn to remove people or objects from photos, cut away a person from their background. In this course you will learn how to properly use Photoshop's tools, discover how to retouch and color correct photographic images.

Course Outcome: On successful completion of the course students will be able to work with the tools in Adobe Photoshop CC, crop image in Adobe Photoshop CC, to resize an image for print and digital media in Adobe Photoshop CC, apply Photoshop filters in print and digital media, apply filters to sharpen the images, different types of brushes used for digital painting.

Tools: Adobe Photoshop CC

Unit I: Getting Started with Adobe Photoshop CC (Lectures 3)

Overview of Adobe Photoshop CC, Features of Adobe Photoshop CC

Unit II: Importance of Adobe Photoshop CC (Lectures 5)

Overview of Tools Used in Adobe Photoshop CC, Importance of Adobe Photoshop CC

Unit III: Working with Typography (Lectures 4)

Typography, Creating Typographies, Choosing the Right Font and Color

Unit IV: Working with Layers and Images (Lectures 6)

Cropping a Photo, Resizing Images, Basics of Layers, Creating Layers for Print and Digital Media, Aligning Images within Multiple Layers, Merging Layer Techniques

Unit V: Working with Filters (Lectures 4)

Photoshop Filters, Smart Filters, Common Features of Photoshop Filter

Unit VI: Digital Painting in Adobe Photoshop CC (Lectures 4)

Working with Brush Tool, Importance of Using Colors

Unit VII: Masking and File Formats in Adobe Photoshop CC (Lectures 4)

Introduction to Mask, Creating Vector and Layer Masks, Essential File Formats, Choosing the Right Format for Print and Digital Media

PHY-SE-4054

MOTION GRAPHICS FOR ADVERTISING & FILMS

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on Photoshop/B.E./B.Tech. in Computer Science/MCA/ B.Sc. with DCA.

This course will give you the skills to design and create motion graphics for Ad Commercials and Films. You will learn to create & edit these motion graphics on the most popular and industry relevant Compositing software, Adobe After Effects.

Course Outcome: On successful completion of the course students will be able to create Motion Graphic Design for Ads, Commercials, Promos & Film / Show Titles, use After Effects templates to create your own customized 2D or 3D Motion Graphics, Understand Working with Layers, create Shape morphing animation and build transitions, utilize After Effects' Motion Graphics Techniques.

Tools: Adobe After Effects CC

Unit I: Getting started with Adobe After Effects CS6 (Lectures 3)

Introduction to Adobe After Effects CS6, Importing Files, Creating a Composition

Unit II: Basic Effects and Composition Animation (Lectures 5)

Adding Effects, Adding Animation, Expressions, Creating animation and Effects Presets

Unit III: Creating Video Composites with Green Screen Footage (Lectures 5)

Masks, Blending Modes, Tracking Mattes

Unit IV: Advanced Compositing Techniques (Lectures 6)

Motion Stabilization, Motion Tracking, Time Remapping Techniques

Unit V: 3D in After Effects (Lectures 6)

Introduction, Text Animation, Particle Preset

Unit VI: Previewing and Rendering Output (Lectures 5)

Previewing the Work, Rendering Process, Exporting to Different Output

PHY-SE-4064

Radiation Safety

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Nuclear Physics/ Radiation Physics (preferably with a RSO degree from BRIT/BARC).

To ensure safety of the public, occupational workers and the environment, this course on the basic knowledge of radiation safety is introduced. The course is designed in such a way to acquaint the students with the sources of various natural and man-made radiation sources, risks involved in working in relatively high radiation zone, and safety measures to be taken to protect individual's health.

The students will acquire a basic knowledge of types and sources of radiations, interactions of radiations with matter, risks involved and safety measures to be taken.

Theory

Unit I: Structure of Matter (Lectures 6)

Constituents of atoms and nuclei, atomic and mass numbers, Isotopes, energy units, electron shells, atomic energy levels, Nuclear energy levels. Transitions between atomic energy levels (resulting optical photons) and nuclear energy levels (resulting gamma photons), -Ionization and excitation, Electromagnetic spectrum, Relationship between wavelengths, Frequency, Energy.

Units and Measurements of Physical Quantities: Force, Work, Power, energy temperature and heat. SI units of above parameters. (6L)

Unit II: Radioactivity (Lectures 6)

Natural and artificial radioactivity, types of nuclear radiations: alpha, beta, and gamma rays – concepts of Half life, activity, units of activity, -specific activity. Interactions of gamma ray and charged particles with matter. Absorbed Dose, Units of Dose. Radiation hazard, Safety measurements: Time, distance and shielding. Occupational dose limit.

Unit III: Radiation Quantities and Units (Lectures 7)

Particle flux and fluence, Radiation flux and fluence, cross section, energy, linear energy transfer (LET), linear and mass attenuation coefficients, mass stopping power, inverse square law, W-value, exposure (rate), Kerma (rate), Terma, absorbed dose (rate), rate constants, radiation weighting factors, tissue weighting factors, equivalent dose, effective dose, collective effective dose, Annual Limit of Intake {ALI}, Derived Air Concentration {DAC}, personnel dose equivalent, committed dose.

Unit IV: X-Ray (Lectures 5)

Electromagnetic waves, X-Rays –Production of X-rays: The X-ray tube, Physics of X-ray production, continuous spectrum, characteristic spectrum,–Basics of X-ray Circuits, measurement of high voltage –control of KV circuit –MA circuit. Loading, processing and storing of X-ray plates. Distribution of X-rays in space, Interaction of X-rays with matter, Attenuation of x-rays. Radiation effect of X-rays, safety measurements to be followed.

Unit V: Computed Tomography (Lectures 3)

Theory of tomography – multi section radiography, tomographic equipment, Computer tomography. Radiation hazard of Tomographic machine, Safety measurement to be followed.

Unit VI: MRI (Lectures 3)

Magnetic Resonance imaging – Basic principle– Imaging methods– Slice section, Image contrast, Bio-effects of MRI. Safety measurements. Counting statistics, errors in counting.

Lab

1. Measurement of alpha track density due to environmental (air) Radon (and its daughter) using SSNTD
2. Taking X-ray of a pen/pencil
3. Visit to a CT scan and MRI laboratory.
4. Study the background radiation levels using Radiation meter

Characteristics of Geiger Muller (GM) Counter:

5. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
6. Study of counting statistics using background radiation using GM counter.
7. Study of radiation in various materials (e.g. KSO_4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
8. Study of absorption of beta particles in Aluminum using GM counter.
9. Detection of α particles using reference source & determining its half life using spark counter
10. Gamma spectrum of Gas Light mantle (Source of Thorium)
11. Studying α particles in air using SSNTDs technique

Reference Books

- [1] Radiation Safety: J S Ballard (<https://openoregon.pressbooks.pub/radsafety130/>)
 - [2] Atomic and Nuclear Physics Vol. II: S N Ghosal
 - [3] An introduction to Radiation Physics: Vivek Mandot (ISBN: 9788179067635, 8179067637)
 - [4] W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
 - [5] G.F.Knoll, Radiation detection and measurements
 - [6] Thermoluminescence Dosimetry, Mcknlly, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
 - [7] W.J. Meredith and J.B. Massey, “Fundamental Physics of Radiology”. John Wright and Sons, UK, 1989.
 - [8] J.R. Greening, “Fundamentals of Radiation Dosimetry”, Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
 - [9] Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
 - [10] A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981. NCRP, ICRP, ICRU, IAEA, AERB Publications.
- W.R. Hendee, “Medical Radiation Physics”, Year Book – Medical Publishers Inc. London, 1981

PHY-SE-4074

RENEWABLE ENERGY AND ENERGY HARVESTING

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Condensed Matter Physics.

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Theory

Unit I: Fossil fuels and Alternate Sources of energy (Lectures 3)

Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Unit II: Solar energy (Lectures 6)

Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Unit III: Wind Energy harvesting (Lectures 3)

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Unit IV: Ocean Energy (Lectures 3)

Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Unit V: (Lectures 2)

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Biomass.

Unit VI: Geothermal Energy (Lectures 2)

Geothermal Resources, Geothermal Technologies.

Unit VII: Hydro Energy (Lectures 2)

Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Unit VIII: Piezoelectric Energy harvesting (Lectures 4)

Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Unit IX: Electromagnetic Energy Harvesting (Lectures 2)

Linear generators, physics mathematical models, recent applications

Unit X: (Lectures 2)

Carbon captured technologies, cell, batteries, power consumption

Unit XI: (Lectures 1)

Environmental issues and Renewable sources of energy, sustainability.

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books

- [1] Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- [2] Solar energy - M P Agarwal - S Chand and Co. Ltd.
- [3] Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- [4] Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
- [5] Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009 • J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- [6] http://en.wikipedia.org/wiki/Renewable_energy

PHY-SE-4084

Introduction to CorelDraw

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on CorelDraw/B.E./B.Tech. in Computer Science/ MCA/B.Sc. with DCA.

This course will give you how to use CorelDraw to present objects, layers, and pages in an effective and presentable form. This course will enable you to create logos, brochures, website graphics, illustrations and other artwork. The trained candidates can develop the designs to meet the computer graphics need of various applications.

***Course Outcome:** On successful completion of the course students will be able to work with layers and symbols in CorelDRAW, Apply fills and outlines to illustrations in CorelDRAW, Use, edit, and create artistic and paragraph text in CorelDRAW, Create boundaries to objects and copy and clone the effect of one object to another in CorelDRAW, Import and export projects, Print objects/documents created on CorelDRAW.*

Unit I: Getting Started with CorelDRAW (Lectures 6)

CorelDRAW Interface, Moving from Adobe Illustrator to CorelDRAW, Drawing Basic Shapes, Selecting Objects, Changing Order of Objects, Transforming Objects, Duplicating Objects, Organizing Objects, Zooming, Panning, and Scrolling, Hiding and Displaying Objects, Using Guides and Grids, Saving the Document

Unit II: Drawing and Coloring (Lectures 6)

Drawing Lines in CorelDRAW, Calligraphy, Shape Edit Tool, Applying Fills and Outlines, Pages and Layout Tools, Viewing Modes, Working with Layers, Working with Symbols, Creating Styles

Unit III: Working with Text (Lectures 6)

Artistic Text, Fitting Text to Curve, Reshaping Tools, Paragraph Text, Entering and Editing, Paragraph Text, Wrapping Text around Other Shapes, Linking Text to Objects, Finding and Replacing
Working with Text Styles, Working with Tables, Inserting Formatting Codes, Font Identification

Unit IV: Applying Effects (Lectures 6)

Envelopes and Distortion Effects, Blends and Contours, Transparency and Drop Shadow, Extrude
Lens, Perspective, Bevel, Powerclip, Create Boundary, Copying and Cloning Effects, Inserting Bar Codes, Inserting and Editing QR Codes

Unit V: Working with Bitmaps and Web Resources (Lectures 6)

Importing and Exporting Bitmaps, Working with Bitmaps, Internet Toolbar, Setting Web pages
Creating Buttons with Rollover Effects, Publishing to PDF, Printing

PHY-SE-4094

GRAPHIC DESIGN FOR DIGITAL ADVERTISING

Credits: 4 (Theory: 2, Lab: 2)

Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on digital advertising /B.E./B. Tech. in Computer Science/ MCA/B.Sc. with DCA.

This course will give you the skills to come up with innovative concepts and visualization and further create Graphic Designs using the principles of Design, Composition & Colour theory. You will learn to create Graphic Design on the most popular and industry relevant design software, Adobe Photoshop.

***Course Outcome:** On successful completion of the course students will be able to Understand aesthetics & visual appeal in design, Using impactful visual content which appeals to target audience, Conceptualize, Visualize and Create Graphic Designs for: Digital Ads, Posters, Banners and Flyers, Social Media Ads & Banners, Websites and Blogs*

Tools: Adobe Photoshop Extended CC

Unit I: Getting Started with Adobe Photoshop CC (Lectures 3)

Overview of Adobe Photoshop CC, Features of Adobe Photoshop CC

Unit II: Importance of Adobe Photoshop CC (Lectures 3)

Overview of Tools Used in Adobe Photoshop CC, Importance of Adobe Photoshop CC

Unit III: Working with Typography (Lectures 4)

Typography, Creating Typographies, Choosing the Right Font and Color

Unit IV: Working with Layers and Images (Lectures 5)

Cropping a Photo, Resizing Images, Basics of Layers, Creating Layers for Print and Digital Media, Aligning Images within Multiple Layers, Merging Layer Techniques

Unit V: Working with Filters (Lectures 5)

Photoshop Filters, Smart Filters, Common Features of Photoshop Filter

Unit VI: Digital Painting in Adobe Photoshop CC (Lectures 5)

Working with Brush Tool, Importance of Using Colors

Unit VII: Masking and File Formats in Adobe Photoshop CC (Lectures 5)

Introduction to Mask, Creating Vector and Layer Masks, Essential File Formats, Choosing the Right Format for Print and Digital Media

Fifth Semester

Honours Core Papers

PHY-HC-5016

Quantum Mechanics & Applications

Total Lectures: 60

Credits: 6 (Theory: 04, Lab:02)

Course Outcome: On successful completion of the course students will be able to understand the principles in quantum mechanics, such as the Schrödinger equation, the wave function, the uncertainty principle, stationary and non-stationary states, time evolution of solutions, as well as the relation between quantum mechanics and linear algebra. Students will be able to solve the Schrödinger equation for hydrogen atom. Students will have the concepts of angular momentum and spin, as well as the rules for quantization and addition of these, spin-orbit coupling and Zeeman Effect.

Theory

Unit I: Time Dependent Schrödinger Equation (Lectures 06)

Time dependent Schrödinger 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 a free particle.

Unit II: Time Independent Schrödinger Equation (Lectures 10)

Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wave function as a linear combination of energy eigenfunctions; General solution of the time dependent Schrödinger 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 wave function; Position-momentum uncertainty principle.

Unit III: Bound States (Lectures 12)

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.

Unit IV: Hydrogen-like Atoms (Lectures 10)

Time independent Schrödinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m ; $s, p, d, \dots$ shells.

Unit V: Atoms in Electric & Magnetic Fields (Lectures 12)

Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Zeeman Effect: Normal and Anomalous Zeeman Effect. Paschen-Back Effect and Stark Effect (Qualitative Discussion only).

Unit VI: Many Electron Atoms (Lectures 10)

Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for 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 Atoms (Na etc.).

Lab

Use C/C++/Scilab/FORTRAN/Mathematica/ Python for solving the following problems based on Quantum Mechanics.

1. Solve the s -wave Schrödinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r},$$

where, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take $e=3.795$ (eV Å), $\hbar c = 1973$ (eV Å) and $m=0.511 \times 10^6$ eV/c².

2. Solve the s -wave radial Schrödinger equation for an atom

$$\frac{d^2y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened Coulomb potential

$$V(r) = -\frac{e^2}{r} e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take $e=3.795$ (eV Å), and $a=3$ Å, 5 Å, and 7 Å in the units of $\hbar c = 1973$ (eV Å) and $m=0.511 \times 10^6$ eV/c². The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s -wave radial Schrödinger equation for a particle of mass m

$$\frac{d^2y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

The anharmonic potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m=940$ MeV/c², $k=100$ MeV fm⁻², $b=0, 10, 30$ MeV fm⁻³. In these units, $\hbar c=197.3$ MeV fm. The ground state energy I is expected to lie in between 90 and 110 MeV for all three cases.

4. Solve the s -wave radial Schrödinger equation for the vibration of hydrogen molecule

$$\frac{d^2y}{dr^2} = A(r)u(r), \quad A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$$

where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), \quad r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take $m=940 \times 10^6$ eV/c², $D=0.755501$ eV, $\alpha=1.44$, and $r_0=0.131349$ Å.

Laboratory based experiments (Optional)

5. Study of electron spin resonance – determine magnetic field as a function of the resonance frequency.
6. Study of Zeeman Effect – with external magnetic field; hyperfine splitting.
7. To show the tunneling effect in tunnel diode using $I - V$ characteristics.
8. Quantum efficiency of CCDs.

Reference Books

- [1] A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- [2] Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- [3] Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- [4] Quantum Mechanics, G. Aruldas, 2nd Edn. 2002, PHI Learning of India.
- [5] Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- [6] Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
- [7] Quantum Mechanics for Scientists & Engineers, D. A. B. Miller, 2008, Cambridge University Press

PHY-HC-5026

Solid State Physics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

***Course Outcome:** On successful completion of the course students should be able to explain the main features of crystal lattices and phonons, understand the elementary lattice dynamics and its influence on the properties of materials, describe the main features of the physics of electrons in solids; explain the dielectric ferroelectric and magnetic properties of solids and understand the basic concept in superconductivity.*

Theory

Unit I: Crystal Structure (Lectures 10)

Amorphous and Crystalline Materials. Lattice Translation Vectors. Symmetry operations, 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 and Geometrical Factor.

Unit II: Elementary Lattice Dynamics (Lectures 10)

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^3 law.

Unit III: Magnetic Properties of Matter (Lectures 08)

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.

Unit IV: Dielectric Properties of Materials (Lectures 08)

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 Sellmeier relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, T_0 modes.

Unit V: Ferroelectric Properties of Materials (Lectures 06)

Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Unit VI: Free Electron Theory of Metals (Lectures 12)

Electrical and thermal conductivity of metals, Wiedemann-Franz law. 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 (4-probe method) & Hall coefficient.

Unit VII: Superconductivity (Lectures 06)

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 theory (No derivation).

Lab

A minimum of five experiments to be done.

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency.
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR).
6. To determine the refractive index of a dielectric layer using SPR.
7. To study the *PE* Hysteresis loop of a Ferroelectric Crystal.
8. To draw the $B - H$ curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150°C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Reference Books

- [1] Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- [2] Elements of Solid State Physics, J. P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
- [3] Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- [4] Solid State Physics, N. W. Ashcroft and N. D. Mermin, 1976, Cengage Learning
- [5] Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- [6] Solid State Physics, Rita John, 2014, McGraw Hill
- [7] Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- [8] Solid State Physics, M. A. Wahab, 2011, Narosa Publications

Discipline Specific Elective Papers [Choose Two]

PHY-HE-5016

Experimental Techniques

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

***Course Outcome:** Upon completion of this course, students will be able to describe the errors in measurement and statistical analysis of data required while performing an experiment. Also, students will learn the working principle, efficiency and applications of transducers & industrial instruments like digital multimeter, RTD, Thermistor, Thermocouples and Semiconductor type temperature sensors.*

Theory

Unit I: Measurements (Lectures 7)

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.

Unit II: Signals and Systems (Lectures 7)

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/f noise.

Unit III: Shielding and Grounding (Lectures 4)

Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference Shielding.

Unit IV: Transducers & industrial instrumentation (working principle, efficiency, applications) (Lectures 21)

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.

Unit V: Digital Multimeter (Lectures 5):

Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

Unit VI: Impedance Bridges and Q-meter (Lectures 4):

Block diagram and working principles of RLC bridge. Qmeter and its working operation. Digital LCR bridge.

Unit VII: Vacuum Systems (Lectures 12):

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).

Lab

(Minimum number of experiments to be completed is seven)

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
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 & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. Design and analyze the Clippers and Clampers circuits using junction diode
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter

Reference Books:

- [1] Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
- [2] Experimental Methods for Engineers, J.P. Holman, McGraw Hill
- [3] Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
- [4] Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
- [5] Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
- [6] Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
- [7] Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer
- [8] Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill

PHY-HE-5026

Embedded System: Introduction to microcontroller

Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

***Course Outcome:** Upon completion of this course, students will be able to understand microprocessor and microcontroller 8051. Students will also learn about the 8051 I/O port programming, various addressing modes, Timer and counter programming, Serial port programming with and without interrupt and interfacing 8051 microcontroller to peripherals.*

Theory

Unit I: Embedded System (Lectures 6)

Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges & design issues in embedded systems,

Unit II: Review of microprocessors (Lectures 6)

Organization of Microprocessor based system, 8085 μ p pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts.

Unit III: 8051 microcontroller (Lectures 13)

Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.

Unit IV: 8051 I/O port programming (Lectures 4)

Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions Bit manipulation.

Unit V: Programming of 8051 (Lectures 13)

8051 addressing modes and examples using assembly language, arithmetic and logic instructions 8051 programming in C: for time delay & I/O operations and manipulation, for arithmetic and logic operations.

Unit VI: Timer and counter programming (Lectures 3)

Programming 8051 timers, counter programming.

Unit VII: Serial port programming with and without interrupt (Lectures 6)

Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051.

Unit VIII: Interfacing 8051 microcontroller to peripherals (Lectures 2)

ADC, DAC interfacing, LCD interfacing.

Unit IX: Programming Embedded Systems (Lectures 3)

Basic Structure of embedded program, compiling, linking and locating, downloading and debugging.

Unit X: Embedded system design and development (Lectures 2)

trends in embedded industry

Unit XI: Introduction to Arduino (Lectures 2)

Pin diagram and description of Arduino UNO. Basic programming.

Lab

(Minimum number of experiments to be completed is seven)

A.8051 microcontroller based Programs and experiments

1. To find that the given numbers is prime or not.
2. To find the factorial of a number.
3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4. Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's .
5. Program to glow the first four LEDs then next four using TIMER application.
6. Program to rotate the contents of the accumulator first right and then left.
7. Program to run a countdown from 9-0 in the seven segment LED display.
8. To interface seven segment LED display with 8051 microcontroller and display „HELP“ in the seven segment LED display.
9. To toggle “1234” as “1324” in the seven segment LED display.
10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction
11. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

B. Arduino based programs and experiments:

12. Make a LED flash at different time intervals.
13. To vary the intensity of LED connected to Arduino
14. To control speed of a stepper motor using a potential meter connected to Arduino
15. To display “PHYSICS” on LCD/CRO.

Reference Books

- [1] Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill
- [2] The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
- [3] Embedded microcomputer system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole
- [4] Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.
- [5] Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India
- [6] Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning Embedded Systems: Architecture, Programming& Design, R.Kamal,]2008,Tata McGraw Hill
- [7] Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.
- [8] Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

PHY-HE-5036

Advanced Mathematical Physics I

Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

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.

Course Outcome: Upon completion of this course, students will be able to solve problems in Physics related to Linear Vector space, Matrix algebra, Tensor.

Theory

Unit I: Linear Vector Spaces (Lectures 20)

Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices.

Unit II: Matrix (Lectures 10)

Eigen-values and Eigenvectors. Cayley-Hamilton Theorem. Diagonalization of Matrices. Coordinate transformations, rotation in two dimensions, rotation in three dimensions. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.

Unit III: Cartesian Tensors (Lectures 20)

Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry : Equation of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors.

Unit IV :General Tensors (Lectures 10)

Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor.

Lab

Scilab/Mathematica/C++ or others based simulations experiments based on Mathematical Physics problems like

1. Linear algebra:

- Multiplication of two 3×3 matrices
- Eigenvalue and eigenvectors of

$$\begin{pmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 3 & 1 & 4 \end{pmatrix}; \begin{pmatrix} 1 & -i & 3+4i \\ i & 2 & 4 \\ 3-4i & 4 & 3 \end{pmatrix}; \begin{pmatrix} 2 & -i & 2i \\ i & 4 & 3 \\ -2i & 3 & 5 \end{pmatrix}$$

2. Orthogonal polynomials as eigenfunctions of Hermitian differential operators.
3. Determination of the principal axes of moment of inertia through diagonalization.
4. Lagrangian formulation in Classical Mechanics with constraints.
5. Study of geodesics in Euclidean and other spaces (surface of a sphere, etc).

Reference Books

- [1] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
- [2] Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
- [3] Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
- [4] Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
- [5] Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning
- [6] Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
- [7] Mathematical Methods for Physics & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press
- [8] Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- [9] Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
- [10] Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

PHY-HE-5046

Physics of Devices and Instruments

Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

***Course Outcome:** Upon completion of this course, students will be able to gain knowledge on advanced electronics devices such as UJT, JFET, MOSFET, CMOS etc., detailed process of IC fabrication, Digital Data serial and parallel Communication Standards along with the understanding of communication systems.*

Theory

Unit I: Devices (Lectures 14)

Characteristic and small signal equivalent circuits of UJT and JFET. Metal- semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO₂-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

Unit II: Power supply and Filters (Lectures 3)

Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection

Unit III: Active and Passive Filters (Lectures 3)

Low Pass, High Pass, Band Pass and band Reject Filters.

Unit IV: Multivibrators (Lectures 3)

Astable and Monostable Multivibrators using transistors.

Unit V: Phase Locked Loop(PLL) (Lectures 5)

Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter–Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

Unit VI: Processing of Devices (Lectures 12)

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 and implantation.

Unit VII: Digital Data Communication Standards (Lectures 5)

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 a COM port.

Unit VIII: Introduction to communication systems (Lectures 15)

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.

Lab

Minimum number of experiments to be completed is seven

(4 from Section A, 3 from Section B)

Experiments should be done from both Section A and Section B:

Section-A

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astable multivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Section-B:

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1st order active low pass and high pass filters of given cutoff frequency
6. Design a Wein's Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop's using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.

Reference Books

- [1] Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
- [2] Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
- [3] Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
- [4] Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
- [5] Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- [6] Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
- [7] Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
- [8] PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

PHY-HE-5056

Nuclear and Particle Physics

Total Lectures: 75

Credits: 6 (Theory: 05, Tutorial: 01)

***Course Outcome:** Upon completion of this course, students will have the understanding of the sub atomic particles and their properties. They will gain knowledge about the different nuclear techniques and their applications in different branches of Physics and societal application. The course will develop problem based skills and the acquire knowledge can be applied in the areas of nuclear, medical, archeology, geology and other interdisciplinary fields of Physics and Chemistry.*

Theory

Unit I: General Properties of Nuclei (Lectures 10)

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 excited states.

Unit II: Nuclear Models (Lectures 12)

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.

Unit III: Radioactivity decay (Lectures 10)

(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.

Unit IV: Nuclear Reactions (Lectures 8)

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).

Unit V: Interaction of Nuclear Radiation with matter (Lectures 8)

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.

Unit VI: Detector for Nuclear Radiations (Lectures 8)

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.

Unit VII: Particle Accelerators (Lectures 5)

Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

Unit VIII: Particle physics (Lectures 14)

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.

Reference Books

- [1] Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- [2] Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
- [3] Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- [4] Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- [5] Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- [6] Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- [7] Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- [8] Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- [9] Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- [10] Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991)

Sixth Semester

Honours Core Papers

PHY-HC-6016

Electromagnetic Theory

Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

***Course Outcome:** On successful completion of the course students will acquire the concepts of Maxwell's equations, propagation of electromagnetic (EM) waves in different homogeneous-isotropic as well as anisotropic unbounded and bounded media, production and detection of different types of polarized EM waves, general information as waveguides and fibre optics.*

Theory

Unit I: Maxwell Equations (Lecture 12)

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 Angular Momentum Density.

Unit II: EM Wave Propagation in Unbounded Media (Lecture 10)

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 through ionosphere.

Unit III: EM Wave in Bounded Media (Lecture 10)

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 (normal Incidence).

Unit IV: Polarization of Electromagnetic Waves (Lecture 12)

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.

Unit V: Rotatory Polarization (Lecture 08)

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's half-shade polarimeter. (5 Lectures) 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.

Unit VI: Optical Fibres (Lecture 03)

Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Lab

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves.
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using $V - I$ characteristics of PN junction diode.

Reference Books

- [1] Introduction to Electrodynamics, D. J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- [2] Elements of Electromagnetics, M. N. O. Sadiku, 2001, Oxford University Press.
- [3] Introduction to Electromagnetic Theory, T. L. Chow, 2006, Jones & Bartlett Learning
- [4] Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
- [5] Electromagnetic field Theory, R. S. Kshetrimayun, 2012, Cengage Learning
- [6] Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
- [7] Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

PHY-HC-6026

Statistical Mechanics

Total Lectures: 60

Credits: 6 (Theory: 04, Lab:02)

Course outcome: On successful completion of the course students will be learn the techniques of Statistical Mechanics to apply in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics, Chemistry and in many other directions.

Theory

Unit I: Classical Statistics (Lectures 18)

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, Negative Temperature.

Unit II: Classical Theory of Radiation (Lectures 09)

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. Ultraviolet Catastrophe.

Unit III: Quantum Theory of Radiation (Lectures 05)

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.

Unit IV: Bose-Einstein Statistics (Lectures 13)

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 of Planck's law.

Unit V: Fermi-Dirac Statistics (Lectures 15)

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.

Lab

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics.

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
 - (a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations.
 - (b) Study of transient behaviour of the system (approach to equilibrium).
 - (c) Relationship of large N and the arrow of time.
 - (d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution.
 - (e) Computation and study of mean molecular speed and its dependence on particle mass.
 - (f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed
2. Computation of the partition function $Z(\beta)$ for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
 - (a) Study of how $Z(\beta)$, average energy $\langle E \rangle$, energy fluctuation ΔE , specific heat at constant volume C_v , depend upon the temperature, total number of particles N and the spectrum of single particle states.
 - (b) Ratios of occupation numbers of various states for the systems considered above.
 - (c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T .
3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.
4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.
5. Plot the following functions with energy at different temperatures
 - (a) Maxwell-Boltzmann distribution
 - (b) Fermi-Dirac distribution
 - (c) Bose-Einstein distribution

Reference Books

- [1] Statistical Mechanics, R. K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- [2] Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- [3] Statistical and Thermal Physics, S. Lokanathan and R. S. Gambhir. 1991, Prentice Hall
- [4] Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- [5] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- [6] An Introduction to Statistical Mechanics & Thermodynamics, R. H. Swendsen, 2012, Oxford Univ. Press

Discipline Specific Elective Papers [Choose Two]

PHY-HE-6016

Communication Electronics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

***Course Outcome:** Upon completion of this course, students will have the concepts of electronics in communication, details of communication techniques based on Analog Modulation, Analog and digital Pulse Modulation including PAM, PWM, PPM, ASK, PSK, FSK, overview of communication and Navigation systems such as GPS and mobile telephony system.*

Theory

Unit I: Electronic communication (Lectures 8)

Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

Unit II: Analog Modulation (Lectures 12)

Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver

Unit III: Analog Pulse Modulation (Lectures 9)

Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, Basic concept of Multiplexing. (time and frequency division.

Unit IV: Digital Pulse Modulation (Lectures 10)

Need for digital transmission, Pulse Code Modulation, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Introduction to Communication and Navigation systems

Unit V: Satellite Communication (Lectures 10)

Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites., path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

Unit VI: Mobile Telephony System (Lectures 10)

Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only).

Unit I: GPS navigation system (Lectures 1)

Qualitative idea only

Lab

(Minimum number of experiments to be completed is seven)

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulator

Reference Books

- [1] Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
- [2] Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
- [3] Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
- [4] Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
- [5] Communication Systems, S. Haykin, 2006, Wiley India
- [6] Electronic Communication system, Blake, Cengage, 5th edition.
- [7] Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

PHY-HE-6026

Digital Signal Processing

Total Lectures: 60

Credits: 6 (Theory: 04, Lab:02)

***Course Outcome:** Upon completion of this course, students will be able This paper describes the discrete-time signals and systems, Fourier Transform Representation of Aperiodic Discrete-Time Signals. This paper also highlights the concept of filters and realization of Digital Filters. At the end of the syllabus, students will develop the understanding of Discrete and fast Fourier Transform.*

Theory

Unit I: Discrete-Time Signals and Systems (Lectures 10)

Classification of Signals, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability.

Unit II: Discrete-Time Fourier Transform (Lectures 15)

Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting, **The z-Transform:** Bilateral (Two-Sided) Transform, Inverse z-Transform, Relationship Between z-Transform and Discrete-Time Fourier Transform, z-plane, Region-of-Convergence; Properties of ROC, Properties; Analysis and Characterization of LTI Systems; Transfer Function and Difference-Equation System.

Unit III: Filter Concepts (Lectures 5)

Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters.

Unit IV: Discrete Fourier Transform (Lectures 10)

Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property.

Unit V: Fast Fourier Transform (Lectures 5)

Direct Computation of the DFT, Symmetry and Periodicity Properties of the Twiddle factor (W_N), Radix-2 FFT Algorithms; Decimation-In-Time (DIT) FFT Algorithm; Decimation-In-Frequency (DIF) FFT Algorithm, Inverse DFT Using FFT Algorithms.

Unit VI: Realization of Digital Filters (Lectures 15)

Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I.

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Impulse Invariance Method.

Lab

(Minimum number of experiments to be completed is seven)

Scilab based simulations experiments based problems like

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence $u(n)$, (c) ramp sequence $r(n)$, (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \leq n \leq 50$.
2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for $N = 5$

$$x(n) = \text{rect}\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 & -N \leq n \leq N \\ 0 & \text{Otherwise} \end{cases}$$

3. An LTI system is specified by the difference equation

$$y(n) = 0.8y(n-1) + x(n)$$

(a) Determine $H(e^{j\omega})$

(b) Calculate and plot the steady state response $y_{ss}(n)$ to

$$x(n) = \cos(0.5\pi n) u(n)$$

4. Given a casual system

$$y(n) = 0.9y(n-1) + x(n)$$

(a) Find $H(z)$ and sketch its pole-zero plot

(b) Plot the frequency response $|H(e^{j\omega})|$ and $\angle H(e^{j\omega})$

5. Design a digital filter to eliminate the lower frequency sinusoid of $x(t) = \sin 7t + \sin 200t$. The sampling frequency is $f_s = 500$ Hz. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let $x(n)$ be a 4-point sequence:

$$x(n) = \begin{matrix} \{1, 1, 1, 1\} \\ \uparrow \\ \{0 \text{ Otherwise} \end{matrix}$$

Compute the DTFT $X(e^{j\omega})$ and plot its magnitude

(a) Compute and plot the 4 point DFT of $x(n)$

(b) Compute and plot the 8 point DFT of $x(n)$ (by appending 4 zeros)

(c) Compute and plot the 16 point DFT of $x(n)$ (by appending 12 zeros)

7. Let $x(n)$ and $h(n)$ be the two 4-point sequences,

$$\begin{matrix} x(n) = \{1, 2, 2, 1\} \\ \uparrow \\ h(n) = \{1, -1, -1, 1\} \\ \uparrow \end{matrix}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.
9. Design an FIR filter to meet the following specifications:

Passband edge $F_p = 2$ KHz

stopband edge $F_s = 5$ KHz

Passband attenuation $A_p = 2$ dB

Stopband attenuation $A_s = 42$ dB

Sampling frequency $F_s = 20$ KHz

10. The frequency response of a linear phase digital differentiator is given by

$$H_d(e^{j\omega}) = j\omega e^{j\omega} \quad |\omega| \leq \pi$$

Using a Hamming window of length $M = 21$, design a digital FIR differentiator. Plot the amplitude response.

Reference Books

- [1] Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India
- [2] Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
- [3] Modern Digital and Analog Communication Systems, B.P. Lathi, 1998, 3rd Edn. Oxford University Press.
- [4] Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
- [5] A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- [6] Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.
- [7] Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- [8] Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
- [9] Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

PHY-HE-6036

Advanced Mathematical Physics II

Total Lectures: 60 Credits: 6 (Theory: 05, Tutorial:01)

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.

Course Outcome: Upon completion of this course, students will be able to apply the concepts of Calculus of Variations, Group Theory and Probability Theory to solve numerical problems in Physics.

Theory

Unit I: Calculus of Variations (Lectures 25)

Variable Calculus: Variational Principle, Euler's Equation and its Application to Simple Problems. Geodesics. Concept of Lagrangian. Generalized co-ordinates. Definition of canonical moment, Euler-Lagrange's Equations of Motion and its Applications to Simple Problems (e.g., Simple Pendulum and One dimensional harmonic oscillator). Definition of Canonical Momenta. Canonical Pair of Variables. Definition of Generalized Force: Definition of Hamiltonian (Legendre Transformation). Hamilton's Principle. Poisson Brackets and their properties. Lagrange Brackets and their properties.

Unit II: Group Theory (Lectures 25)

Review of sets, Mapping and Binary Operations, Relation, Types of Relations. Groups: Elementary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group, Permutation/Transformation. Homomorphism and Isomorphism of group.

Unit III: Advanced Probability Theory (Lectures 25)

Fundamental Probability Theorems. Conditional Probability, Bayes' Theorem, Repeated Trials, Binomial and Multinomial expansions. Random Variables and probability distributions, Expectation and Variance, Special Probability distributions: The binomial distribution, The poisson distribution, Continuous distribution: The Gaussian (or normal) distribution, The principle of least squares.

Reference Books

- [1] Mathematical Methods for Physicists: Weber and Arfken, 2005, Academic Press.
- [2] Mathematical Methods for Physicists: A Concise Introduction: Tai L. Chow, 2000, Cambridge Univ. Press.
- [3] Elements of Group Theory for Physicists by A. W. Joshi, 1997, John Wiley.
- [4] Group Theory and its Applications to Physical Problems by Morton Hamermesh, 1989, Dover
- [5] Introduction to Mathematical Physics: Methods & Concepts: Chun Wa Wong, 2012, Oxford University Press
- [6] Introduction to Mathematical Probability, J. V. Uspensky, 1937, Mc Graw-Hill.

PHY-HE-6046

Astronomy and Astrophysics

Total Lectures: 75

Credits: 6 (Theory: 05, Tutorial:01)

***Course Outcome:** Upon completion of this course, students will be able to understanding the origin and evolution of the Universe. The course will give a comprehensive introduction on the measurement of basic astronomical parameters such as astronomical scales, luminosity and astronomical quantities. It will give an overview on key developments in observational astrophysics. Students will have the idea of the instruments implemented for astronomical observation, the formation of planetary system and its evolution with time, the physical properties of Sun and the components of the solar system; and stellar and interstellar components of our Milky Way galaxy. Students will have the understanding of the origin and evolution of galaxies, presence of dark matter and large scale structures of the Universe.*

Theory

Unit I: Stellar properties (Lectures 15)

Radiant flux and Luminosity, Magnitude scale. Measurement of astronomical quantities: Stellar distances(parallax), Radii, Mass and Effective Temperature. Equilibrium of stars, Gravity and thermodynamics, virial theorem. Stellar spectral classification – Hertzsprung-Russell (HR) diagram. Introductory idea of stellar evolution: white dwarf, neutron stars and black holes.

Unit II: The Sun and the solar system (Lectures 15)

The Sun; properties of photosphere, chromosphere and corona. Solar system's objects: Theory of formation of the solar system (introductory idea only); physical properties of the planets- their distances, atmospheres, asteroid belt, meteorites and the comets – Kuiper belt and the Oort cloud; Introduction to Extra-Solar Planets.

Unit III: Positional Astronomy (Lecture 10)

Celestial sphere, spherical geometry and celestial coordinates. Concept of time: universal time, solar time, mean solar time, local sidereal time and Julian day. Introduction to constellations (hands on practice in evening sky with small telescopes or laser pointer), ecliptic and diurnal motion of stars. Solar system's objects : rotation, revolution and coordinates in the sky.

Unit IV: Astronomical Techniques (Lecture 10)

Introduction to telescopes – telescope size and light gathering power, resolving power, f-number. Different types of optical telescopes (reflecting and refracting). Space telescopes. Concept of virtual observatory, on-line tools in astronomy: SDSS, SkyView, SIMBAD, Aladin, AAVSO database etc. Introduction to photometry, spectroscopy and polarimetry.

Unit V: Galaxies (Lecture - 10)

The Milky Way, properties of the galactic centre. Classification of galaxies, Hubble's tuning fork diagram, normal (spiral, elliptical and lenticular) and active galaxies. Black holes in galaxies.

Unit VI: Large Scale Structure and Cosmology (Lecture - 15)

Distance ladder in cosmology, Cepheid variables. Cosmic expansion of the universe and Hubble(- Lemaitre) law. Clusters of galaxies and dark matter - virial theorem. Concept of the Hot Big Bang, Oscillating Universe, Cosmic Microwave Background (CMB).

Reference Books

- [1] Astrophysics-Stars and Galaxies; K D Abhyankar
- [2] Astrophysics-A modern perspective, K. S. Krishnaswamy
- [3] Astrophysics for Physicists; A Rai Choudhuri
- [4] Textbook of Astronomy and Astrophysics with elements of Cosmology; V B Bhatia
- [5] An Introduction to Astrophysics by Baidyanath Basu
- [6] Introduction to Astrophysics by H. L. Duorah and Kalpana Duorah
- [7] The Physical Universe: An Introduction to Astronomy, Frank H. Shu

PHY-HE-6056

PHYSICS-DSE: CLASSICAL DYNAMICS

Total Lectures: 75 Credits: 6 (Theory: 05, Tutorial: 01)

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.

Course Outcome: Upon completion of this course, students will have the overview of Newton's Laws of Motion, Special Theory of Relativity by 4-vector approach and fluids. Students will also have the understanding of the Lagrangian and Hamiltonian of a system.. By the end of this course, students will be able to solve the seen or unseen problems/numericals in classical mechanics.

Theory

Unit I: Classical Mechanics of Point Particles (Lectures 22)

Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields.constraints, Generalized coordinates and velocities, principle of virtual work, D'Alembert's principle, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy.

Unit II: Small Amplitude Oscillations (Lectures 10)

Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Unit III: Special Theory of Relativity (Lectures 33)

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Unit IV: Fluid Dynamics (Lectures 10)

Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

Reference Books

- [1] Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
- [2] Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- [3] Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
- [4] The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
- [5] Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
- [6] Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
- [7] Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
- [8] Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
- [9] Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press