MAHATMA GANDHI CENTRAL UNIVERSITY

[Established by an Act of Parliament]

TempCamp, Zila School Campus, Motihari, District – East Champaran, Bihar – 845 401

www.mgcub.ac.in

B.Sc. (PHYSICS) HONOURS

DISTRIBUTION OF DIFFERENT COURSES, CREDITS AND COURSE CONTENTS IN VARIOUS SEMESTERS

OFFERED BY:

Department of Physics

School of Physical Sciences

Mahatma Gandhi Central University, Motihari-845401, Bihar

Semester-wise Distribution of Courses and Credits			
Semester	**Course Code**	**Course Title**	**Credits**
I	PHYS3001	Mathematical Physics-I	6
	PHYS3002	Mechanics	6
		AECC-1	2
		AECC-2	2
		GE-1	6
		Total	**22**
II	PHYS3003	Electricity and Magnetism	6
	PHYS3004	Waves and Optics	6
		AECC-3	2
		GE-2	6
		Total	**20**
III	PHYS3005	Mathematical Physics-II	6
	PHYS3006	Thermal Physics	6
	PHYS3007	Analog Systems and Applications	6
		SEC-1	2
		GE-3	6
		Total	**26**
IV	PHYS3008	Atomic and Molecular Physics	6
	PHYS3009	Elements of Modern Physics	6
	PHYS3010	Digital Systems and Applications	6
		SEC-2	2
		GE-4	6
		Total	**26**
V	PHYS3011	Quantum Mechanics and Applications	6
	PHYS3012	Solid State Physics	6
		DSE-1	6
		DSE-2	6
		Total	**24**
VI	PHYS3013	Electromagnetic Theory	6
	PHYS3014	Statistical Mechanics	6
		DSE-3	6
	PHYS3999	**DSE-4 (Dissertation)**	6
		Total	**24**

Total Credit: 142 (for all 6 semesters)

CORE COURSES (CC)			
Sl. No.	**List of Core courses**	**Course Code**	**Credit**
1.	Mathematical Physics-I	PHYS3001	6
2.	Mechanics	PHYS3002	6
3.	Electricity and Magnetism	PHYS3003	6
4.	Waves and Optics	PHYS3004	6
5.	Mathematical Physics-II	PHYS3005	6
6.	Thermal Physics	PHYS3006	6
7.	Analog Systems and Applications	PHYS3007	6
8.	Atomic and Molecular Physics	PHYS3008	6
9.	Elements of Modern Physics	PHYS3009	6
10.	Digital Systems and Applications	PHYS3010	6
11.	Quantum Mechanics and Applications	PHYS3011	6
12.	Solid State Physics	PHYS3012	6
13.	Electromagnetic Theory	PHYS3013	6
14.	Statistical Mechanics	PHYS3014	6
DISCIPLINE SPECIFIC ELECTIVE (DSE) PAPERS			
15.	Experimental Techniques	PHYS3015	6
16.	Embedded Systems-Introduction to Microcontroller	PHYS3016	6
17.	Physics of Devices and Instruments	PHYS3017	6
18.	Advanced Mathematical Physics-I	PHYS3018	6
19.	Classical Dynamics	PHYS3019	6
20.	Applied Dynamics	PHYS3020	6
21.	Nuclear and Particle Physics	PHYS3021	6
22.	Astronomy and Astrophysics	PHYS3022	6
23.	Atmospheric Physics	PHYS3023	6
24.	Nano Materials and Applications	PHYS3024	6
25.	Physics of the Earth	PHYS3025	6
26.	Medical Physics	PHYS3026	6
27.	Biological Physics	PHYS3027	6
28.	Dissertation	PHYS3999	6
SKILL ENHANCEMENT COURSES (SEC)			

29.	Physics Workshop Skills	PHYS3028	2
30.	Computational Physics Skills	PHYS3029	2
31.	Electrical Circuits and Network Skills	PHYS3030	2
32.	Basic Instrumentation Skills	PHYS3031	2
33.	Renewable Energy and Energy Harvesting	PHYS3032	2
34.	Mechanical Drawing	PHYS3033	2
35.	Applied Optics	PHYS3034	2
36.	Weather Forecasting	PHYS3035	2
37.	Radiation Safety	PHYS3036	2
GENERIC ELECTIVE (GE) PAPERS			
38.	GE-Mechanics	PHYS3037	6
39.	GE-Electricity and Magnetism	PHYS3038	6
40.	GE-Thermal Physics and Statistical Mechanics	PHYS3039	6
41.	GE-Waves and Optics	PHYS3040	6
42.	GE-Digital, Analog Circuits and Instrumentation	PHYS3041	6
43.	GE-Elements of Modern Physics	PHYS3042	6
44.	GE-Mathematical Physics	PHYS3043	6
45.	GE-Solid State Physics	PHYS3044	6
46.	GE-Quantum Mechanics	PHYS3045	6
47.	GE-Embedded System: Introduction to Microcontroller	PHYS3046	6
48.	GE-Nuclear and Particle Physics	PHYS3047	6
49.	GE-Optics and Optical Instruments	PHYS3054	6
50.	GE-Semiconductors and their Applications	PHYS3055	6
51.	GE-Atoms and Nuclei	PHYS3056	6
52.	GE-Mechanics and Properties of Matter	PHYS3057	6
53.	GE-Physics of Technologically Important Materials	PHYS3058	6

One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.

Semester-I

Course Code: PHYS3001

Course Name: Mathematical Physics-I

Credits Equivalent: 6 (4L + 2P) Credits

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

Course Contents:

UNIT-1: Vector Calculus: (12 Lectures)
Scalar and Vector fields, Orthogonal Curvilinear Coordinates: Derivation of Gradient, Divergence, Curl and Laplacian, Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gauss' divergence theorem, Green's and Stokes Theorems, Dirac delta function

UNIT-2: Ordinary Differential Equation: (15 Lectures)
First Order Differential Equations: exact and inexact, Second Order Differential equations: Homogeneous Equations with constant coefficients, Wronskian and general solution, Particular Integral with operator method, method of undetermined coefficients and variation method of parameters, Singular Points of Second Order Linear Differential Equations, Frobenius method.

UNIT-3: Special Functions and Special Integrals: (15 Lectures)
Legendre, Bessel, Hermite and Laguerre Differential Equations, Rodrigues Formula, Generating Function, Orthogonality, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials, Bessel Functions of the First Kind, Beta and Gamma Functions, Error Function.

UNIT-4: Matrices: (10 Lectures)
Types and Properties of Matrices, Inverse of a Matrix by Adjoint Method, Similarity Transformations, Orthogonal and Unitary Matrices, Inner Product, Eigen-values and Eigenvectors, Cayley-Hamiliton Theorem, Diagonalization of Matrices, Solutions of Coupled Linear Ordinary Differential Equations, Functions of a Matrix.

UNIT-5: Introduction to probability and Error Analysis: (8 Lectures)
Probability distribution functions; binomial, Gaussian, and Poisson. Mean and variance, Dependent events: Conditional Probability, Bayes' Theorem,Systematic and Random Errors, Propagation of Errors, Normal Law of Errors, Standard and Probable Error, Least-squares fit.

Text and Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Introduction to Mathematical Physics, Charlie Harper, P.H.I., 1995.

6. Vector Spaces and Matrices in Physics by M. C. Jain, Alpha Science International Ltd, 2007.
7. Matrices and Tensors in Physics, A. W. Joshi, (New Age Int. Pub., 1995).

List of Experiments for Mathematical Physics-I Lab

1. Random number generation: Area of circle, area of square, volume of sphere, value of pi (π).
2. Diagonalization of matrix and to find out its Eigen values.
3. To find the inverse of a matrix.
4. To solve Transcendental and Polynomial equations by Bisection method.
5. To solve Transcendental and Polynomial equations by Newton-Raphson method.
6. Numerical Integration by Trapezoidal rule.
7. Numerical Integration by Simpson's rule
8. Solution of Differential Equation by Euler method
9. Solution of Differential Equation by Runge-Kutta method
10. Solution of ODE: Harmonic oscillator (no friction)

Text and Reference Books

1. Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rdEdn., 2007, Cambridge University Press.
3. A first course in Numerical Methods, U.M. Ascher& C. Greif, 2012, PHI Learning.
4. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
5. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
6. An Introduction to computational Physics, T. Pang, 2ndEdn., 2006,Cambridge Univ. Press.
7. Computational Physics, Darren Walker, 1stEdn., 2015, Scientific International Pvt. Ltd.

Course Code: PHYS3002

Course Name: Mechanics

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *This course is to introduce students to laws of mechanics, laws of motions, fluid mechanics and its applications to learn the fundamentals of this important topic.*

UNIT-1: Fundamental of Dynamics (22 Lectures)
Dynamics of a system of particles, Centre of Mass, Principle of conservation of momentum, Angular momentum of a particle and system of particles, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of inertia for rectangular, cylindrical and spherical bodies, Motion involving both translation and rotation, Non-inertial frames and fictitious forces, Elastic and inelastic collisions between particles, Work and Kinetic Energy Theorem, Work done by Conservative and non-conservative forces, Stable and unstable equilibrium.

UNIT-2: Theory of Relativity (12 Lectures)
Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations, Lorentz contraction, Time dilation, Relativistic transformation, Relativistic addition of velocities, Variation of mass with velocity, Mass-energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics, Transformation of Energy and Momentum.

UNIT-3: Properties of Matter (6 Lectures)
Hooke's Law, Relation between Elastic constants, Twisting torque on a Cylinder or Wire, Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

UNIT-4: Gravitation (10 Lectures)
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, The energy equation and energy diagram, Kepler's Laws, Satellite in circular orbit and applications, Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS)

UNIT-5: Oscillations (10 Lectures)
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.

Reference Books:

1. An introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973).
2. Mechanics Berkeley physics course, vol. 1: By Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholz, Burton Moyer, (Tata McGraw-Hill, 2007).
3. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
4. Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson

Education
5. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. Additional
7. Fundamentals of Physics (10^{th} Edition) Halliday, Resnick & Walker
8. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
9. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning

List of Experiments Mechanics Lab

1. Measurements of length using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method.
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Text and Reference Books

1. B.L. Worsnop and H.T. Flint, Advanced Practical Physics, Asia Publishing House, NewDelhi.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. G.L. Squires, Practical Physics, 2015, 4th Edition, Cambridge University Press.
4. GeetaSanon, B.Sc. Practical Physics, 1^{st}Edn. (2007), R. Chand & Co.
5. Practical Physics by R.K. Shukla and AnchalSrivastava (New Age International Publishers), ISBN: 978-81-224-2482-9.
6. InduPrakash and Ramakrishna, A Text Book of Practical Physics, KitabMahal, New Delhi.

Semester-II

Course Code: PHYS3003

Course Name: Electricity and Magnetism

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *At the end of the course the student should be able to understand the laws of electrostatics and magnetostatics as well as electric circuits for various applications in electrical instruments.*

UNIT-1: Electrostatics: (15 Lectures)
Gauss's law, Electrostatic Potential, Laplace's and Poisson equations, Potential and Electric Field of a dipole, Electrostatic energy of system of charges and 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-2: Dielectric Properties of Matter (10 Lectures)
Polarization, Electrical Susceptibility and Dielectric Constant, Capacitor filled with dielectric, Relations between E, P and D, Gauss' Law in dielectrics, Electronic, Ionic and Orientational polarization, Polarizability, Clausius-Mossotti equation, Debye equation.

UNIT-3: Magnetostatics and Magnetic Properties of Matter (15 Lectures)
Biot-Savart's law, Ampere's law, Magnetic field due to a straight wire, Circular coil, Helmholtz's coils, Solenoid, Toroid; Electromagnetic induction: Faraday's law, Lenz's Law, Self and Mutual Induction, Gauss's law of magnetism (Integral and Differential Forms), Relative Permeability of a Material, Magnetic Susceptibility, Relation between B, M and H, B-H Curve and Energy Loss in Hysteresis.

UNIT-4: Electromagnetic Theory (10 Lectures)
Faraday's law: integral and differential forms, Displacement current, Equation of Continuity, Maxwell's equations, E.M. field energy density, EM waves in vacuum, non-conducting and Conducting Media, Poynting vector and Poynting Theorem, Skin depth.

UNIT-5: Electric Circuits and Network Theorem (10 Lectures)
Kirchhoff's laws for AC circuits, Series and parallel combination of inductances, mutual induction, Complex Reactance and Impedance, Series and Parallel LCR Circuit, Ballistic Galvanometer, Electromagnetic damping & Logarithmic damping, Coupled circuits and ideal transformer, Ideal Constant-voltage and Constant-current Sources, Network Theorems: (1) Thevenin theorem, (2) Norton theorem, (3) Superposition theorem, (4)Reciprocity theorem, and (5) Maximum Power Transfer theorem, J operator, AC bridges.

Reference Books:

1. Electricity and Magnetism By Edward M. Purcell (McGraw-Hill Education, 1986)
2. Fundamentals of Electricity and Magnetism By Arthur F. Kip (McGraw-Hill, 1968
3. Electricity and Magnetism by J.H.Fewkes & John Yarwood. Vol. I (Oxford Univ. Press, 1991).
4. Electricity and Magnetism. By D.C.Tayal (Himalaya Publishing House, 1988).

5. David J. Griffiths, Introduction to Electrodynamics, 3rd Edition
6. Introduction to Electric Circuits by Richard C. Dorf, John Wiley & Sons, Inc.
7. Fundamentals of Electric Circuits by Charles K. Alexander & Matthew N. O. Sadiku, McGraw-Hill.

List of Experiments Electricity and Magnetism Lab

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. Determination of specific charge (e/m) of electron by Thompson method
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To compare capacitances using De'Sauty's bridge.
5. To determine self inductance of a coil by Anderson's bridge.
6. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
7. To study the characteristics of a series RC Circuit.
8. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
9. Study the half wave and full wave rectification process.
10. Study the I-V characteristic of a Solar cell.
11. Study the I-V characteristic of Zener diode in forward and reverse biased condition
12. Electrical band gap measurement of semiconductor device (Ge/Si)
13. Verification of Thevenin's / Nortan's theorem.
14. Verification of Superposition theorem and reciprocity theorem.
15. Verification of laws of series and parallel combination in LCR circuit

Text and Reference Books

1. Geeta Sanon, B.Sc. Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. Practical Physics by R.K. Shukla and Anchal Srivastava (New Age International Publishers), ISBN: 978-81-224-2482-9.
3. B.L. Worsnop and H.T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
4. Introduction to Electric Circuits by Richard C. Dorf, John Wiley & Sons, Inc.
5. Fundamentals of Electric Circuits by Charles K. Alexander & Matthew N. O. Sadiku, McGraw-Hill

Course Code: PHYS3004

Course Name: Waves and Optics

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *The objective of this course is to introduce the fundamentals of optical phenomenon and its applications.*

Course Contents:

UNIT-1: Waves (12 Lectures)

Wave Equation, Phase and Group Velocities, Energy Transport, Intensity of Wave, Newton's Formula for Velocity of Sound, Laplace's Correction, Lissajous Figures, Normal Modes of Stretched Strings, Melde's Experiment, Longitudinal Standing Waves and Normal Modes.

UNIT-2: Wave Optics (6 Lectures)

Fermat's Principle, Electromagnetic nature of light, Definition and properties of wave front. Huygens Principle, Temporal and Spatial Coherence.

UNIT-3: Interference (15 Lectures)

Division of amplitude and wavefront, Young's double slit experiment, Fresnel's Biprism, Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes),Newton's Rings: Michelson Interferometer, Fabry-Perot Interferometer.

UNIT-4: Diffraction (15 Lectures)

Single slit, Double slits and Multiple slits, Diffraction grating, Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light, Zone Plate, Fresnel diffraction pattern of a straight edge, a slit and a wire, Resolving power of Optical Instruments (Microscope, Prism and Grating).

UNIT-5: Polarization (12 Lectures)

Polarized light and its mathematical representation, Production of polarized light by reflection, refraction and scattering, Polarization by Double Refraction and Huygen's theory, Nicol prism, Retardation plates, Production and analysis of Circularly and Elliptically polarized light, Optical activity, Biquartzpolarimeter.

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, 7thEdn., 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.

List of ExperimentsWavesand Optics Lab

1. To determinethe wavelength of sodium yellow line by Fresnel's Biprism.
2. To determine the specific rotation of cane sugar by Biquartz polarimeter.
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the wavelength of sodium light using Newton's Rings.
5. To determine the dispersive power and Cauchy's constants of the material of a prismusing mercury source.
6. To determine the wavelength of sodium source using Michelson's Interferometer.
7. To determine the wavelength of (i) sodium source and (ii) spectral lines of mercury source using plane diffraction grating.
8. To determine the resolving power of a Prism.
9. To determine the focal length of thin lenses and their combination by Nodal slide.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by wedge-shaped film.
11. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
12. To determine the frequency of an A.C. source using Sonometer.
13. To study Lissajous figures.

Text and Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, InduPrakash and Ramakrishna, 11th Edition, 2011, KitabMahal, New Delhi.

Semester-III

Course Code: PHYS3005

Course Name: Mathematical Physics-II

Credits Equivalent: 6 (4L + 2P) Credits

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

Course Contents:

UNIT-1: Complex Analysis: (15 Lectures)
Euler's formula, De Moivre's theorem, Roots of Complex Numbers, Functions of Complex Variables, Cauchy-Riemann Conditions. Singular functions: poles and branch points, order of singularity, branch cuts, 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.

UNIT-2: Fourier Transforms: (12 Lectures)
Fourier Integral theorem, Fourier Transform (FT), FT of trigonometric & other functions, Representation of Dirac delta function as a FT, Fourier transform of derivatives, Inverse FT, Convolution theorem, Properties of FT, Application of FT to differential equations: One dimensional Wave and Heat Flow Equations.

UNIT-3: Laplace Transform (12 Lectures)
Laplace Transform (LT) of Elementary functions, Properties of LTs, LTs of Derivatives and Integrals of Functions, LT of Unit Step function, Dirac Delta function, Periodic Functions, Convolution Theorem, Inverse LT, Application of LT to 2^{nd} order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

UNIT-4: Fourier Series (11 Lectures)
Orthogonality of sine and cosine functions, Dirichlet Conditions, Expansion of periodic functions and determination of Fourier coefficients, Complex representation of Fourier series, Expansion of functions with arbitrary period, Expansion of non-periodic functions over an interval, Even and odd functions and their Fourier expansions, Application, Summing of Infinite Series, Term-by-Term differentiation and integration of Fourier Series, Parseval's Identity.

UNIT-5: Partial Differential Equations (10 Lectures)
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, Diffusion Equation.

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
5. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
6. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
7. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

List of Experiments: Mathematical Physics-II

1. Curve fitting.
2. Solution of mesh equations of electric circuits by Gauss elimination method
3. Solve differential equations: $dy/dx = e^{-x}$ with $y = 0$ for $x = 0$
4. Find the two square roots of $-5+12j$
5. Compute the n^{th} roots of unity for n = 2, 3, and 4.
6. Solution of ODE: Damped Harmonic oscillator
7. Fourier Series: Program to sum $\sum_{n=1}^{\infty} 0.2^n$
8. Evaluate the Fourier coefficients of a given periodic function (square wave).
9. Solve Kirchoff's Current/Voltage law for an arbitrary circuit using Laplace's transform.
10. Solution of PDE: Wave equation

Reference Books:

1. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rdEdn., 2007, Cambridge University Press.
2. A first course in Numerical Methods, U.M. Ascher& C. Greif, 2012, PHI Learning.
3. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
4. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
5. An Introduction to computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press.
6. Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.

Course Code: PHYS3006

Course Name: Thermal Physics

Credits Equivalent: 6(4L + 2P) Credits

Course Objectives: *The emphasis of course is on laws of thermodynamics and its application in solving problems of interest to physicists.*

Course Contents:

UNIT-1: Kinetic Theory of Gases (15 Lectures)

Maxwell-Boltzmann Law of Distribution of Velocities, Mean, RMS and Most Probable Speeds,Law of Equipartition of Energy, Specific heats of Gases, Molecular Collisions, Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion, Brownian Motion and its Significance, Behavior of Real Gases, The Virial Equation, Andrew's Experiments on CO_2Gas, Critical Constants, Continuity of Liquid and Gaseous State, Vapour and Gas, Boyle Temperature, Vander Waal's Equation of State for Real Gases, Values of Critical Constants, P-V Diagrams, Joule-Thomson Porous Plug Experiment and its applications.

UNIT-2: Laws of Thermodynamics: (15 Lectures)

Zeroth Law of Thermodynamics&ConceptofTemperature, Concept of Work & Heat, First Law ofThermodynamics, Internal Energy, ApplicationsofFirst Law: General Relation between C_P and C_V, Work Done during Isothermal andAdiabatic Processes, Second Law of Thermodynamics:Reversible and Irreversible process with examples, Kelvin-Planck and Clausius Statements and their Equivalence,Heat Engines, Carnot's Theorem, Carnot engine & efficiency, Refrigerator & coefficient of performance.

UNIT-3: Entropy (12 Lectures)

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, T-S diagrams for Carnot's Cycle, Third Law of Thermodynamics, Unattainability of Absolute Zero.

UNIT-4: Thermodynamic Potentials (12 Lectures)

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, ClausiusClapeyronand Ehrenfest equations.

UNIT-5: Maxwell's Thermodynamic Relations: **(6 Lectures)**

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

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

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

Course Code: PHYS3007

Course Name: Analog System and Applications

Credits Equivalent: 6(4L + 2P) Credits

Course Objectives: *The aim of this course is to study the basics and circuit design of analog systems for its several applications.*

Course Contents:

UNIT-1: Semiconductor Diodes: (10 Lectures)

P and N type semiconductors, Energy Level Diagram, Conductivity and Mobility,PN Junction Fabrication (Simple Idea).Barrier Formation in PN Junction Diode, Static and Dynamic Resistance. PN junction biasing, Barrier Potential, Barrier Width.

UNIT-2: Two-terminal Devices and their Applications: (10 Lectures)

(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-3: Bipolar Junction transistors: (10 Lectures)

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations, Current gains α and β, Load Line analysis of Transistors, DC Load line and Q-point.

UNIT-4: Amplifiers: (10 Lectures)

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, Classification of Class A, B & C Amplifiers,Two stage RC-coupled amplifier and its frequency response.

UNIT-5: Oscillator and Op-Amps (20 Lectures)

Positive and Negative Feedback, Barkhausen's Criterion, RC Phase shift oscillator, Hartley & Colpitt's oscillators, Operational Amplifiers (Black Box approach), Characteristics of an Ideal and Practical Op-Amp (IC 741), Applications of Op-Amps: Inverting and non-inverting amplifiers, Adder& Subtractor, Differentiator& Integrator, Log amplifier, Zero crossing detector, Wein bridge oscillator.

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, 6thEdn.,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. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer.
7. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.
8. Microelectronic Circuits, M.H. Rashid, 2ndEdition, Cengage Learning.
9. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

List of Experiments Analog Systems and Applications Lab

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. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4. To study the various biasing configurations of BJT for normal class A operation.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a Wien bridge oscillator for given frequency using an op-amp.
8. To design a phase shift oscillator of given specifications using BJT.
9. To study the Colpitt`s oscillator.
10. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gains and studies its frequency response.
11. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response.
12. To study the zero-crossing detector and comparator
13. To investigate the use of an op-amp as an Integrator.
14. To investigate the use of an op-amp as a Differentiator.
15. To design a circuit to simulate the solution of a 1st/2nd order differential equation.

Reference Books:

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

Semester-IV

Course Code: PHYS3008

Course Name: Atomic and Molecular Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Atomic model: Summerfield model and fine structure of H_α line, Vector atom model, Pauli'sexclusion principle and electronic configuration of atom.

UNIT-2: Atomic Spectra of one valence electron system: Optical spectra of Alkali atoms, electron spin and fine structure, spin orbit interaction; Zeeman and Paschen-Back effects, Stark effect.

UNIT-3: Atomic spectra of two valence electrons system: Spectra of helium and alkali earth elements, different types of coupling schemes and interaction energies, Zeeman effect, Paschen-Back effect, Intensity of spectral lines, Stark Effects. X-Ray Spectra

UNIT-4: Molecular spectra of diatomic molecules: Quantum mechanical interpretation of near and far infra-red spectra of diatomic molecules, Rotation, vibration and rotation-vibration spectra, P, Q, R branches; Classification of molecular electronic status of a diatomic molecules, Coupling of rotation and electronic motion, Electronic band systems, Franck-Condon principle.

UNIT-5: Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules, Fluorescence and Phosphorescence; Elementary theory and applications of NMR and EPR; Elementary ideas about Lamb shift and its significance.

Reference Books:

1. Atomic and Molecular Physics by Raj Kumar; Campus Book International, 2003, ISBN: 9788180300356.
2. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
3. Introduction to Atomic Spectra by H.E. White, Mcgraw Nill Kogakusha Limited, 1939.
4. Fundamentals of Molecular Spectroscopy: C.N. Banwell, 5th Edition, Tata McHraw-Hill Publications, 1994.
5. Introduction to Spectroscopy: D.L. Pavia, 4th Edition.

List of Experiments

1. Stern-Gerlach experiment.
2. To study hydrogen spectrum and determination of Rydberg Constant with the help of a spectrometer diffraction grating and hydrogen discharge tube.

3. To study the absorption spectra of iodine vapour and determine the dissociation energy of iodine molecule.
4. Fine structure of the spectral lines of Hydrogen atom
5. Moseley's Law and determination of Rydberg constant
6. Curie Weiss law
7. Dielectric constant
8. Photoelectric effect
9. Photoluminescence

Course Code: PHYS3009

Course Name: Elements of Modern Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

Unit-1: Planck's law of radiation, Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering, De-Broglie wavelength and matter waves; Davisson-Germer experiment. Group and Phase velocities and relation between them, Wave-particle duality, Heisenberg uncertainty, Estimating minimum energy of a confined particle using uncertainty principle. **(15 Lectures)**

Unit-2: Two slit interference experiment with photons, atoms and particles; Matter waves and wave amplitude; physical interpretation of a wave function, probabilities and normalization; Schrodinger Wave equation (Time independent & time dependent), Probability and probability current densities in one dimension. One dimensional infinitely rigid box-energy eigen values and eigen functions, normalization; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

(15 Lectures)

Unit-3: Size and structure of atomic nucleus and its relation with atomic weight; Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers, Radioactivity: stability of the nucleus; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino, Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

(15 Lectures)

Unit-4: Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons, Nuclear reactor: slow neutrons interacting with Uranium 235. **(7 Lectures)**

Unit-5: Lasers: Basics of LASER, 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, Nd-YAG Laser. **(8 Lectures)**

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.

a. Additional Books for Reference

7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.

8. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W.Savin, 2nd Ed., Tata McGraw-Hill Publishing Co. Ltd.
9. Quantum Physics, Berkeley Physics, Vol.4. E. H. Wichman, 1971, Tata McGraw-Hill Co.
10. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill.

List of Experimentsin Elements of Modern Physics Lab:

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. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn ,4th Edition reprinted 1985, Heinemann Educational Publishers Publishing.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

Course Code: PHYS3010

Course Name: Digital Systems and Applications

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Introduction to CRO and Integrated Circuits: Block Diagram of CRO, Electron Gun, Deflection System and Time Base, Deflection Sensitivity, Applications of CRO, 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. **(8 Lectures)**

UNIT-2: Digital Circuits: Binary Numbers, BCD, Octal and Hexa decimal numbers, AND, OR and NOT Gates (realization using Diodes and Transistor), Boolean algebra: De Morgan's Theorems, 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 ProductsMethod and (2) Karnaugh Map, Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition, Binary Subtraction using 2's Complement, Half and Full Adders, Half & Full Subtractors, 4-bit binary Adder/Subtractor. **(10 Lectures)**

UNIT-3: Sequential Circuits: SR, D, and JK Flip-Flops Master Slave. Clocked (Level and Edge Triggered), Flip-Flops, **Timers**: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **(6 Lectures)**

UNIT-4: Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-outand Parallel-in-Parallel-out Shift Registers (only up to 4 bits), **Counters (4 bits):** Ring Counter. Asynchronous counters, Decade Counter, Synchronous Counter.

(8 Lectures)

UNIT-5: Microprocessor: Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses, Registers, ALU, Memory. Stack memory, Timing & Control circuitry, Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions. **(8Lectures)**

Reference Books:

Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw

1. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
3. Digital Electronics G K Kharate,2010, Oxford University Press
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S. Widmer, 2001, PHI

Learning
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
7. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
8. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
9. Digital Electronics Tobb Seley
10. Digital Fundamentals: Thomas Floyd, Pearson Education, 8th Edition, 2005.
11. Modern Digital Electronics: R. P. Jain, Tata McGraw-Hill Publications, 2003.

List of Experiments in Digital Systems and Applications Lab:

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. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. . To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor-

    a) Addition and subtraction of numbers using direct addressing mode24

    b) Addition and subtraction of numbers using indirect addressing mode

    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.

    h) Other programs (e.g. Parity Check, using interrupts, etc.)

Reference Books:

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

Semester-V

Course Code: PHYS3011

Course Name: Quantum Mechanics and Applications

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Time dependent Schrodinger equation: Properties of Wave Function, 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. **(12 Lectures)**

UNIT-2: Time independent Schrodinger equation: 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 Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle. **(12 Lectures)**

UNIT-3: General discussion of bound states in an arbitrary potential: Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **(12 Lectures)**

UNIT-4: Quantum theory of hydrogen-like atoms: Time independent Schrodinger equation in spherical polar coordinates; separation of variables; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells. **(10 Lectures)**

UNIT-5: Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization, Electron Spin and Spin Angular Momentum, Larmor's Theorem, Spin Magnetic Moment, Stern-Gerlach Experiment, Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **Atoms in External Magnetic Fields**: - Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). **Many electron atoms**: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave functions, Fine structure splitting, Spin orbit coupling. Spectral Notations for Atomic States, Total angular momentum, L-S and J-J couplings, Spectra of Hydrogen and Alkali Atoms (Na etc.). **(14 Lectures)**

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. Aruldhas, 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, CambridgeUniversity Press

Additional Books for Reference

1. Quantum Mechanics, EugenMerzbacher, 2004, John Wiley and Sons, Inc.
2. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
3. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.

<u>List of Experiments in Quantum Mechanics and Applications</u>:

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

1. Solve the s-wave Schrodinger equation for the ground state and the first excitedstate of the hydrogen atom:

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

Here, *m* is the reduced mass of the electron. Obtain the energy eigen values and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, $\hbar c$ = 1973 (eVÅ) and *m* = 0.511x10^6eV/c^2.

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

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

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

$$where \; V(r) = -\frac{e^2}{r}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of threesignificant digits. Also, plot the corresponding wavefunction. Take *e* = 3.795$(eVÅ)^{1/2}$, *m* = 0.511x106 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units $\hbar c$ = 1973(eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

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

$\frac{d^2y}{dx^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$For the anhormonic 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/c^2, k = 100MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}.In these units, $c\hbar$ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

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

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

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

   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 = 940x10^6eV/C^2, D = 0.755501 eV, α = 1.44, r_o= 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of theresonance 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. Schaum's outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publication
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific &Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández.2014 Springer.
5. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press

Course Code: PHYS3012

Course Name: Solid State Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1:Crystal Structure: Solids: Amorphous and Crystalline Materials, Lattice Translation Vectors, Lattice with a Basis–Central and Non-Central Elements, Unit Cell, Miller Indices, Reciprocal Lattice, Types of Lattices, Brillouin Zones, Diffraction of X-rays by Crystals, Bragg's Law. **(12 Lectures)**

UNIT-2: Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons, Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. **(10 Lectures)**

UNIT-3: Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials, Classical Langevin Theory of diaand Paramagnetic Domains, Quantum Mechanical Treatment of Paramagnetism, Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains, B-H Curve, Hysteresis and Energy Loss. **(12 Lectures)**

UNIT-4: Dielectric Properties of Materials: Polarization, Local Electric Field at an Atom.Electric Susceptibility, Polarizability, ClausiusMossotti Equation, Normal and Anomalous Dispersion.Langevin-Debye equation, Complex Dielectric Constant, Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, **Ferroelectric Properties of Materials:** Classification ofcrystals, Piezoelectric effect, Ferroelectric effect, Curie-Weiss Law, Ferroelectric domains, P-E hysteresis loop. **(13 lectures)**

UNIT-5: Band Theory of Solids& Superconductivity: Conductor, Semiconductor(p- and n-type) and insulator, Kronig-Penny model,Conductivity of Semiconductor, mobility, Hall Effect, Measurement of conductivity (Four probe method) & Hall coefficient, **Superconductivity:** Experimental Results. Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's Equation and Penetration Depth, Isotope effect, Idea of BCS theory (No derivation) **(13 Lectures)**

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 ofIndia
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

List of Experiments: Solid State Physics

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

Semester-VI

Course Code: PHYS3013

Course Name: Electromagnetic Theory

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Maxwell 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, **(12 Lectures)**

UNIT-2: EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, Transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance, Propagation through conducting media, relaxation time, skin depth, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, (**12 Lectures)**

UNIT-3: EM Wave in Bounded Media: Boundary conditions at a plane interface between two media, Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law, Reflection & Transmission coefficients, Total internal reflection, **(12 Lectures)**

UNIT-4: Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization, Propagation of E.M. Waves in Anisotropic Media, Symmetric Nature of Dielectric Tensor, Fresnel's Formula, Uniaxial and Biaxial Crystals, Light Propagation in Uniaxial Crystal. **(12 Lectures)**

UNIT-5: Optical Fibres & Wave Guides: Basics of Optical Fibre, Numerical Aperture, Step and Graded Index fibres (Definitions Only), Single and Multi-mode Fibres (Concept and Definition Only), Planar optical wave guides, Planar dielectric wave guide, Condition of continuity at interface, Phase shift on total reflection, Phase and group velocity of guided waves, Field energy and Power transmission. **(12 Lectures)**

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

Additional Books for Reference

1. Electromagnetic Fields & Waves, P.Lorrain&D.Corson, 1970, W.H.Freeman& Co.
2. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
3. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004,Cambridge University Press

List of Experiments in Electromagnetic Theory 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 usingWollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internalreflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing anglefor 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 junctiondiode.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, AsiaPublishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer.

Course Code: PHYS3014

Course Name: Statistical Mechanics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Gibbs Paradox, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. **(18 Lectures)**

UNIT-2: Classical Theory of Radiation: Properties of Thermal Radiation, Blackbody Radiation, Kirchhoff's law, Stefan-Boltzmann law: Thermodynamic proof, Radiation Pressure, Wien's Displacement law, Wien's Distribution Law. **(9 Lectures)**

UNIT-3: Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates, Planck's Law of Blackbody Radiation: Experimental Verification, Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **(5 Lectures)**

UNIT-4: Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas, Bose derivation of Planck's law. **(13 Lectures)**

UNIT-5: Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. **(15 Lectures)**

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, OxfordUniversity 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

List of Experiments in Statistical Mechanics Lab:

Use C/C^{++}/other numerical simulations for solving the problems based on Statistical Mechanics like

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 behavior 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 andcomparison with the Maxwell velocity distribution
   e) Computation and study of mean molecular speed and its dependence onparticle mass
   f) Computation of fraction of molecules in an ideal gas having speed nearthe most probable speed

2. Computation of the partition function Z(β) for examples of systems with a finitenumber of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number ofnon-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
   a) Study of how Z(β), average energy <E>, 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-JeansLaw at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distributionfunction, (c) Debye distribution function for high temperature and lowtemperature 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. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition.
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
3. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987.
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. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
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.

Course Code: PHYS3015

Course Name: Experimental Techniques

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: Measurements: Accuracy and precision, Significant figures, Error and uncertainty analysis, Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting, Guassian distribution. **(10 Lectures)**

UNIT-2: Signals and Systems: Periodic and aperiodic signals, Impulse response, transfer functionand frequency response of first and second order systems, Fluctuations and Noise inmeasurement system, S/N ratio and Noise figure, Noise in frequency domain. Sources ofNoise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise **(10 Lectures)**

UNIT-3: Transducers & industrial instrumentation (working principle, efficiency, applications): Transducers and sensors, Characteristics of Transducers, Transducers as electrical element and their signal conditioning, Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning, Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers, Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector. **(20 Lectures)**

UNIT-4: Analog & Digital Instrumentation: Comparison of analog and digital instruments. Block diagram of Digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement, Block diagram and working principles of RLC bridge, Q-meter and its working operation, Digital LCR bridge. **(8 Lectures)**

UNIT-5: Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path, Application of vacuum, Vacuum system-Chamber, Mechanical pumps, Diffusion pump & Turbo Molecular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

(12 Lectures)

Reference Books:

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Man Singh, 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 & applications, U. Tietze, Ch. Schenk, Springer.

List of Experiments:

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:

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

Course Code: PHYS3016

Course Name: Embedded Systems: Introduction to Microcontroller

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: Embedded system introduction: Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, operational and non-operational quality attributes of embedded systems, elemental description of embedded processors and microcontrollers. **(12Lectures)**

UNIT-2: Review of microprocessors: Organization of Microprocessor based system, 8085µp pin-diagram and architecture, concept of data bus and address bus, **8051 microcontroller:** Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming. **(12 Lectures)**

UNIT-3: 8051 I/O port programming: Introduction of I/O port programming, pin out diagramof8051 microcontroller, I/O port pins description & their functions, I/O port programming in 8051 (using assembly language), I/O programming: Bit manipulation. **Programming:** 8051 addressing modes and accessing memory using various addressing modes. **(12 Lectures)**

UNIT-4: Timer and counter programming: Programming 8051 timers, counter programming. **Serial port programming with and without interrupt:** Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051. **(12 Lectures)**

UNIT-5: Programming Embedded Systems: Structure of embedded program, infinite loop, compiling, linking and locating, downloading and debugging, file types generated after cross compilation, disassembler/decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry. **(12 Lectures)**

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 microcomputor 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.

List of Experiments:

Following experiments using **8051**:

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.

Reference Books:

1. 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.
2. Embedded Systems: Architecture, Programming& Design, R. Kamal, 2008, Tata McGraw Hill.
3. Embedded Microcomputor System: Real Time Interfacing, J.W. Valvano, 2000, Brooks/Cole.
4. Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.
5. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning.

Course Code: PHYS3017

Course Name: Physics of Devices and Instruments

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: Devices: Characteristic and small signal equivalent circuits of UJT and JFET, Metal-Semiconductor Junction, Metal oxide semiconductor (MOS) device, Ideal MOS and Flat Band voltage, SiO_2-Si based MOS, MOSFET–their frequency limits. Enhancement and Depletion Mode MOSFETs, CMOS, Charge coupled devices, Tunnel diode. **(15 Lectures)**

UNIT-2: Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L-Filters. IC Regulators, Line and load regulation, Short circuit protection, Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters. **(7 Lectures)**

UNIT-3: Multivibrators: Astable and Monostable Multivibrators using transistors, Phase Locked Loop (PLL): Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, Varactor), Basic idea of PLL IC (565 or 4046). **(7 Lectures)**

UNIT-4: Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon, Crystal plane and orientation, Defects in the lattice, Oxide layer, Oxidation Technique for Si, Metallization technique, Positive and Negative Masks, Optical lithography, Electron lithography, Feature size control and wet anisotropic etching. Lift off Technique, Diffusion and implantation. **(15 Lectures)**

UNIT-5: Communication System: Introduction to communication systems: Block diagram of electronic communication system, Need for modulation, Amplitude modulation, Modulation Index, Analysis of Amplitude Modulated wave, Sideband frequencies in AM wave, CE Amplitude Modulator, Demodulation of AM wave using Diode Detector, basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK. **(15 lectures)**

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, 4th 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. PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India.

List of Experiments:

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 LEDconnected with another pin of USB port.

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. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
4. OP-Amps and Linear Integrated Circuit, R.A. Gayakwad, 4th Edn., 2000, Prentice Hall.
5. Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning.

6. PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India.

Course Code: PHYS3018

Course Name: Advanced Mathematical Physics

Credits Equivalent: 6 Credits

Course Objectives: *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 Contents:

UNIT-1: Linear Vector Spaces: 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. **(12 Lectures)**

UNIT-2: Matrices: Addition and Multiplication of Matrices, Null Matrices, Diagonal, Scalar and Unit Matrices, Symmetric and Skew-Symmetric Matrices, Hermitian and Skew-Hermitian Matrices, Singular and Non-Singular matrices, Orthogonal and Unitary Matrices, Trace of a Matrix, Inner Product, Eigen-values and Eigen vectors, Cayley-Hamiliton Theorem, Diagonalization of Matrices, Solutions of Coupled Linear Ordinary Differential Equations, Functions of a Matrix. **(12 Lectures)**

UNIT-3: Cartesian Tensors: 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 Antisymmetric Tensors, Invariant Tensors: Kronecker and Alternating Tensors. **(12 Lectures)**

UNIT-4: 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: Symmetric Nature, Elasticity Tensor, Generalized Hooke's Law. **(14 lectures)**

Unit 5: General Tensors: 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. **(10 Lectures)**

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.

List of Experiments:

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

1. Linear algebra:

- Multiplication of two 3 x 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 eigen functions of Hermitian differential operators.

3. Determination of the principal axes of moment of inertia through diagonalization.

4. Vector space of wave functions in Quantum Mechanics: Position and momentum differential operators and their commutator, wave functions for stationary states as eigen functions of Hermitian differential operator.

5. Lagrangian formulation in Classical Mechanics with constraints.

6. Study of geodesics in Euclidean and other spaces (surface of a sphere, etc).

7. Estimation of ground state energy and wave function of a quantum system.

Reference Books:

1. 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.
2. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444.
3. Scilab Image Processing: L.M. Surhone, 2010, Betascript Pub., ISBN: 978-6133459274.

Course Code: PHYS3019

Course Name: Classical Dynamics

Credits Equivalent: 6 Credits

Course Objectives: *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 Contents:

UNIT-1: Classical Mechanics of Point Particles: 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, Generalized coordinates and velocities.

(10 Lectures)

UNIT-2: Lagranagian & Hamiltonian Formalism: 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. **(12 Lectures)**

UNIT-3: Small Amplitude Oscillations: 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. **(10 Lectures)**

UNIT-4: Special Theory of Relativity: Postulates of Special Theory of Relativity, Lorentz Transformations, Minkowski space, the invariant interval, light cone and world lines, Space-time diagrams, Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like, Four-velocity and acceleration, 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. **(16 Lectures)**

UNIT-5: Fluid Dynamics: Density 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, qualitative description of turbulence, Reynolds number. **(12 Lectures)**

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.

Course Code: PHYS3020

Course Name: Applied Dynamics

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1:Introduction to Dynamical systems: Idea of phase space, flows and trajectories, Simple mechanical systems as first order dynamical systems: the free particle, particle under uniform gravity, simple and damped harmonic oscillator, Sketching flows and trajectories in phase space; Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples, Computing and visualizing trajectories on the computer using a software packages. **(20 Lectures)**

UNIT-2:Introduction to Chaos and Fractals: Projection of the trajectory on momentum space, Sinai Billiard and its variants, Computational visualization of trajectories in the Sinai Billiard, Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle, Electron motion in mesoscopic conductors as a chaotic billiard problem, Other examples of chaotic systems; visualization of their trajectories on the computer, Self-similarity and fractal geometry: Fractals in nature– trees, coastlines, earthquakes, etc. Parameter dependence-steady, periodic and chaos states. **(20 Lectures)**

UNIT-3:Elementary Fluid Dynamics: Basic physics of fluids: The continuum hypothesis concept of fluid element or fluid parcel; Definition of a fluid-shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform & non-uniform flows, viscous &in viscid flows, incompressible & compressible flows, laminar and turbulent flows, rotational and irrotational flows, separated & unseparated flows. **(20 Lectures)**

Reference Books:

1. Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007.
2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G.K. Batchelor, Cambridge Univ. Press, 2002.
4. Fluid Mechanics, 2nd Edition, L.D. Landau and E.M. Lifshitz, Pergamon Press, Oxford, 1987.

List of Experiments:

Laboratory/Computing and visualizing trajectories using software such as Scilab, Maple, Octave, XPPAUT based on Applied Dynamics problems like

1. To determine the coupling coefficient of coupled pendulums.
2. To determine the coupling coefficient of coupled oscillators.
3. To determine the coupling and damping coefficient of damped coupled oscillator.

4. To study population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits.
5. To study rate equations for chemical reactions e.g. auto catalysis, bistability.
6. To study examples from game theory.
7. Computational visualization of trajectories in the Sinai Billiard.
8. Computational visualization of trajectories Electron motion in mesoscopic conductors as a chaotic billiard problem.
9. Computational visualization of fractal formations of Deterministic fractal.
10. Computational visualization of fractal formations of self-similar fractal.
11. Computational visualization of fractal formations of Fractals in nature–trees, coastlines, earthquakes.
12. Computational Flow visualization-streamlines, pathlines, Streaklines.

Reference Books:

1. Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007.
2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G.K. Batchelor, Cambridge Univ. Press, 2002
4. Fluid Mechanics, 2nd Edn., L.D. Landau & E.M. Lifshitz, Pergamon Press, Oxford, 1987.
5. 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.
6. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444.
7. Scilab Image Processing: L.M. Surhone. 2010, Betascript Pub., ISBN: 978-6133459274.

Course Code: PHYS3021

Course Name: Nuclear and Particle Physics

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, 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 Models:** Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, 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 nuclear force. **(12 Lectures)**

UNIT-2: Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis, (c)Gamma decay: Gamma rays emission & kinematics, **Nuclear Reactions:** Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Coulomb scattering (Rutherford scattering). **(10 Lectures)**

UNIt-3: Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. **(12 Lectures)**

UNIT-4: Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter, Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT), Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. **(12 Lectures)**

UNIT-5: Particle Accelerators: Accelerator facility available in India: Van-de Graff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. **Particle physics:** Particle interactions; basic features, types of particles and its families, Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. **(14 Lectures)**

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).

Course Code: PHYS3022

Course Name: Astronomy and Astrophysics

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature, Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Hertzsprung-Russell Diagram. **Astronomical techniques:** Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes). **(12 Lecture)**

UNIT-2: Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium, Theory of Radiative Transfer (Radiation Field, Radiative Transfer Equation), Optical Depth; Solution of Radiative Transfer Equation, Local Thermodynamic Equilibrium, **The Sun** (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere, Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics, Helioseismology), The Solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets, Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, Luminosity Classification). **(15 Lectures)**

UNIT-3: Evolution of Stars (Evolution on the Main Sequence, Evolution beyond the Main Sequence), Supernovae, Compact stars: Basic Familiarity with Compact Stars, Equation of State and Degenerate Gas of Fermions, Theory of White Dwarf, Chandrasekhar Limit, Neutron Star (Gravitational Red-shift of Neutron Star, Detection of Neutron Star: Pulsars), Black Hole. The milky way: Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus. **(15 Lectures)**

UNIT-4: Galaxies: Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies, Spiral and Lenticular Galaxies, The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms, Active Galaxies. **Active galaxies:** 'Activities' of Active Galaxies, Classification of the Active Galaxies, Behaviour of Active Galaxies (Quasars and Radio

Galaxies, Seyferts, BL Lac Objects and Optically Violent Variables), Unified Model of the Various Active Galaxies. **(8 Lectures)**

UNIT-5: Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies Friedmann Equation and its Solutions. **(10 Lectures)**

Reference Books:

1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
3. The physical universe: An introduction to astronomy, F. Shu, Mill Valley: University Science Books.
4. Fundamental of Astronomy (4th Edition), H. Karttunen et al. Springer.
5. K.S. Krishnasamy, 'Astrophysics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi, 2002.
6. Baidyanath Basu, 'An introduction to Astrophysics', Second printing, Prentice-Hall of India Private limited, New Delhi, 2001.
7. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

Course Code: PHYS3023

Course Name: Atmospheric Physics

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze, Cyclones and anticyclones, thunderstorms. **(12 Lectures)**

UNIT-2: Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Mesoscale circulations, The general circulations, Tropical dynamics. **(12 Lectures)**

UNIT-3: Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a Non-homogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration. **(12 Lectures)**

UNIT-4: Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Lidar and its applications, Data analysis tools and techniques. **(12 Lectures)**

UNIT-5: Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry. **(12 Lectures)**

Reference Books:

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol. 61, 1996.
2. The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3rd edn. 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004.

4. Radar for meteorological and atmospheric observations–S. Fukao and K. Hamazu, Springer Japan, 2014.

List of Experiments:

1. Numerical Simulation for atmospheric waves using dispersion relations
2. Atmospheric gravity waves
1. (b) Kelvin waves
2. (c) Rossby waves, and mountain waves
3. Offline and online processing of radar data
   (a) VHF radar,
   (b) X-band radar, and53
   (c) UHF radar
4. Offline and online processing of LIDAR data
5. Radiosonde data and its interpretation in terms of atmospheric parameters using vertical profiles in different regions of the globe.
6. Handling of satellite data and plotting of atmospheric parameters using radio occultation technique.
7. Time series analysis of temperature using long term data over metropolitan cities in India – an approach to understand the climate change.

Reference Books:

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol. 61, 1996.
2. The Physics of Atmosphere – J.T. Houghton; Cambridge Univ. Press; 3rd edn. 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004.
4. Radar for meteorological and atmospheric observations–S. Fukao and K. Hamazu, Springer Japan, 2014.

Course Code: PHYS3024

Course Name: Nano Materials and Applications

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: Nanoscale Systems: Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems. **(10 Lectures)**

UNIT-2: Synthesis of Nanostructure Materials: Top down and Bottom up approach, Photo-lithography, Ball milling, Vacuum deposition, Physical Vapor Deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical Vapor Deposition (CVD), Sol-Gel, Spray pyrolysis, Hydrothermal synthesis, Preparation through colloidal methods, MBE growth of quantum dots. **(10 Lectures)**

UNIT-3: Characterization Techniques: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Probe Microscopy: Atomic Force Microscopy, Magnetic Force Microscopy, Scanning Tunneling Microscopy, Differential Scanning Calorimetry, Thermo-gravimetric Analysis, Spectroscopy of Nanomaterials (UV-vis/NIR, FTIR/ATR, X-ray Photoelectron study). **(10 Lectures)**

UNIT-4: Optical and Electronic Properties: Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure, Quasi-particles and excitons, Excitons in direct and indirect band gap semiconductor nanocrystals, Quantitative treatment of quasi-particles and excitons, charging effects, emission and luminescence, Optical properties of heterostructures and nanostructures. **Electron Transport:** Carrier transport in nanostructures, Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity, Defects and impurities: Deep level and surface defects. **(15 Lectures)**

UNIT-5: Applications of Nanomaterials: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells), Single electron transfer devices (no derivation), CNT based transistors, Nanomaterial Devices: Quantum dots heterostructure lasers, Optical switching and optical data storage. **(15 Lectures)**

Reference books:

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

5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
7. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

List of Experiments:

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristics.

Reference Books:

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

Course Code: PHYS3025

Course Name: Physics of the Earth

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: The Earth and the Universe: Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography, Introduction to various branches of Earth Sciences. General characteristics and origin of the Universe, The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin, The terrestrial and Jovian planets, Meteorites & Asteroids, Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age, Energy and particle fluxes incident on the Earth, The Cosmic Microwave Background. **(12 Lectures)**

UNIT-2: The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy, The Hydrosphere: The oceans, their extent, depth, volume, chemical composition, The Atmosphere: variation of temperature, density and composition with altitude, clouds, The Cryosphere: Polar caps and ice sheets. Mountain glaciers, The Biosphere: Plants and animals, Chemical composition, mass, Marine and land organisms. **(12 Lectures)**

UNIT-3: Dynamical Processes: Source of geothermal energy, Convection in Earth's core and production of its magnetic field, Mechanical layering of the Earth, Introduction to geophysical methods of earth investigations, Concept of plate tectonics; sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs, Origin of oceans, continents, mountains and drift valleys, Earthquake and earthquake belts. Volcanoes: types products and distribution, The Hydrosphere: Ocean circulations. Oceanic current system and effect ofcoriolis forces, Concepts of eustasy, tend – air-sea interaction; wave erosionand beach processes, Tides, Tsunamis, The Atmosphere: Atmospheric circulation, Weather and climatic changes, Earth's heat budget, Cyclones, Climate: i. Earth's temperature and greenhouse effect. ii. Paleoclimate and recent climate changes.iii. The Indian monsoon system, Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle, The role of cycles in maintaining a steady state. **(12 Lectures)**

UNIT-4: Evolution: Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies, Introduction to geochronological methods in their application in geological studies, History of development in concepts of uniform itarianism, catastrophism and neptunism, Law of superposition and faunal succession, Introduction to the geology and geomorphology of Indian subcontinent, 1.Time line of major geological and biological events, 2. Origin of life on Earth, 3. Role of the biosphere in shaping the environment, 4. Future of evolution of the Earth and solar system: Death of the Earth. **(12 Lectures)**

UNIT-5: Disturbing the Earth – Contemporary dilemmas

Human population growth, Atmosphere: Greenhouse gas emissions, climate change, air pollution, Hydrosphere: Fresh water depletion, Geosphere: Chemical effluents, nuclear waste, Biosphere: Biodiversity loss, Deforestation, Robustness and fragility of ecosystems. **(12 Lectures)**

Reference Books:

1. Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
2. Consider a Spherical Cow: A Course in Environmental Problem Solving, John Harte, University Science Books.
3. Holme's Principles of Physical Geology, 1992, Chapman & Hill.
4. Emiliani, C. 1992.

Course Code: PHYS3026

Course Name: Medical Physics

Credits Equivalent: 6 Credits

Course Contents:

UNIT-1: PHYSICS OF THE BODY-I

Mechanics of the body: Skeleton, forces, and body stability. Muscles and the dynamics of body movement, Physics of body crashing, **Energy household of the body:** Energy balance in the body, Energy consumption of the body, Heat losses of the body, **Pressure system of the body:** Physics of breathing, Physics of cardiovascular system.

PHYSICS OF THE BODY-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. **Optical system of the body:** Physics of the eye. **Electrical system of the body:** Physics of the nervous system, Electrical signals and information transfer. **(12 Lectures)**

UNIT-2: PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I

X-RAYS: Electromagnetic spectrum–production of x-rays–x-ray spectra Brehmsstrahlung- Characteristic x-ray – X-ray tubes – Coolidge tube – x-ray tube design – tube cooling stationary mode – Rotating anode x-ray tube – Tube rating – quality and intensity of x-ray. X-ray generator circuits – half wave and full wave rectification – filament circuit – kilo voltage circuit – high frequency generator – exposure timer – HT cables. **(12 Lectures)**

UNIT-3: RADIATION PHYSICS& MEDICAL IMAGING PHYSICS: Radiation units - exposure - absorbed dose – units: rad, gray-relative biological effectiveness-effective dose - inverse square law - interaction of radiation with matter - linear attenuation coefficient. Radiation Detectors –Thimble chamber- condenser chambers–Geiger counter–Scintillation counter–ionization chamber–Dosimeters–survey methods – area monitors–TLD and semiconductor detectors, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR) – NMR imaging – MRI Radiological imaging – Radiography – Filters – grids – cassette – X-ray film – film processing – fluoroscopy – computed tomography scanner – principle function – display – generations – mammography. Ultrasound imaging – magnetic resonance imaging – thyroid uptake system – Gamma camera (Only Principle, function and display) **(12 Lectures)**

UNIT-4: RADIATION THERAPY PHYSICS& RADIATION AND RADIATION PROTECTION: Radiotherapy – kilo voltage machines – deep therapy machines – Telecobalt machines–Medical linear accelerator, Basics of Teletherapy units – deep x-ray, Telecobalt units, medical linear accelerator – Radiation protection – external beam characteristics – phantom – dose maximum and build up – bolus – percentage depth dose – tissue – air ratio – back scatter factor, Principles of radiation protection– protective materials-radiation effects – somatic, genetic stochastic & deterministic effect, Personal monitoring devices – TLD film badge – pocket dosimeter.

Radiationdosimetry, Natural radioactivity, Biological effects of radiation, Radiation monitors**.** **(12 Lectures)**

UNIT-5: PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-II
Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment. **(12 Lectures)**

Reference Books:

1. Medical Physics, J.R. Cameron and J.G. Skofronick, Wiley (1978).
2. Basic Radiological Physics, K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003).
3. Physics of the human body, Irving P. Herman, Springer (2007).
4. Physics of Radiation Therapy : F M Khan - Williams and Wilkins, 3rd edition (2003)
5. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002).
6. The Physics of Radiology-H E Johns and Cunningham.

List of Experiments:

1. Understanding the working of a manual Hg Blood Pressure monitor and measure the Blood Pressure.
2. Understanding the working of a manual optical eye-testing machine and to learn eye-testing procedure.
3. Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard.
4. Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard.
5. To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation.
6. Familiarization with Geiger-Muller (GM) Counter and to measure background radiation.
7. Familiarization with Radiation meter and to measure background radiation.
8. Familiarization with the construction of speaker-receiver system and to design a speaker-receiver system of given specification.

Reference Books:

1. Basic Radiological Physics, K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003).
2. Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990).
3. Physics of Radiation Therapy : F M Khan - Williams and Wilkins, 3rd edition (2003).
4. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002).
5. The Physics of Radiology-H E Johns and Cunningham.

Course Code: PHYS3027

Course Name: Biological Physics

Credits Equivalent: 6 Credits

Course Contents:

Unit-1: Overview: The boundary, interior and exterior environment of living cells, Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution, Self-replication as a distinct property of biological systems. Time scales and spatial scales. Universality of microscopic processes and diversity of macroscopic form, Types of cells, Multi-cellularity, Allometric scaling laws. **(10 lectures)**

Unit-2: Molecules of life: Metabolites, proteins and nucleic acids, Their sizes, types and roles in structures and processes, Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell, Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways, Random walks and applications to biology, Mathematical models to be studied analytically and computationally.

(15 lectures)

Unit-3: The complexity of life: At the level of a cell: The numbers of distinct metabolites, genes and proteins in a cell, Complex networks of molecular interactions: metabolic, regulatory and signaling networks, Dynamics of metabolic networks; the stoichiometric matrix, Living systems as complex organizations; systems biology, Models of cellular dynamics, The implausibility of life based on a simplified probability estimate, and the origin of life problem. **(20 lectures)**

Unit-4: At the level of a multicellular organism: Numbers and types of cells in multi-cellular organisms, Cell types as distinct attractors of a dynamical system, Stem cells and cellular differentiation, Pattern formation and development, Brain structure: neurons and neural networks, Brain as an information processing system, Associative memory models, Memories as attractors of the neural network dynamics, **At the level of an ecosystem and the biosphere:** Foodwebs, Feedback cycles and self-sustaining ecosystems. **(15 lectures)**

Unit-5: Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism, Models of evolution, The concept of genotype-phenotype map, Examples. **(15 lectures)**

References:

1. Physics in Molecular Biology; Kim Sneppen & Giovanni Zocchi (CUP 2005).
2. Biological Physics: Energy, Information, Life; Philip Nelson (W.H. Freeman & Co., NY, 2004).
3. Physical Biology of the Cell (2^{nd} Edition), Rob Phillips et al. (Garland Science, Taylor & Francis Group, London & NY, 2013).

4. An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013).
5. Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition).

Skill Enhancement Courses (SEC papers)

Course Code: PHYS3028

Course Name: Physics Workshop Skills

Credits Equivalent: 2 Credits

Course Objectives: *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.*

UNIT-1: Introduction: Measuring units, conversion to SI and CGS, Vernier calliper, Screw gauge and their utility, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc. **(6 Lectures)**

UNIT-2: Mechanical Skill: Concept of workshop practice, Overview of manufacturing methods: casting, foundry, machining, forming and welding, Types of welding joints and welding defects'. **(6 Lectures)**

UNIT-3: 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, Smoothening of cutting edge of sheet using file, Drilling of holes of different diameter in metal sheet and wooden block. **(6 Lectures)**

UNIT-4: Electrical and Electronic Skill: 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. **(6 Lectures)**

UNIT-5: Introduction to prime movers: 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. **(6 Lectures)**

Reference Books:

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

Course Code: PHYS3029

Course Name: Computational Physics Skills

Credits Equivalent: 2 Credits

Course Objectives: *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.*

Course Contents:

UNIT-1: Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution**,** Algorithm: Definition, properties and development, Flowchart: Concept of flowchart, symbols, guidelines, types, Roots of Quadratic Equation, calculation of sin(x) as a series. **(5 Lectures)**

UNIT-2: Scientific Programming: Some fundamental Linux Commands, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Operators, Expressions, Fortran Statements **(6 Lectures)**

UNIT-3: Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements, Looping Statements, 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.

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1 **(7 Lectures)**

UNIT-4: Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, errors. **(4 Lectures)**

UNIT-5: Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, Understanding data with Gnuplot.

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices.
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an .eps file and as a .pdf file.
9. To find the roots of a quadratic equation. **(8 Lectures)**

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
- LaTeX–A Document Preparation System", Leslie Lamport (2nd Edition, Addison-Wesley, 1994).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010).
- Schaum's Outline of Theory and Problems of Programming with Fortran, S. Lipsdutz and A. Poe, 1986, Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R.C. Verma, et al., New Age International Publishers, New Delhi (1999).
- 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.

Course Code: PHYS3030

Course Name: Electrical circuits and Network Skills

Credits Equivalent: 2 Credits

Course Objectives: *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.*

Course Contents:

UNIT-1: Basic Electricity Principles & Understanding Electrical Circuits: Ohm's law, Series, parallel, and series-parallel combinations, AC Electricity and DC Electricity, Familiarization with multimeter, voltmeter and ammeter, Single-phase and three-phase alternating current sources. **(6 Lectures)**

UNIT-2: Electrical Drawing & Symbols: Drawing symbols, Blueprints, Reading Schematics, Ladder diagrams, Electrical Schematics, Power circuits, Control circuits, Reading of circuit schematics, tracking the connections of elements and identify current flow and voltage drop. **(6 Lectures)**

UNIT-3: Generators, Transformers & Electric Motors: DC Power sources, AC/DC generators, Inductance, capacitance, and impedance, Operation of transformers, Single-phase, three-phase & DC motors, ac motor. **(6 Lectures)**

UNIT-4: Solid-State Devices: Resistors, inductors and capacitors, Diode and rectifiers, Components in Series or in shunt, Response of inductors and capacitors with DC or AC sources. **(4 Lectures)**

UNIT-5: Electrical Protection & Electrical Wiring: Relays, Fuses and disconnect switches, Circuit breakers, Overload devices, Ground-fault protection, Grounding and isolating, Phase reversal, Surge protection, Different types of conductors and cables, Voltage drop and losses across cables and conductors, Instruments to measure current, voltage, power in DC and AC circuits, Insulation, Solid and stranded cable. **(8 Lectures)**

Reference Books:

1. A text book in Electrical Technology – B.L. Theraja – S. Chand & Co.
2. A text book of Electrical Technology – A.K. Theraja
3. Performance and design of AC machines – M.G. Say ELBS Edn.

Course Code: PHYS3031

Course Name: Basic Instrumentation Skills

Credits Equivalent: 2 Credits

Course Objectives: *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.*

Course Contents:

UNIT-1: Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects, Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance, Specifications of a multimeter and their significance. **(6Lectures)**

UNIT-2: Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity, Principles of voltage, measurement (block diagram only), AC millivoltmeter, Block diagram of ac millivoltmeter, specifications and their significance. **(6 Lectures)**

UNIT-3: Cathode Ray Oscilloscope: Block diagram of basic CRO, Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only), brief discussion on screen phosphor, Front panel controls, Use of CRO for the measurement of voltage and time period, digital oscilloscope. **(5 Lectures)**

UNIT-4: Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator, Impedance Bridges & Q-Meters:Block diagram of bridge, working principles of basic (balancing type) RLC bridge, Block diagram & working principles of a Q- Meter.

(7 Lectures)

UNIT-5: Digital Instruments: Principle and working of digital meters, Characteristics of a digital meter, Working principles of digital voltmeter, Block diagram and working of a digital multimeter. **(6 Lectures)**

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

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltageand 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:

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

Reference Books:

1. Performance and design of AC machines - M G Say ELBS Edn.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
3. Logic circuit design, Shimon P. Vingron, 2012, Springer.
4. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
5. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012,TataMc-Graw Hill.
6. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer.
7. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

Course Code: PHYS3032

Course Name: Renewable Energy and Energy Harvesting

Credits Equivalent: 2 Credits

Course Objectives: *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.*

Course Contents:

UNIT-1: Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources, Wind Energy, Tidal Energy, biomass, biochemical conversion, biogas generation. **(6 Lectures)**

UNIT-2: Solar energy: Solar energy and its importance, storage of solar energy, solar pond, non-convective solar pond, 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. **(6 Lectures)**

UNIT-3: Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines. **(5 Lectures)**

UNIT-4: Ocean Energy, Geothermal Energy and Hydro Energy: Ocean Energy, Tide Energy, Ocean Thermal Energy, Geothermal Resources, Geothermal Technologies, Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(6 Lectures)**

UNIT-5: Piezoelectric Energy Harvesting & Electromagnetic Energy Harvesting: Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters, Piezoelectric energy harvesting applications, Human power, Linear generators, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability. **(7 Lectures)**

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.
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

Course Code: PHYS3033

Course Name: Mechanical Drawing

Credits Equivalent: 2 Credits

Course Contents:

UNIT-1: Introduction: Drafting Instruments and their uses, Lettering: construction and uses of various scales. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, in volute: spiral: helix and loci of points of simple moving mechanism, 2D geometrical construction. **(6 Lectures)**

UNIT-2: Projections: Straight lines, planes and solids, Development of surfaces of right and oblique solids, Section of solids. **(4 Lectures)**

UNIT-3: Object Projections: Orthographic projection, Interpenetration and intersection of solids, Isometric and oblique parallel projection of solids. **(5 Lectures)**

UNIT-4: CAD Drawing-I: 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. **(6 Lectures)**

UNIT-5: CAD Drawing-II: 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), dimensioning, internet and collaboration, Blocks, **(8 Lectures)**

Reference Books:

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

Course Code: PHYS3034

Course Name: Applied Optics

Credits Equivalent: 2 Credits

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

Course Contents:

UNIT-1: Properties of LASER, Spontaneous and stimulated emission, Theory of laser action, Einstein's coefficients, Light amplification, He-Ne laser, Ruby Laser, Semiconductor lasers. **(6 Lectures)**

UNIT-2: Fundamentals of the LED, laser and detectors operation, devices band diagram, characteristics and testing technique for lasers as well as avalanche and PIN photodetectors. **(6 Lectures)**

UNIT-3: Analysis of Two-Dimensional Signals and Systems, Fourier Analysis in Two Dimensions, Concept of Spatial frequency filtering, Fourier transforming property of a thin lens. **(6 Lectures)**

UNIT-4: Optical fibres and their properties, Principal of light propagation through a fibre, Numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres. **(6 Lectures)**

UNIT-5: Holography: Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy. **(6 Lectures)**

List of Experiments:

1. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
2. To find the polarization angle of laser light using polarizer and analyser.
3. V-I characteristics of LED.
4. Fourier optic and image processing
   1. Optical image addition/subtraction
   2. Optical image differentiation
   3. Fourier optical filtering
5. Recording and reconstructing holograms.

Reference Books:

- Fundamental of optics, F.A. Jenkins & H.E. White, 1981, Tata McGraw Hill.
- LASERS: Fundamentals & applications, K. Thyagrajan & A.K. Ghatak, 2010, Tata McGraw Hill.
- Fibre optics through experiments, M.R. Shenoy, S.K. Khijwania, et.al. 2009, Viva Books.
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.

- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4thEdn., 1996, Cambridge Univ. Press.

Course Code: PHYS3035

Course Name: Weather Forecasting

Credits Equivalent: 2 Credits

Course Objectives: *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.*

Course Contents:

UNIT-1: Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; variation of pressure and temperature with height; air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics. **(6 Lectures)**

UNIT-2: Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

(6 Lectures)

UNIT-3: Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

(4 Lectures)

UNIT-4: Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate. **(6 Lectures)**

UNIT-5: Basics of weather forecasting: Weather forecasting, 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.

(8 Lectures)

List of Experiments (Demonstrations):

1. 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.
2. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts,

upper wind charts and its analysis.

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.

Course Code: PHYS3036

Course Name: Radiation Safety

Credits Equivalent: 2 Credits

Course Objectives: *The aim of this course is for awareness and understanding regarding radiation hazards and safety. The list of laboratory skills and experiments listed below the course are to be done in continuation of the topics.*

Course Contents:

UNIT-1:Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, binding energy, stable and unstable isotopes, law of radioactive decay, basic concept of alpha, beta and gamma decay, concept of cross section, Nuclear Fusion &fission. **(5 Lectures)**

UNIT-2: Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, Interaction of Photons-Photoelectric effect, Compton Scattering, Pair Production, Interaction of Charged Particles, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation, Interaction of Neutrons-Collision. **(6 Lectures)**

UNIT-3: Radiation detection and monitoring devices: Radiation Quantities and Units: exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter and Geiger Muller Counter), Scintillation Detectors, Solid States Detectors and Neutron Detectors. **(6 Lectures)**

UNIT-4: Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation, Nuclear waste and disposal management, Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. **(7 Lectures)**

UNIT-5: Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterization, Food preservation. **(6 Lectures)**

Experiments:

1. Study the background radiation levels using Radiation meter.

Characteristics of Geiger Muller (GM) Counter:

2) Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).

3) Study of counting statistics using background radiation using GM counter.

4) Study of radiation in various materials (e.g. K_2SO_4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.

5) Study of absorption of beta particles in Aluminum using GM counter.

6) Detection of α particles using reference source & determining its half life using spark counter

7) Gamma spectrum of Gas Light mantle (Source of Thorium).

Reference Books:

1. W.E. Burcham and M. Jobes–Nuclear and Particle Physics – Longman (1995).

2. G.F. Knoll, Radiation detection and measurements.

3. Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5).

4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.

5. J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.

6. Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001

7. A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Wiley & Sons, Inc. New York, 1981.

8. NCRP, ICRP, ICRU, IAEA, AERB Publications.

9. W.R. Hendee, "Medical Radiation Physics", Year Book–Medical Publishers Inc. London, 1981.

Course Code: PHYS3037

Course Name: GE-Mechanics

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *This course has been designed to teach the graduate students the basics of Newtonian mechanics.*

Course Contents:

UNIT-1: Fundamentals of Dynamics (15 Lectures)

Concept of Scalar and vector, Frames of reference, Newton's Laws of motion, Dynamics of system of particles, Centre of Mass, Conservation of momentum. Work and energy, Conservation of energy, Motion of rockets, Angular velocity and angular momentum, Torque, Conservation of angular momentum.

UNIT-2: Gravitation: (10 Lectures)

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), Satellite in circular orbit and applications, Geosynchronous orbits, Basic idea of global positioning system (GPS), Weightlessness.

UNIT-3: Oscillations: (8 Lectures)

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

UNIT-4: Elasticity: (15 Lectures)

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, Twisting couple on a cylinder, Determination of Rigidity modulus by static torsion, Torsional pendulum, Determination of Rigidity modulus and moment of inertia, Searle's method.

UNIT-5: Special Theory of Relativity: (12 Lectures)

Constancy of speed of light, Postulates of Special Theory of Relativity, Lorentz Transformations, Lorentz contraction, Time dilation, Relativistic transformation, Relativistic addition of velocities, Variation of mass with velocity, Mass-energy Equivalence.

Reference Books:

1. An introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973).
2. Mechanics Berkeley physics course, vol. 1: By Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholz, Burton Moyer, (Tata McGraw-Hill, 2007).
3. Analytical Mechanics, G.R. Fowles and G.L. Cassiday, 2005, Cengage Learning.
4. Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
5. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

6. Fundamentals of Physics (10th Edition) Halliday, Resnick & Walker.

List of Experiments: GE-Mechanics Lab

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
5. To determine the Elastic Constants of a Wire by Searle's method.
6. To determine g by Bar Pendulum.
7. To determine g by Kater's Pendulum.
8. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

Text and Reference Books

1. Geeta Sanon, B.Sc. Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. Practical Physics by R.K. Shukla and Anchal Srivastava (New Age International Publishers), ISBN: 978-81-224-2482-9.
3. B.L. Worsnop and H.T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
4. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
5. G.L. Squires, Practical Physics, 2015, 4th Edition, Cambridge University Press.

Course Code: PHYS3038

Course Name: GE-Electricity and Magnetism

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *The aim of this course is to introduce the basics of Electricity and Magnetism and its applications.*

Course Contents:

UNIT-1: Vector Analysis: **(10 Lectures)**

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.

UNIT-2: Electrostatics: **(20 Lectures)**

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

UNIT-3: Magnetism: **(12 Lectures)**

Magnetostatics: Biot-Savart's law and 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: permeability, magnetic susceptibility, Brief introduction of dia-, para-and ferromagnetic materials.

UNIT-4: Electromagnetic Induction: **(6 Lectures)**

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-5: Maxwell`s equations and Electromagnetic wave propagation: **(12 Lectures)**

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.

Reference Books:

1. Electricity and Magnetism: Edward M. Purcell (McGraw-Hill Education, 1986)
2. Fundamentals of Electricity and Magnetism: Arthur F. Kip (McGraw-Hill, 1968.
3. Electricity and Magnetism: J.H. Fewkes & John Yarwood. Vol. I (Oxford Univ. Press, 1991).
4. Electricity and Magnetism: D.C. Tayal (Himalaya Publishing House,1988).

5. David J. Griffiths, Introduction to Electrodynamics, 3rd Edition.
6. Electricity and Magnetism by K.K. Tewari (S. Chand & Co. Ltd.); ISBN: 81-219-0667-9.

List of Experiments:GE-Electricity and Magnetism Lab

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages,(c) DC Current, and (d) checking electrical fuses.
2. To verify Ohm's law and Kirchoff's laws.
3. To compare capacitances using De'Sauty's bridge.
4. To determine a Low Resistance by Carey Foster's Bridge.
5. To verify the Thevenin theorems.
6. To verify the Norton theorems.
7. To verify the Superposition Theorem.
8. To verify the Maximum Power Transfer Theorem.
9. To study a series LCR circuit and determine its (a) Resonant frequency, (b) Quality factor.

Text and Reference Books

1. Geeta Sanon, B.Sc. Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. Practical Physics by R.K. Shukla and Anchal Srivastava (New Age International Publishers), ISBN: 978-81-224-2482-9.
3. B.L. Worsnop and H.T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
4. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.

Course Code: PHYS3039

Course Name: GE-Thermal Physics and Statistical Mechanics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Laws of Thermodynamics: Zeroth Law of thermodynamics and temperature. First law and internal energy, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible &irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, **(15 Lectures)**

UNIT-2: Thermo dynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications-Joule-Thompson Effect, Phase transitions, Clausius Clapeyron equation, TdS equations. **(10 Lectures)**

UNIT-3: Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path, Transport Phenomena: Viscosity, Law of equipartition of energy (no derivation) and its applications to specific heat of gases **(12 Lectures)**

UNIT-4: Theory of Radiation: 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. **(8 Lectures)**

UNIT-5: Statistical Mechanics: Maxwell-Boltzmann law-distribution of velocity, Quantum statistics, Phase space, Fermi-Dirac distribution law-electron gas, Bose-Einstein distribution law - photon gas, comparison of three statistics. **(10 Lectures)**

Reference Books:

• Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
• A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
• Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
• Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa.
• University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

List of Experiments:

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne'sconstant 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 Cu 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 Leeand 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 oftime using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off Balance Bridge

Reference Books:

• Advanced Practical Physics for students, B.L.Flint & H.T. Worsnop, 1971,Asia Publishing House.
• A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEdition, 2011, Kitab Mahal, New Delhi.
• A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal,1985, Vani Publication.

Course Code: PHYS3040

Course Name: GE-Waves and Optics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Wave Motion, Group velocity, Phase velocity. Plane waves, Spherical waves, Wave intensity, Sound: Simple harmonic motion, forced vibrations and resonance.

(14 Lectures)

UNIT-2: Wave Optics: Electromagnetic nature of light, Definition and Properties of wave front, Huygens Principle. **(4 Lectures)**

UNIT-3: Interference: Division of amplitude and division of wave front, Young's Double Slit experiment, Fresnel's Biprism, 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. Michelson's Interferometer. **(15 Lectures)**

UNIT-4: Diffraction: Fraunhofer diffraction-Single slit; Double Slit, Multiple slits and Diffraction grating, Fresnel Diffraction: Half-period zones, Zone plate, Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

(15 Lectures)

UNIT-5: Polarization: Transverse nature of light waves. Plane polarized light– production and analysis, Circular and elliptical polarization. **(12 Lectures)**

Reference Books:

• Fundamentals of Optics, F.A. Jenkins and H.E. White, 1976, Tata McGraw-Hill.

• Principles of Optics, B.K. Mathur, 1995, Gopal Printing.

• Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications.

• University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13th ed. 1986, Addison-Wesley.

List of Experiments:

1. To investigate the motion of coupled oscillators.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a Prism using Mercury Light.
8. To determine the value of Cauchy Constants.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.

13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

Reference Books:

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

Course Code: PHYS3041

Course Name: GE-Digital, Analog Circuits and Instrumentation

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Digital Circuits: Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates, De-Morgan's Theorems, Minterms and Maxterms, Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map, Binary Addition, Binary Subtraction using 2's Complement Method), Half Adders and Full Adders and Subtractors.

(12 Lectures)

UNIT-2: Semiconductor Devices and Amplifiers: Semiconductor Diodes: P and N type semiconductors, Barrier Formation in PN Junction Diode, Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode, Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell. **(8 Lectures)**

UNIT-3: Bipolar Junction transistors: n-p-n and p-n-p Transistors, Characteristics of CB, CE and CC Configurations, Load Line analysis of Transistors, DC Load line & Q-point, h-parameter Equivalent Circuit, Analysis of single-stage CE amplifier using hybrid Model, Class A, B & C Amplifiers. Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. **(12 Lectures)**

UNIT-4: Operational Amplifiers: Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed loop Gain, CMRR, concept of Virtual ground, Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator. **(12 Lectures)**

UNIT-5: Instrumentations: Introduction to CRO: Block Diagram of CRO, Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference, Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation, Timer IC: IC555 Pin diagram and its application as Astable and Monostable Multivibrator. **(16 Lectures)**

Reference Books:

• Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata McGraw-Hill.
• Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata McGraw-Hill
• Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.
• Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning
• Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
• Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.
• Op-Amp & Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

List of Experiments:

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To minimize a given logic circuit.
4. Half adder, Full adder and 4-bit Binary Adder.
5. Adder-Subtractor using Full Adder I.C.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. To study IV characteristics of PN diode, Zener and Light emitting diode
9. To study the characteristics of a Transistor in CE configuration.
10. To design a CE amplifier of given gain (mid-gain) using voltage divider bias.
11. To design an inverting amplifier of given gain using Op-amp 741 and study itsfrequency response.
12. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
13. To study Differential Amplifier of given I/O specification using Op-amp.
14. To investigate a differentiator made using op-amp.
15. To design a Wien Bridge Oscillator using an op-amp.

Reference Books:

• Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
• Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
• OP-Amps & Linear Integrated Circuit, R.A. Gayakwad, 4th Edn, 2000, Prentice Hall.
• Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

Course Code: PHYS3042

Course Name: GE-Elements of Modern Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Planck's quantum theory, Photoelectric effect and Compton scattering, De-Broglie wavelength and matter waves; Davisson-Germer experiment, Hydrogen like atoms and their spectra, Wave-particle duality, Heisenberg uncertainty principle, Estimating minimum energy of a confined particle using uncertainty principle. **(14 Lectures)**

UNIT-2: Two slit interference experiment, Matter waves and wave amplitude, physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension, Time dependent and time independent Schroedinger equations. **(14 Lectures)**

UNIT-3: One dimensional infinitely rigid box-energy eigenvalues and eigen functions, normalization; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier. **(12 Lectures)**

UNIT-4: Size and structure of atomic nucleus and its relation with atomic weight, Nature of nuclear force, Semi-empirical mass formula and binding energy, Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; α decay; β-decay, Pauli's prediction of neutrino. **(12 Lectures)**

UNIT-5: Fission and Fusion: Fission–nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions. **(8 Lectures)**

Reference Books:

• Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill.
• Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2009, PHI Learning.
• Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, Tata Mc-Graw Hill.
• Quantum Physics, Berkeley Physics, Vol. 4, E.H. Wichman, 2008, Tata McGraw-Hill Co.
• Modern Physics, R.A. Serway, C.J. Moses, and C.A. Moyer, 2005, Cengage Learning.

List of Experiments:

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine the ionization potential of mercury.
4. To determine value of 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 absorption lines in the rotational spectrum of Iodine vapour.
7. To study the diffraction patterns of single and double slits using laser and measure its intensity variation using Photosensor & compare with incoherent source – Na.
8. Photo-electric effect: photo current versus intensity and wavelength of light;maximum energy of photo-electrons versus frequency of light

9. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
10. To setup the Millikan oil drop apparatus and determine the charge of an electron.

Reference Books:

• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
• A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11thEdition, 2011, Kitab Mahal, New Delhi.

Course Code: PHYS3043

Course Name: GE-Mathematical Physics

Credits Equivalent: 6 (4L + 2P) Credits

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

Course Contents:

UNIT-1: Fourier series: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet's 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. **(14 Lectures)**

UNIT-2: Legendre, Bessel, Hermite & Laguerre Differential Equations, Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality, Simple recurrence relations. **(16 Lectures)**

UNIT-3: Some Special Integrals: Beta and Gamma Functions and Relation between them, Expression of Integrals in terms of Gamma Functions. **(4 Lectures)**

UNIT-4: Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. **(12 Lectures)**

UNIT-5: Complex Analysis: Complex Numbers, Euler's formula, De Moivre's theorem, Roots of Complex Numbers, Analyticity and Cauchy-Riemann Conditions, Singular functions: poles and branch points, order of singularity, branch cuts, Cauchy's Inequality, Cauchy's Integral formula. **(14 Lectures)**

Reference Books:

• Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
• Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
• Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
• An Introduction to Ordinary Differential Equations, E.A Coddington, 1961, PHI Learning
• Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
• Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993,Dover Publications.
• Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books.

List of Experiments:

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.

• The course will consist of lectures (both theory and practical) in the Lab
• Evaluation done on the basis of formulating the problem
• Aim at teaching students to construct the computational problem to be solved

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

Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers,algorithms, Sequence, Selection and Repetition, singleand double precision

arithmetic, underflow &overflowemphasize the importance of making equations in termsof dimensionless variables, Iterative methods.

Errors and error Analysis: Truncation and round off errors, Absolute and relativeerrors, Floating point computations.

Review of C & C++ Programmingfundamentals: Introduction to Programming, constants, variables anddata types, operators and Expressions, I/O statements,scanf and printf, c in and c out, Manipulators for dataformatting, Control statements (decision making andlooping statements) (If-statement. If-else Statement.Nested if Structure.Else-if Statement.Ternary Operator.Goto Statement. Switch Statement. Unconditional andConditional Looping.While Loop. Do-While Loop. FORLoop. 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 givenlist of numbers and its location in the list, sorting ofnumbers in ascending descending order, Binary search**Random number generation:** Area of circle, area of square, volume of sphere, valueof π

Solution of Algebraic and Transcendentalequations by Bisection, Newton Raphsonand Secant methods: Solution of linear and quadratic equation, solvingα =tanα;I =Io[(Sinα)/α]2 in optics

Interpolation by Newton Gregory Forwardand Backward difference formula, Errorestimation of linear interpolation: Evaluation of trigonometric functions e.g. sin θ, cos θ, tan θ, etc.

Numerical differentiation (Forward andBackward difference formula) andIntegration (Trapezoidal and Simpsonrules), Monte Carlo method: Given Position with equidistant time data to calculatevelocity and acceleration and vice versa. Find the area ofB-H Hysteresis loop.

Also attempt the some problems on differential equations like:

1. Solve the coupled first order differential equations

$$\frac{dx}{dt} = y + x - \frac{x^3}{3}, \frac{dy}{dt} = -x,$$

for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$.

2. The ordinary differential equation describing the motion of a pendulum is

$$\vartheta'' = -\sin(\vartheta)$$

The pendulum is released from rest at an angular displacement α i.e.

$$\vartheta(0) = \alpha, \vartheta'(0) = 0.$$

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

$$\vartheta \; (sin(\vartheta) \approx \vartheta).$$

3. Solve the differential equation:

$$x^2 \frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^3$$

with the boundary conditions:

at x = 1, y = (1/2) e^2, dy/dx = - (3/2) e^2– 0.5, in the range $1 \le x \le 3$. Plot y and$\frac{dy}{dx}$ against x in the given range. Both should appear on the same graph.

Referred Books:

• Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.

• Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.

• Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal.,

3rd Edn.,2007, Cambridge University Press.
• A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
• Elementary Numerical Analysis, K.E. Atkinson, 3rd edn. 2007, Wiley IndiaEdition.
• Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
• An Introduction to computational Physics, T.Pang, 2nd Edn., 2006,CambridgeUniv.Press.

Course Code: PHYS3044

Course Name: GE-Solid State Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Crystal Structure: Solids: Amorphous and Crystalline Materials, Lattice Translation Vectors, Lattice with a Basis – Central and Non-Central Elements, Unit Cell, Miller Indices, Reciprocal Lattice, Types of Lattices, Brillouin Zones, Diffraction of X-rays by Crystals, Bragg's Law. **(12 Lectures)**

UNIT-2: Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains, Acoustical and Optical Phonons, Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. **(14 Lectures)**

UNIT-3: Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials, 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. **(12 Lectures)**

UNIT-4: Dielectric Properties of Materials: Polarization, Local Electric Field at an Atom, Electric Susceptibility, Polarizability, Clausius-Mosotti Equation, Classical Theory of Electric Polarizability, Langevin-Debye equation, Complex Dielectric Constant, Optical Phenomena. **(12 Lectures)**

UNIT-5: B and Theory of Solids and Superconductivity: Conductors, Semiconductors and insulators and band gap, P and N type Semiconductors, Conductivity of Semiconductors, Hall Effect, Superconductivity: Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's Equation and Penetration Depth. **(10 Lectures)**

Reference Books:

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

List of Experiments:

1. Measurement of susceptibility of paramagnetic solution (Quincke'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 study the BH curve of iron using a Solenoid and determine the energy loss.
9. To measure the resistivity of a semiconductor (Ge) crystal 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:

• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

• A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.

• Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Course Code: PHYS3045

Course Name: GE-Quantum Mechanics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1:Time dependent Schrodinger equation: Time dependent Schrodinger equation Properties of Wave Function, Interpretation of Wave Function, Probability and probability current densities in three dimensions; Normalization, Linearity and Superposition Principles, Eigen values and Eigen functions, Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum, Wave Function of a Free Particle. **(12 Lectures)**

UNIT-2: Time independent Schrodinger equation: 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 Schrodinger equation in terms of linear combinations of stationary states; Position-momentum uncertainty principle. (**12 Lectures)**

UNIT-3: Simple harmonic oscillator-energy levels and energy eigenfunctions, Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; angular momentum operator and quantum numbers; Radial wave functions from Frobenius method; Orbital angular momentum quantum numbers: l and m; s, p, d,.. shells (idea only). **(12 Lectures)**

UNIT-4: Atoms in Electric and Magnetic Fields: Electron Angular Momentum, Electron Spin and Spin Angular Momentum, Spin Magnetic Moment, Stern-Gerlach Experiment, Zeeman Effect, Bohr Magneton, Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. **(12 Lectures)**

UNIT-5: Many electron atoms: Pauli's Exclusion Principle, Symmetric and 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. **(12 Lectures)**

Reference Books:

• A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Ed., 2010, Mc-Graw Hill.
• Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
• Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
• Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
• Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
• Quantum Mechanics for Scientists and Engineers, D.A.B. Miller, 2008, Cambridge University Press.

Additional Books for Reference

• Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
• Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education.
• Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.

List of Experiments:

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

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

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

Here, m is the reduced mass of electron. Obtain the energy eigenvalues and plot thecorresponding wavefunctions. Note that the ground state energy of hydrogen atomis ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511x10^6 eV/c^2.

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

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

where m is the reduced mass of the system (which can be chosen to be the mass ofan 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 threesignificant digits. Also, plot the corresponding wavefunction. Take e = 3.795$(eVÅ)^{1/2}$, m = 0.511x10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973(eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

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

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

For the anharmonic oscillator potential

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

for the ground state energy (in MeV) of the particle to an accuracy of threesignificant digits. Also, plot the corresponding wave function. Choose m = 940MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}In these units, cħ = 197.3MeV fm. The ground state energy I expected to lie between 90 and 110 MeVfor all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

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

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

$$V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right), \qquad r' = \frac{r - r_o}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy ofthree significant digits. Also plot the corresponding wave function.

Take: m = 940x10^6eV/c^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

Some laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of theresonance frequency

6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting

7. To study the quantum tunnelling effect with solid state device, e.g. tunneling current in backward diode or tunnel diode.

Reference Books:

• Schaum's Outline of Programming with C^{++}. J. Hubbard, 2000, McGraw-Hill Pub.

• Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press.

• Elementary Numerical Analysis, K.E. Atkinson, 3rdEd.2007, Wiley India Edition.

• Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific&Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer.

• Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444.

• Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.

• Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

Course Code: PHYS3046

Course Name: GE-Embedded System: Introduction to Microcontroller

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1: Embedded system introduction: Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges and design issues in embedded systems, operational and non-operational quality attributes of embedded systems, elemental description of embedded processors and microcontrollers. **(10 Lectures)**

UNIT-2: Review of microprocessors: Organization of Microprocessor based system, 8085µppin 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. **(10 Lectures)**

UNIT-3:8051 microcontroller: 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. **(14 Lectures)**

UNIT-4: 8051 I/O port programming: Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description and their functions, I/O port programming in 8051, (Using Assembly Language), I/O programming: Bit manipulation. **(12 Lectures)**

UNIT-5: Programming of 8051: 8051 addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, Arithmetic& logic instructions, 8051 programming in C: for time delay and I/O operations and manipulation, for arithmetic & logic operations, for ASCII and BCD conversions. **(12 Lectures)**

Reference Books:

• Embedded Systems: Architecture, Programming & Design, R. Kamal, 2008,Tata McGraw Hill

• 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.

• Embedded microcomputor system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole

• Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.

• Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education

• Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

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List of Experiments:

Following experiments using 8051:

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 smallestnumber and decreasing the largest number.
4. Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulatebinary 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 anddisplay '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 motorthrough a given angle in clock wise or counter clockwise direction.
11. Application of embedded systems: Temperature measurement, someinformation on LCD display, interfacing a keyboard.

Reference Books:

• Embedded Systems: Architecture, Programming & Design, R. Kamal, 2008, TataMc-Graw Hill.
• The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A.Mazidi, J.G. Mazidi, and R.D. Mc-Kinlay, 2nd Ed., 2007, Pearson Education.
• Embedded Microcomputor System: Real Time Interfacing, J.W. Valvano, 2000,Brooks/Cole.
• Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.
• Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011,Cengage Learning.

Course Code: PHYS3047

Course Name: GE-Nuclear and Particle Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Contents:

UNIT-1:General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve. **(12 Lectures)**

UNIT-2: Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, nuclear magic numbers, basic assumption of shell model. **(12 Lectures)**

UNIT-3: Radioactivity decay: Basics of α-decay processes, Gamow factor, Geiger Nuttall law, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission, internal conversion. **(10 Lectures)**

UNIT-4: Nuclear Reactions and Nuclear Detectors: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, Coulomb scattering (Rutherford scattering), Photoelectric effect, Compton scattering, pair production, Detector for Nuclear Radiations: Gas detectors, GM Counter, Scintillation Detectors, Semiconductor Detectors, **Particle Accelerators:** Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron. **(14 Lectures)**

UNIT-5: Particle Physics: Particle interactions; basic features, types of particles and its Families, Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Iso-spin, Strangeness and charm, concept of quark model, color quantum number and gluons. **(12 Lectures)**

Reference Books:

• Introductory nuclear Physics by Kenneth S.Krane (Wiley India Pvt. Ltd., 2008).
• Concepts of nuclear physics by Bernard L.Cohen. (Tata Mcgraw Hill, 1998).
• Introduction to the physics of nuclei & particles, R.A.Dunlap (Thomson Asia, 2004).
• Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
• Quarks and Leptons, F. Halzen and A.D.Martin, Wiley India, New Delhi.
• Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K.Heyde (IOP- Institute of Physics Publishing, 2004).
• Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
• Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991).

Course Code: PHYS3048

Course Name: GE-Optics and Modern Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Objective: *This course has been designed keeping in mind the requirements of the students with respect to the concept of Optics and Modern Physics (especially Quantum Mechanics) as its wide applicability in different branches of science.*

Course Contents:

UNIT-1:Interference

Interference: Division of amplitude and division of wavefront, Young's Double Slit experiment, Fresnel's Biprism, Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes), Michelson's Interferometer, Newton's Rings.

(12 Lectures)

UNIT-2: Diffraction

Fraunhofer diffraction at Single slit, Double Slit and N-slits, Diffraction Grating, Fresnel Diffraction: Half-period zones, Zone plate, Fresnel Diffraction pattern of a straight edge, a slit and a wire using Half-period zone analysis, Rayleigh criterion and Resolving power of Optical Instruments (Microscope, Prism and Grating). **(12 Lectures)**

UNIT-3: Polarization

Transverse nature of light waves, Brewster's law, Law of Malus, Double Refraction, Nicol Prism, Quarter wave and half wave plate, Production and detection of Plane, Elliptically and Circularly polarized light. **(12 Lectures)**

UNIT-4: Laser and Fibre Optics

Brief Introduction about LASER and its properties, Relation between Einstein's coefficients, Concept of three and four level Laser system, Ruby and He-Ne laser, Fundamental ideas about Optical Fibre, Numerical Aperture, Single and Multi-mode Fibres, Applications of Fibers. **(10 Lectures)**

UNIT-5: Modern Physics

Particle nature of matter: Quantum theory of light, Photoelectric effect, Compton Effect and pair production, Wave nature of matter: de-Broglie wavelength, phase velocity and group velocity, particle diffraction, Heisenberg uncertainty principle, Wave function, Physical significance of wave function, Schrödinger wave equations: Time independent and dependent forms, Particle in a box. **(14 Lectures)**

Text books:

1. Fundamentals of Optics by Jenkins and White, 1976, McGraw-Hill.
2. Concepts of Modern Physics by Arthur Beiser (Tata Mc-Ggraw Hill publications).
3. University Physics by F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley.
4. Optics by Ajoy Ghatak
5. Introduction to Fiber Optics by Ajoy Ghatak and K. Thyagarajan.
6. Lasers: Fundamentals and Applications by Ajoy Ghatak and K. Thyagarajan.

List of Experiments: GE-Optics and Modern Physics Lab

1. To determine the wavelength of sodium yellow line by Fresnel's Biprism.
2. To determine the specific rotation of cane sugar by Biquartzpolarimeter.
3. To determine the wavelength of sodium light using Newton's Rings.
4. To determine the dispersive power and Cauchy's constants of the material of a prism using mercury source.
5. To determine the wavelength of sodium source using Michelson's Interferometer.
6. To determine the wavelength of (i) sodium source and (ii) spectral lines of mercury source using plane diffraction Grating.
7. To determine the wavelength of Laser light using Diffraction of Single Slit.
8. To determine the resolving power of a Prism.
9. To determine the focal length of thin lenses and their combination by Nodal slide.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by wedge shaped film.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Course Code: PHYS3049

Course Name: GE-Elementary Physics

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *This course has been designed to teach the graduate students the basics of Newtonian mechanics, basics of solid state physics with emphasis on crystal structure, band formation in solids and Superconductors.*

Course Contents:

UNIT-1: Vector Analysis

Review of vector operations, Rectangular Cartesian co-ordinates, Spherical and cylindrical co-ordinate systems, Gradient, curl and divergence, Green's theorem, Gauss's divergence theorem and Stoke's theorem. **(10 Lectures)**

UNIT-2: Relativity

Frames of reference, Galilean Transformations, Ether hypothesis, Michelson-Morley Experiment, Einstein's postulates, Lorentz transformations, Length contraction and time dilation, Addition of velocities, Mass-energy equivalence relation, Relativistic mass (without derivation), Concept of zero rest mass. **(12 Lectures)**

UNIT-3: Rotational Motion

Rigid body, Torque, Angular momentum, Relation between torque and angular momentum, Moment of inertia, Radius of gyration, Centre of mass, theorem of moment of inertia, Moment of inertia of thin uniform rod, ring, circular disc, Relation between angular momentum and angular velocity, Conservation of angular momentum.

(13 Lectures)

UNIT-4: Crystallography

Crystalline and amorphous solids, Space lattice, Basis, Unit cell, Lattice parameter, Seven crystal systems and fourteen Bravais lattices, Crystal structure, Packing fraction (simple cubic, body centered and face centered), Crystal structure of NaCl and Diamond, lattice planes and Miller indices, Diffraction of X-rays by crystal, Bragg's law. **(13 Lectures)**

UNIT-5: Condensed Matter Physics

Types of bonding, Band theory of solids, Fermi level and Fermi energy, Drift velocity and mobility, Conductivity of semiconductors, Superconductors, Meissner effect, Types of superconductor, BCS theory. **(12 Lectures)**

Text books:

1. Mechanics: H.S. Hans and S.P. Puri (Tata Mcgraw Hill Publications).
2. Mechanics by J.C. Upadhyay
3. Fundamentals of Physics (10^{th} Edition) by Halliday, Resnick and Walker.
4. Concepts of Modern Physics by Arthur Beiser

5. Solid State Physics by Charles Kittel

List of Experiments: GE-Elementary Physics Lab 2 Credits

1. Determination of modulus of rigidity for a given wire by dynamical method using Maxwell needle
2. Determination of coefficient of viscosity for given liquid using Stoke's method
3. Determination of Young's modulus, modulus of rigidity and Poisson's ratio of given wire using Searle's dynamical method.
4. Determination of modulus of rigidity of a given wire and the moment of inertia of an irregular body with the help of torsion table.
5. Determination of acceleration due to gravity 'g' and the moment of inertia of a bar about center of gravity by means of bar pendulum.
6. Determination of restoring force per unit extension of a spiral spring by statical and dynamical method.

Text and Reference Books

1. GeetaSanon, B.Sc. Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. Practical Physics by R.K. Shukla and AnchalSrivastava (New Age International Publishers), ISBN: 978-81-224-2482-9.
3. B.L. Worsnop and H.T. Flint, Advanced Practical Physics, Asia Publishing House, NewDelhi.
4. InduPrakash and Ramakrishna, A Text Book of Practical Physics, KitabMahal, New Delhi.

Course Code: PHYS3050

Course Name: Mechanics and Special Theory of Relativity

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *This course is to introduce students to laws of mechanics, laws of motions, fluid mechanics and its applications to learn the fundamentals of this important topic. It describes the relative motion of different bodies in different frame of references. It will contain the calculations of differences in measured parameters from different frames of references at relative motion or at rest relative to each other.*

UNIT-1: Fundamental of Mechanics and Dynamics of Rigid Bodies (15 Lectures)

Inertial frames, Galilean transformation, Velocity and acceleration in rotating coordinate system, Coriolis force, Effect of rotation of earth on g, Foucault Pendulum, Center of mass (C.M), Lab and C.M frame of reference, motion of CM of system of particles subject to external forces, elastic, and inelastic collisions in one and two dimensions, Equation of motion of a rigid body, moment of inertia, products of moment of inertia, radius of gyration, theorems of parallel and perpendicular axes, moments of inertia of a ring, disc, rectangular beam, hollow and solid cylinders, spherical shell, solid and hollow spheres, moment of inertia of fly wheel, Compound pendulum.

UNIT-2: Elasticity (12 Lectures)

Hooke's Law, Elastic constants and their mutual relations, Modulus of rigidity, Poisson's ratio, Relation connecting different elastic-constants, Twisting couple of a cylinder(solid and hallow), Statical method (Barton's method), Dynamical method (Maxwell's needle) for determining the modulus of rigidity, Bending moment, Cantilever (neglecting mass), Young modulus by bending of beam, Torsion of cylinder.

UNIT-3: Work and Energy (10 Lectures)

Work and Kinetic Energy Theorem, Conservative and Non-conservative Forces, Potential Energy, Energy Diagram,Stable and Unstable Equilibrium, Gravitational Potential Energy, Elastic Potential Energy, Force as Gradient of Potential Energy, Work and Potential energy, Work done by Non-conservative Forces, Law of Conservation of Energy.

UNIT-4: Fluid Mechanics (10 Lectures)

Stream line motion, Reynold number, Poiseuille's equation, Stoke's law and terminal velocity, Surface tension and surface energy, Molecular interpretation of surface tension, Pressure over curved surfaces, Capillarity, Jager's method.

UNIT-5: Theory of Relativity (13 Lectures)

Special Theory of Relativity: Michelson-Morley experiment, Principle of simultaneity, postulates of special theory of relativity, Lorentz transformation,Physical significance of Lorentz invariance, Length contraction and time dilation, Addition of velocities, Doppler Effect, Aberration of light. Relativistic momentum, Variation of mass with velocity, Relativistic energy, Concept of zero rest mass of photon, Mass-Energy equivalence,

transformations of momentum and energy.

Text/Reference Books:

1. An introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973).
2. Mechanics Berkeley physics course, vol:1: By Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholz, Burton Moyer, (Tata McGraw-Hill, 2007).
3. Mechanics by D.S. Mathur (S. Chand & Company Limited, 2000).
4. Fundamentals of Physics (10^{th} Edition) Halliday, Resnick & Walker
5. University Physics by F.W. Sears, M.W. Zemansky and H.D. Young (Narosa Publishing House, 1982).
6. Mechanics by J.C. Upadhyay, Himalaya Publishing House.

List of Experiments Mechanics and Special Theory of Relativity Lab 2 Credits

1. Determination of modulus of rigidity for a given wire by dynamical method using Maxwell needle
2. Determination of acceleration due to gravity ‘g’ using Kater’s reversible pendulum
3. Determination of moment of inertia for a given fly wheel
4. Determination of coefficient of viscosity for given liquid using Stoke’s method
5. Determination of Young’s modulus, modulus of rigidity and Poisson’s ratio of given wire using Searle’s dynamical method.
6. Determination of modulus of rigidity of a given wire and the moment of inertia of an irregular body with the help of torsion table.
7. Determination of acceleration due to gravity ‘g’ and the moment of inertia of a bar about centre of gravity by means of bar pendulum.
8. Determination of restoring force per unit extension of a spiral spring by statical and dynamical method.
9. Determination of modulus of rigidity of a given wire by statical method using Barton’s apparatus having horizontal pattern
10. Determination of modulus of rigidity of a given wire by statical method using Barton’s apparatus having vertical pattern

Course Code: PHYS3051

Course Name: Engineering Physics-I

Credits Equivalent: 4 (3L + 1P) Credits

Course Objectives: *At the end of the course, the students will have sufficient scientific understanding of different phenomena associated with wave optics, theory of relativity and modern physics.*

UNIT-1: Interference (8 Lectures)

Phenomenon of Interference: Quantitative Analysis of Interference, Classification of Interference, Intensity distribution of fringe system, Fresnel's Biprism, Newton's Rings, Michelson Interferometer and its application, Possible Technological Applications of Interferometry

UNIT-2: Diffraction (8 Lectures)

Diffraction of Light: Classification of Diffraction: Fresnel & Fraunhofer type, An Elaborate Analysis of Fraunhofer Type Diffraction, Diffraction from Single & Double Slits and Diffraction Grating, Possible Technological Applications of Diffraction.

UNIT-3: Polarization (8 Lectures)

Phenomenon of Polarization: Fundamental Ideas of Polarization in Waves, Phenomenological understanding of Birefringence, Uniaxial crystals, Polarizers, Compensators and Wave Plates, Production and analysis of completely polarized light, Optical Activity, Applications of Polarization

UNIT-4: Special Theory of Relativity (8 Lectures)

Concept of Frame of Reference, Newtonian Relativity and Galilean Transformation, Michelson-Morley experiment, Lorentz's Transformation, Relativistic Addition of Velocities, Variation of mass with velocity and derivation of famous equation $E = mc^2$

UNIT-5: Modern Physics (13 Lectures)

Maxwell-Boltzmann distribution, Bose-Einstein Statistics, Fermi-Dirac Statistics, Applications of the above mentioned distributions, Black-Body Radiation, Wein's law, Rayleigh Jean's law, Planck's Law of Radiation, Compton Scattering, Origin of Spectral Lines, Basic Ideas of Spin Angular Momentum, Bohr's Atomic Model and quantum numbers, Atoms under the influence of magnetic field: Zeeman effect, Principle and Working of LASER, Types of LASERS (He-Ne Laser, Ruby Laser, Semiconductor Laser) and a brief introduction to Holography.

List of Experiments

1. To determine the wavelength of light using Newton's rings apparatus.
2. Determination of wavelength of Light by Fresnel's Biprism.
3. Optical Activity of a sugar solution.
4. To determine the wavelength of the given source using the Michelson interferometer.
5. To determine the dispersive power and Cauchy's constants of the material of a prism using mercury source.
6. To determine the wavelength of (i) sodium source and (ii) spectral lines of mercury and (iii) Laser source using plane diffraction grating.

Text /Reference Books:

1. Optics By: Ajoy Ghatak
2. Perspectives of Modern Physics, or Concepts of Modern Physics, By: Arthur Beiser
3. Introduction to Special Relativity By: R. Resnick
4. Schaum's Outline of Theory and Problems of Modern Physics
5. Fundamentals of Statistical and Thermal Physics, F. Reif, McGraw-Hill

Course Code: PHYS3052

Course Name: Engineering Physics-II

Credits Equivalent: 4 (3L + 1P) Credits

Course Objectives: *At the end of the course, the students will have sufficient scientific understanding of different phenomena associated with Electromagnetic theory, thermodynamics, quantum mechanics, solid state physics and band theory of solids.*

UNIT-1: Electromagnetic Theory (12 Lectures)

Vector Calculus: Gradient, Divergence and Curl; Line, Surface and Volume integrals. Gauss's divergence theorem and Stokes' theorem in Cartesian coordinates, Gauss's law and its applications, Laplace and Poisson's equations, Biot-Savart law, Ampere's law, Maxwell's equations, EM wave equation, Polarization of EM waves, superposition, wave packets, Poynting vector and Poynting theorem, electromagnetic boundary conditions, Propagation of EM waves for normal and oblique incidence and total internal reflection.

UNIT-2: Thermodynamics (8 Lectures)

Zeroth and first law of thermodynamics, Specific heat relation, gas equation during an adiabatic process, Work done during an isothermal and adiabatic process, second law of thermodynamics, concept of entropy, calculation of entropy for an ideal gas, Reversible and irreversible processes, Carnot cycle and Carnot engine, refrigerator, phase transitions, Clausius-Cleyperon equation, Thermodynamic Potentials.

UNIT-3: Quantum Mechanics (10 Lectures)

Failure of classical physics:- qualitative review of relevant experiments, de Broglie waves, interpretation of Bohr's quantization rule, Concepts of wave packet, Heisenberg uncertainty principle and experimental illustration, applications of uncertainty principle, Time-independent and time-dependent Schrodinger wave equation, Physical significance of wave function, Normalized and orthogonal wave functions, Probability interpretation, Operator algebra, Eigenvalues and Eigenfunctions, expectation value, Particle in one dimensional box and its extension to 3-dimensional box, potential barrier, Qualitative summary of Harmonic oscillator and Hydrogen atom.

UNIT-4: Crystal Structure (05 Lectures)

Concepts of Lattice points, space lattice, Basis, crystal structure, unit cell, crystal systems and Bravais space lattice, coordination number, atomic packing factor,calculation of lattice constant, lattice planes and Miller indices, Bragg's law.

UNIT-5: Band Theory of Solids (10 Lectures)

Bonding in solids, Electronic conduction in metals, classical and quantum theory of free electrons, band theory of solids, Kronig-Penny model and its interpretation, Brillouin zones, distinction between metals, semiconductors and insulators, Basics of semiconductors, Fermi level and energy band diagram in semiconductor, effect of temperature on extrinsic semiconductor, Electrical conductivity of intrinsic semiconductor and extrinsic semiconductor, Hall effect and its applications

List of Experiments

1. Magnetic Field Variation by Helmholtz Galvanometer.
2. To determine charge to mass ratio of electron by Thomson's Method.
3. To determine the thermal conductivity of bad conductors by Lee's method

4. To calculate the Hall coefficient and the charge carrier concentration of the given material.
5. To study the temperature variation of electrical resistivity of a semiconducting materials using four-probe technique and to estimate their band gap energy.
6. To determine the value of Planck's constant (h) using h/e (photoelectric effect) apparatus.
7. Franck-Hertz Experiment.

Text /Reference Books:

1. Introduction to Electrodynamics By: David J. Griffiths
2. Heat and Thermodynamics: Mark Waldo Zemansky, Richard Dittman
3. Concepts of Modern Physics By: Arthur Beiser
4. Introduction to Solid State Physics, By: Charles Kittel
5. Schaum’s Outline of Theory and Problems of Quantum Mechanics
6. Schaum’s Outline of Theory and Problems of Electromagnetics

Course Code: PHYS3053

Course Name: Electrical and Electronics Engineering

Credits Equivalent: 4 (3L + 1P) Credits

Course Objectives: *The course is designed to understand the basic concepts of magnetic, AC & DC circuits and learn the basics of semiconductor diodes, BJTs and FETs to analyze basic electrical and electronic circuits.*

UNIT- 1: Basics of Electrical Components
Resistors, Capacitors, Inductors, Motors, Transformers, Generators. **(5 Lectures)**

UNIT- 2: DC and AC Circuits
Kirchhoff's Law, Star-Delta Transformation, Superposition, Thevenin's, Norton's and Reciprocity Theorem, Maximum Power Transfer Theorem, RL, RC and LCR circuits, Phasor representation, Response of RL, RC and LCR circuit to sinusoidal input, Resonance in LCR Circuits, Q-factor, Bandwidth. **(15 Lectures)**

UNIT- 3: Magnetic Circuits
Magnetomotive Force, Magnetic Field Strength, Permeability, Reluctance, Permeance, Analogy between Electric and Magnetic Circuits. (**3 Lectures)**

UNIT-4: Semiconductor Devices
PN Junction, Barrier Formation in PN Junction Diode, Static and Dynamic Resistance, Barrier Potential, Barrier Width, Half-wave and Full Wave Rectifiers, C-filter, Zener Diode and Voltage Regulation, Principle and structure of LEDs, Photodiode and Solar Cells, Varactor, Transistors, Amplifier. **(15 Lectures)**

UNIT- 5: Digital Electronics
Logic gates and Boolean algebra, combinational circuits: adder, decoder, encoder, multiplexer and demultiplexer; sequential circuits: flip-flops-SR, D, JK and T, counters and shift registers. **(7 Lectures)**

List of Experiments

1. Verification of Thevenin's / Nortan's theorem.
2. Verification of Superposition theorem and reciprocity theorem.
3. To study resonance condition in LCR circuit
4. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
5. To study the characteristics of a BJT.
6. To design a combinational logic system for a specified Truth Table.
7. To build Flip-Flop (RS and JK) circuits.

Text /Reference Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, PHI Learning.
3. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.
4. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.
5. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson.
6. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
7. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Tata McGraw-Hill Publications.

Course Code: PHYS3054

Course Name: GE-Optics and Optical Instruments

Credits Equivalent: 6 (4L + 2P) Credits

UNIT-1: Reflection and Refraction of light: Sign convention, Snell's law of refraction, Total internal reflection and its application, Lens maker's formula, Power of lens, combination of lenses. **(10 Lectures)**

UNIT-2: Dispersion and Scattering of Light: Dispersion of light through Prism, Spectrometer, Spherical and chromatic aberration, Scattering of light in atmosphere. **(11 Lectures)**

UNIT-3: Electromagnetic Waves: Light as wave, Huygen's wave theory, Interference: Young's double slit experiment, Diffraction of light, Maxwell's theory of electromagnetic waves, Properties of electromagnetic waves, Electromagnetic spectra, Propagation of electromagnetic waves. **(12 Lectures)**

UNIT-4: Polarization and Modern Optics: Production and detection of linearly and circularly polarized light, Double refraction, retardation plates (half wave and quarter wave plate), Principles of fiber optics, LASER: Einstein's 'A' and 'B' coefficient, Ruby and He-Ne Laser, Spatial and temporal coherence. **(15 Lectures)**

UNIT-5: Optical Instruments: Compound Microscope and its magnifying power, Telescope, Rayleigh criterion of resolution, Resolving power, Resolving power of eye, telescope and microscope. **(12 Lectures)**

Reference Books:

1. Fundamentals of Optics, H.E. White
2. Optics, Brijlal and Subrahmanyam, S. Chand Publications.
3. Optics, Ajoy Ghatak
4. Optoelectronics, Ajoy Ghatak and K. Thyagrajan
5. Engineering Physics, H.K. Malik and A.K. Singh, McGraw Hill Education Pvt. Ltd.

List of Experiments: GE-Optics and Optical Instruments

1. To determine the wavelength of sodium yellow line by Fresnel's Biprism.
2. To determine the specific rotation of cane sugar by Biquartz polarimeter.
3. To determine the wavelength of sodium light using Newton's Rings.
4. To determine the wavelength of sodium source using Michelson's Interferometer.
5. To determine the wavelength of (i) sodium source and (ii) spectral lines of mercury source using plane diffraction Grating.
6. To determine the wavelength of Laser light using Diffraction of Single Slit.
7. To determine the focal length of thin lenses and their combination by Nodal slide.
8. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by wedge shaped film.

Course Code: PHYS3055

Course Name: GE-Semiconductors and their Applications

Credits Equivalent: 6 (4L + 2P) Credits

UNIT-1: Basics of Semiconductors: Energy band in Solids, Conductors, Insulators and semiconductors, charge carriers in semiconductors (Holes & Electrons), Intrinsic and extrinsic semiconductors. **(12 Lectures)**

UNIT-2: Semiconductor Devices: P-N junction diode, characteristic of P-N junction diode, Zener diode, LED, Solar cell, Photodiode, Transistor (p-n-p and n-p-n), characteristics of a transistor. **(15 Lectures)**

UNIT-3: Applications of Semiconductor Device: P-N junction diode as a rectifier, Transistor as an amplifier, RC coupled CE amplifier, Transistor as a switch. **(10 Lectures)**

UNIT-4: Oscillators and its applications: Barkhausen's criteria of sustained oscillation, LC tuned collector oscillator, Kinds of modulations (AM, FM and PM), AM transmitter (block diagram and function of different blocks). **(12 Lectures)**

UNIT-5: Digital Electronics: Binary system, Boolean algebra, Logic gates and their realization (OR, AND, NOT, NAND, NOR), Combinational and sequential circuits. **(11 Lectures)**

Reference Books:

1. Physics of Semiconductor Devices, S.M. Sze, Wiley Publications, 2007.
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, 6th Edition, 2009, PHI Learning.
4. Introduction to Semiconductor Materials and Devices, M.S. Tyagi, Wiley Publications, 2002.
5. Electronics: Fundamentals and Applications, D. Chattopadhyay and P.C. Rakshit.

List of Experiments

1. Determination of energy band gap of a semiconductor.
2. To study the V-I characteristics of a P-N junction diode.
3. To study resonance condition in LCR circuit.
4. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
5. To study the characteristics of a BJT.
6. To design a combinational logic system for a specified Truth Table.
7. To build Flip-Flop (RS and JK) circuits.

Course Code: PHYS3056

Course Name: GE-Atoms and Nuclei

Credits Equivalent: 6 (4L + 2P) Credits

UNIT-1: Structure of Atom: α-particle scattering and Rutherford's atomic model, Bohr's atomic model, energy levels and Hydrogen spectrum. **(12 Lectures)**

UNIT-2: Photoelectric Effect and Matter Waves: Photoelectric effect, Photocell and its applications, Wave nature of matter, de Broglie's waves: Davisson and Germer experiment. **(12 Lectures)**

UNIT-3: Nuclei and Radioactivity: Concept of Nucleus, static properties (size, spin, magnetic moment) of nucleus, Isotopes, Mass defect and binding energy, α-, β-decay and γ-emission, half life and decay constant of nuclei, Liquid drop model, Semi-empirical mass and binding energy formula. **(15 Lectures)**

UNIT-4: Nuclear Fission and Fusion: Fission reaction, Fusion reaction, Nuclear reactor, Nuclear pollution. **(10 Lectures)**

UNIT-5: Elementary Particles: Interaction of charge particles with matter, Laptons, Hadrons, Quarks- charm, bottom and top quarks, elementary particle quantum numbers. **(11 Lectures)**

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, Mc Graw Hill International, 1987.
2. Atomic and Nuclear Physics, S.N. Ghosal, Vol. 2.
3. Introductory Nuclear Physics, K.S. Krane, 3rd Edition.
4. Introduction to Elementary Particles, D. Griffiths, Harper & Row, New York, 1987.
5. Nuclear Physics, I. Kaplan, 2nd edition, Narosa, Madras, 1989.
6. Nuclear & Particle Physics, D.C. Tayal.
7. Concepts of Nuclear Physics, B.L. Cohen, Tata McGraw Hill, Bombay, 1971.

Course Code: PHYS3057

Course Name: GE-Mechanics and Properties of Matter

Credits Equivalent: 6 (4L + 2P) Credits

UNIT-1: Newton's Laws of motion, Concept of force and inertia, conservation of linear momentum, Friction, Projectile motion, centripetal acceleration, Relation between velocity and angular velocity. **(10 Lectures)**

UNIT-2: Kepler's laws, Motion of planets, orbital and escape velocity, Satellites – geostationary, weightlessness, Rigid body motion, center of mass, couple and Torque, Moment of inertia, Angular momentum and its conservation, Rotational and translational motions with example (motion of ball, cylinder, flywheel on an inclined plane.

(15 Lectures)

UNIT-3: Work done by a constant force, Work-energy relation, Conservative and non-conservative force, Mechanical energy (kinetic and potential), Conservation of energy, Elastic and inelastic collision, Power and its units. **(10 Lectures)**

UNIT-4: Elastic properties and Hooke's law, Young's modules, Bulk modulus, modulus of rigidity and compressibility, Cantilever, Cohesive and Adhesive force, Surface energy and surface Tension, Angle of contact and capillary action, Types of liquid flow-laminar and turbulent, Reynold's number, Viscosity and Stoke's law. **(15 Lectures)**

UNIT-5: Kinetic theory of gases, Kinetic energy and temperature relationship, Law of equipartition of energy, Specific heat of gases, Specific heats C_p and C_v and their relationship, Mean, RMS and Most Probable Speeds, Van der Waal's equation of state.

(10 Lectures)

Reference Books:

1. An introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973).
2. University Physics with Modern Physics, Young & Freedman, 12th Edition.
3. Fundamentals of Physics (10th Edition) Halliday, Resnick & Walker
4. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
5. Mechanics, J.C. Upadhyaya, Himalaya Publication.
6. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill.

List of Experiments:

1. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
2. To determine the Moment of Inertia of a Flywheel.
3. To determine Coefficient of Viscosity of water by Capillary Flow Method.
4. To determine the elastic Constants of a wire by Searle's method.
5. To determine the value of g using Bar Pendulum.

6. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
7. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
8. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
9. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.

Course Code: PHYS3058

Course Name: GE-Physics of Technologically Important Materials

Credits Equivalent: 6 (4L + 2P) Credits

Course Objectives: *To acquire basic understanding of advanced materials, their functions and properties for technological applications.*

UNIT-1: Semiconductors: Energy band in Solids, Conductors, Insulators and semiconductors, charge carriers in semiconductors (Holes & Electrons), density of states, Intrinsic and extrinsic semiconductors, Fermi level.

UNIT-2: Dielectric and Magnetic Properties of Materials: Dielectric constant, Types of polarization, Clausius-Mossotti equation, Ferroelectricity, P-E loop, Magnetization, origin of magnetic moment, Dia-, para and ferromagnetic materials, Hysteresis phenomenon and applications.

UNIT-3: Superconductivity: Introduction, Properties of superconductors: Meissner effect, Classification of superconductors, London equation, Isotope effect, Cooper pair, Application of Superconductors.

UNIT-4: Nanophysics: Basic principle of nanoscience and nanotechnology, properties of nanoparticles, Synthesis and characterization of nanomaterials (basic idea), Carbon Nanotubes (CNT), Magnetic thin films, Application of nanotechnology.

UNIT-5: Functional Materials: Smart materials, Shape memory alloys, phase change memory materials, Chromic materials (Thermo, Photo and Electro-), Metallic glasses, Advanced ceramics, Composites.

Reference Books:

1. Elementary Solid State Physics: Principles and Applications, M. Ali Omar, Addison-Wesley, 1975.
2. Introduction to Solid State Physics, Charles Kittel.
3. Solid State Physics: Structure and Properties of Materials, M.A. Wahab, Narosa Publishing House, 1999.
4. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, Wiley Publication.
5. Nanoscale Magnetic Materials and Applications, J.P. Liu, E. Fullerton, D.J. Sellmyer, Springer Publications.
6. Encyclopedia of Nanoscience.

List of Experiments:

1. Measurement of dielectric constant of an insulating material.

2. Magnetic susceptibility
3. Hysteresis curve of a ferromagnetic material
4. Electrical conductivity using four-probe method
5. Piezoelectric effect