Integrated B.Sc.+ M.Sc. Physics- 5 years

Program structure for B.Sc.+M.Sc. Physics Integrated-5 years (All Semesters)

Semester-Wise Programme structure for B.Sc. Physics [3 year]										
Sr. No.	Year 1		Year 2							
	Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8	Semester 9	Semester 10
1	ELECTRICITY AND MAGNETISM-I (PHY10) [CU:4; L-3, P-1] {CC}	ELECTRICITY AND MAGNETISM-II (PHY112) [CU:4; L-3, P-1] {CC}	SPECIAL THEORY OF RELATIVITY [CU:4; L-3, T-1] {CC}	ELECTRO-MAGNETIC THEORY [CU:4; L-3, P-1] {CC}	NUCLEAR PHYSICS [CU:4; L-4, P-0] {CC}	PARTICLE PHYSICS [CU:4; L-4, P-0] {CC}	CLASSICAL MECHANICS [**CU:4,** L-4, P-0] {CC}	CLASSICAL ELECTRODYNAMICS [**CU:4,** L-4, P-0] {CC}	NUCLEAR PHYSICS [**CU:4,** L-4, P-0] {CC}	ASTRO/NANO/RADIAT PHYSICS/ADVANCED MATHEMATICAL [**CU:4,** L-4, P-0]
2	Mechanics (PHY105) [CU:4, L-3, P-1] {CC}	OSCILLATIONS AND WAVES (PHY111) [CU:4; L-3, P-1] {CC}	ELEMENTS OF MODERN PHYSICS [CU:4; L-3, P-1] {CC}	THERMAL PHYSICS [CU:4; L-3, P-1] {CC}	Solid State Physics [CU:6; L-4, P-2] {CC}	Statistical Physics [CU:6; L-4, P-2] {CC}	STATISTICAL MECHANICS (P [**CU:4,** L-4, P-0] {CC}	ADVANCED MATHEMATICAL METHODS [CU:4, L-4, P-0] {CC}	PARTICLE PHYSICS [**CU:4,** L-4, P-0] {CC}	ADVANCED PARTICLE PHYSICS [**CU:4,** L-4, P-0] {CC}
3				QUANTUM PHYSICS [CU:4; L-3, P-1] {CC}	ANALOG SYSTEMS AND APPLICATIONS [CU:6, L-4, P-2] {SE}	DIGITAL SYSTEMS AND APPLICATIONS s [CU:6, L-4, P-2] {SE}	QUANTUM MECHANICS [**CU:4,** L-4, P-0] {CC}	Research Methodology [**CU:4**, L-4, P-0]	CONDENSED MATTER PHYSICS-II [**CU:4,** L-4, P-0]	ADVANCED NUCLEAR PHYSICS [**CU:4,** L-4, P-0] {CC}
4	MATHEMATICAL PHYSICS-I (PHY 104) [CU:4; L-3, P-1]	MATHEMATICAL PHYSICS-II [CU:4; L-3, P-1]	OOPs USING C++ [CU:4; L-3, P-1]	PROGRAMMING IN PYTHON [CU:4; L-3, P-1]	DATA SCIENCE AND ANALYTICS [CU:6; L-4, P-2]	ASTRO/BIO/NANO [CU:6; L-4, P-2]	ELECTRONICS [**CU:4,** L-4, P-0] {CC}	COMPUTATIONAL PHYSICS [**CU:4,** L-2, P-2]	ATOMIC AND MOLECULAR PHYSICS [**CU:4,** L-4, P-0]	ARTIFICIAL INTELLIGE AND MACHINE LEARNING/BIOPHYSIC MEDICAL PHYSICS/MC

5	VAC: 3Cr EVS-2Cr BS-1Cr	VAC: 3Cr EVS-2Cr BS-1Cr					PHYSICS LABORATORY [**CU:4,** L-0, P-4] {SEC}	QUANTUM FIELD THEORY [**CU:4**, L-4, P-0]	RESEARCH BASED COURSE [**CU:8**] {NTCC}	RESEARCH BASED COURSE [**CU:8**] {NTCC}
6	AECC : 2Cr FBL-1Cr HCP/Punjabi-1C	AECC : 2Cr FBL-1Cr HCP/Punjabi-1Cr	AECC : 2Cr CS-2Cr	AECC : 2Cr CS-2Cr			NUMERICAL METHODS AND ANALYSIS [**CU:4,** L-2, P-2]	PHYSICS LABORATORY [**CU:4,** L-0, P-4] {SEC}		
7	SEC1: 3Cr Basic of Computational physics (PHY 106)	SEC2: 3Cr Renewable energy & Harvesting CU:3, L-2, P-0] {SEC}	SEC3: 3Cr Basic Instrumentation Skills [CU:3, L-2, P-1] {SEC	SEC4: 3Cr Electrical circuits & Network Skills [CU:3, L-2, P-1] {SEC			VAC [**CU:2,** L-2, P-0] {CC}	VAC [**CU:2,** L-2, P-0] {CC}		
8	General Chemistry [CU:3, L-2, P-1] [MD]	Weather Forecasting [CU:3, L-3, P-0] [MD]	MOOC	Internshi of 4 Cr						
Credits	**23**	**23**	**20**	**21**	**22**	**22**	**26**	**26**	**24**	**24**

Total Credit:279 Credit Layout as per Curriculum and Credit Framework Guidelines - UGC 2022

AC	**Allied Course**
AEC	**Ability Enhancement Course**
CC	**Core Course**
GE	**General Elective**
OE	**Open Elective**
SC	**Skill component**
SE	**Specialization Elective Course**
SEC	**Skill Enhancement Course**
VAC	**Value Added Course**

MOOC	**MOOC Courses**							

List of MOOC Courses:

Sem.	MOOC COURSES	Lecture (L)	Tutorial (T)	Practical P	Contact Hour	Credits
MOOC-I	Introduction to LASERS	3	0	0	3	3
MOOC-II	Applied Optics	3	0	0	3	3

Core Course (PH): Electricity and Magnetism I

L	T	P	Total Credits
3	**0**	**1**	**4**

Electricity and Magnetism I	**Theory:54 h, Pract:36h**

Course Outcomes

CO1	Explanation on the knowledge of mathematics required to learn electrostatics and magnetostatics
CO2	Explanation of differential analysis of the electric force and field vectors as well as on scalar quantities such as potential and potential energy
CO3	Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential. Demonstrate a working understanding of capacitors

CO4	Understand the dielectric properties, magnetic properties of materials and the phenomena of electromagnetic induction
CO5	Understanding on magnetostatics and its applications

Unit-1-Mathematical tools	**Lectures: 13 h**
Complex Numbers : Real and imaginary parts, complex plane, polar representation, conjugation, Vector Algebra, Vector Calculus : scalar and vector fields, Derivatives, gradient, Del operator, divergence and curl of a vector field, integrals : line, surface and volume, The Fundamental Theorem: Gauss, Stokes and Green, Introduction to Spherical and Cylindrical Coordinates, Dirac Delta Function	
Unit-2- Electrostatics	**Lectures: 14 h**
Concept of charge, Coulomb's Law for point charges and continuous distribution of charges, Electric field (due to point charges, group of point charges, distributed charges) and field lines, Electric flux, Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry, differential form of Gauss law, conservative nature of electric field, Electric potential and its relation with electric field and electric potential energy, Laplace's and Poisson equations, Electric Field and potential of a dipole. Force and Torque on a dipole, Electrostatic energy of the system of charges, charged sphere.	
Unit-3- Introduction to Magnetostatics	**Lectures: 14 h**
Lorentz Force Law, Biot-Savart Law and its simple applications: straight wire, circular loop, solenoid and toroid, cyclotron and cycloid motion, work done by magnetic force, force between parallel current carrying wires, Force on Current-carrying Conductor Placed in a Magnetic Field, Torque on a current Loop, Current Loop as a Magnetic Dipole,. Ampere's Circuital Law and its applications, curl and divergence of B, Vector Potential, Magnetic Properties of Matter: Magnetization vector (M). Magnetic Intensity	

(H). Magnetic Susceptibility and permeability. Relation between B, H, M. Magnetic materials (Dia, para and ferro), Superconducting materials	
Unit-4- Electromagnetic Induction	**Lectures: 13 h**
Faraday's law of electromagnetism and their differential forms, direction of induced e.m.f., self and mutual inductance, coefficient of coupling, inductors in series and in parallel, energy stored in magnetic field, current growth and decay in inductive circuits, eddy currents, Displacement currents, introduction to Maxwell's equations	

Practicals	**72 hours**
Objective: The aim of this section of the course is to build an understanding about various components of an electrical circuit and to develop skill to measure the related physical quantities. ● Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and I Checking electrical fuses. ● To determine an unknown Low Resistance using Potentiometer. ● To determine an unknown Low Resistance using Carey Foster's Bridge. ● Measurement of field strength B and its variation in a solenoid (determine dB/dx) ● To determine the value of an air capacitance by de-Sauty Method and to find permittivity of air. To determine the dielectric constant of a liquid. ● To verify the Thevenin and Norton theorems. ● To verify the Superposition, and Maximum power transfer theorems. ● To determine self-inductance of a coil by Anderson's bridge. ● To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width. ● Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer ● Determine a high resistance by leakage method using Ballistic Galvanometer. ● To determine self-inductance of a coil by Rayleigh's method. ● To determine the mutual inductance of two coils by Absolute method. ● To determine the frequency of A.C. mains using sonometer. ● To measure iophys e.m.f. of a thermocouple as a function of temperature and find inversion temperature.	

- To study C.R.O. as display and measuring device by recording sines and square waves, output from a rectifier, verification (qualitative) of law of electromagnetic induction and frequency of A.C. mains.
- To plot the Lissajous figures and determine the phase angle by C.R.O.
- To study B-H curves for different ferromagnetic materials using C.R.O.
- Determination of low inductance by Maxwell-Wein bridge.
- Studies based on LCR Board: Impedance of LCR circuit and the phase and between voltage and current.

Text/Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Edward M. Purcell	Electricity and Magnetism	Tata McGraw-Hill	1986	978-1107014022
D.J. Griffiths	Introduction to Electrodynamics	Cambridge University Press	1998	978-1108822909
R.P. Feynman, R.B. Leighton, M. Sands	Feynman Lectures Vol.2	Pearson Education	1981	978-1842652497
Matthew N.O. Sadiku	Elements of Electromagnetics	Oxford University Press	2010	978-0199461851
S. Mahajan and Choudhury	Electricity, Magnetism & Electromagnetic Theory	Tata McGraw	2012	978-1259004599

Course Title: PHY105 (Mechanics)

L	T	P	Total Credits
3	0	1	4

Course Outcomes

CO1	Students must get the ability to understand the fundamentals of dynamics with the revision of Newton's laws of motion and their applications in various advanced dynamical situations. The ability to explain different reference frames and accordingly the various conservation theorems
CO2	Understanding the transition from single particle to the system of particles, concept of centre of mass and collisions
CO3	Learning of the expressions of Moment of Inertia for different- different uniformly distributed mass systems with the application of parallel and perpendicular axis theorems
CO4	Understanding the general properties of matter such as fluid motion (principle and governing equations), elasticity, modulus of elasticity and rigidity
CO5	Understanding of central force field and gravitational law to define the motion of planets and satellites

Course Contents/syllabus:

	Time (H)
Unit I: Particle Dynamics	**14**
Reference frames. Inertial frames; Review of Newton's Laws of Motio Galilean transformations; Galilean invariance. Momentum of variable-ma system: motion of rocket. Motion of a projectile in Uniform gravitational fie Dynamics of a system of particles. Centre of Mass. Principle of conservation	

momentum. Impulse. Work and Energy: Work and Kinetic Energy Theorem. Conservative and no conservative forces. Potential Energy. Energy diagram. Stable and unstab equilibrium. Elastic potential energy. Force as gradient of potential energ Work & Potential energy. Work done by non- conservative forces. Law Conservation of Energy, Collisions: Elastic and inelastic collisions betwee particles. Centre of Mass and Laboratory frames	
Unit II: Rotational Dynamics	13
Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.	
Unit III:Fluid Motion & Elasticity	13
Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Hooke's law Stress strain diagram,Elastic moduli, Relation between Elastic constants. Twisting torque on a Cylinder or Wire	
Unit IV: Gravitation and Central Force Motion	14
Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	
Practicals	**72 hours**
List of Experiments -with basic instructions ● Use of Vernier callipers, Screw gauge, Spherometer, Barometer, Sphygmomanometer, Lightmeter, dry and wet thermometers, TDS/conductivity meter and other measuring instruments based on applications of the experiments.	

Use of Plumb line and Spirit level.

- To study the random error in observations.
- Determination of height (of inaccessible structure) using sextant.
- To study the Motion of Spring and calculate (a) Spring constant, (b) g and © Modulus of rigidity.
- To determine the Moment of Inertia of a Flywheel.
- To determine g and velocity for a freely falling body using Digital Timing Technique.
- To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
- To determine the value of g using Kater's Pendulum.
- To study the variation of time period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
- Determination of coefficient of viscosity of a given liquid by Stoke's method. Study its temperature dependence.
- To determine the Young's Modulus of a Wire by Optical Lever Method.
- To determine the Young's modulus by (i) bending of beam using traveling microscope/laser, (ii) Flexural vibrations of a bar.
- Determination of modulus of rigidity by (i) dynamic method Maxwell's needle/Torsional pendulum; (ii) Forced torsional oscillations excited using electromagnet.
- To determine the elastic Constants of a wire by Searle's method.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Kittel, C. and Knight, W.	Mechanics, Berkeley Physics, vol.1	Tata McGraw-Hill	2007.	978-0521198110

Feynman, Leighton and M. Sands	Feynman Lectures, Vol. I	Pearson Education	2008	9780465023820
Kleppner, D Kolenkow, R J	An introduction to mechanics	Mcgraw hill	2017	978-0521198110
Mathur, D S	Mechanics	S Chand	1981	9788121905992
Flint, B L Worsnop, T	Advanced practical physics for students	Asia Publishing House	1971	978-0423738902

Course Title: PHY104 (Mathematical Physics-I)

L	T	P	Total Credits
3	0	1	4

Course Outcomes

CO1	Revision of vectors, calculus, vector calculus, probability and statistical distribution functions
CO2	Understand the differential equation applications to many Physics problems
CO3	Appreciates the physics behind the vector differentiation, vector integrations and its analogy
CO4	Learning of Cartesian, spherical and cylindrical coordinate systems
CO5	Introduce the concept of Dirac delta functions which have applications in quantum mechanics

Course Contents/syllabus:

	Time (H)
Unit I: Vectors, Limits and Probability	8
Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area & volume respectively. Scalar and Vector fields. Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only).	
Unit II: Introduction to Probability	4
Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.	
Unit III: Ordinary Differential Equations	15
First Order and Second Order Differential equations: First Order Differenti Equations and Integrating Factor. Homogeneous Equations with consta coefficients. Wronskian and general solution. Statement of existence Uniqueness Theorem for Initial Value Problems. Particular Integra Calculus of functions more than one variable: Partial derivatives, exact and inexact differential	

Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.	
Unit IV: Vector Calculus	18
Vector Differentiation: Directional derivatives and normal derivatives. Gradie of a scalar field and its geometrical interpretation. Divergence and curl of vector field. Del & Laplacian operators. Vector identities. Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobia Notion of infinitesimal line, surface and volume elements. Line, surface ar volume integrals of Vector fields. Flux of a vector field. Gauss' divergen theorem, Green's and Stokes Theorems and their applications (no rigoro proofs).	
Unit-5- Orthogonal Curvilinear Coordinates	6
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Cu and Laplacian in Cartesian, Spherical and Cylindrical Coordinate System Components of Velocity and Acceleration in Cylindrical and Spheric Coordinate Systems.	
Unit-6- Dirac Delta function and its Properties	3
Definition of Dirac delta function. Representation as limit of a Gaussian functi and rectangular function. Properties of Dirac delta function	
Practicals	**36 hours**
List of Experiments -with basic instructions ● Introduction: Computer architecture and organization, memory and Input/output devices. ● Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods ● Errors and error Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations.	

- C & C++ Programming fundamentals: Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements). (If statement. If else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.
- Programs: Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
- Random number generation: Area of circle, area of square, volume of sphere, value of pi (**π).**
- Solution of Algebraic and Transcendental equations: Using Bisection, Newton Raphson and Secant methods find the Solution of linear and quadratic equation and solve $\alpha = \tan\alpha$; $I = I_o \left[\frac{\sin\alpha}{\alpha}\right]^2$ in optics
- Solution of Ordinary Differential Equations (ODE) :First order differential equation, Radioactive decay, Current in RC, LC circuits with DC source, Newton's law of cooling, Classical equations of motion.
- Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods:
- Interpolation: Evaluation of trigonometric functions e.g. sin θ, cos θ, tan θ etc. using Newton Gregory Forward and Backward difference formula.
- Numerical differentiation and Integration: Using Forward and Backward difference formula for differentiation and Trapezoidal and Simpson rules for integration and Monte Carlo method solve the following problems.
  - Given Position with equidistant time data to calculate velocity and acceleration and vice versa.
  - Find the area of B-H Hysteresis loop
- Runge Kutta Method Problems :
  - Solve the coupled 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 ≤ t ≤ 15
  - The differential equation describing the motion of a pendulum is. $\frac{d^2\theta}{dt^2} = -\sin\theta$
- The pendulum is released from rest at an angular displacement 〈 and ’(0) = 0. Solve the equation for α = 0.1, 0.5 and 1.0 and plot as a function of time in the range 0 ≤ t ≤ 8π. Also plot the analytic solution valid for small (sin =)

Text / Reference Books:

Author	Title	Publisher	Year of publication	ISBN
Arfken, G B & Weber, F E	Mathematical Methods for Physicists	Elsevier	7th edition,2013	9780120598328
K.F.Riley & M.P.Hobson	Essential Mathematical Methods	Cambridge Univ. Press	2011	9780521761147
Zill, D G and Wright, W S	Advanced Engineering mathematics	Jones and bartlett Learning	5 Ed., 2012,	9780471021407
Atkinson, K E	Elementary Numerical Analysis	Wiley India	3 Ed., 2007	9780471433378
Walker, Darren	Computational Physics	Scientific Int. Pvt. Ltd.	2015	9781942270737

Reference Books:

Author	Title	Publisher	Year of publication	ISBN

C.L.Arora	Refresher Course in B.Sc. Physics (Vol I)	S Chand & Company	2010	978-8121904650
C.L.Arora	Refresher Course in B.Sc. Physics (Vol II)	S Chand & Company	2010	978-8121904667
C.L.Arora	Refresher Course in B.Sc. Physics (Vol III)	S Chand & Company	2013	978-8121906265

Course Title: ENV101 (Environmental Studies-I)

L	T	P	Total Credits
2	0	0	2

Course Contents/syllabus:

	Teaching hours
Unit-1- Multidisciplinary nature of environmental studies	**8 h**
Multidisciplinary nature of environmental studies: Definition, scope and importance; components of environment –atmosphere, hydrosphere, lithosphere and biosphere. Concept of sustainability and sustainable development.	
Unit-2-Natural Resources	**10 h**
Natural resources: Land resources and land use change, land degradation, soil erosion and desertification. Deforestation: causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal population. Water Resources-Use and over-exploitation of surface and groundwater, floods, drought, conflicts over water (international and inter-state). Heating of earth and circulation of air; air	

mass formation and precipitation. Energy resources- renewable and non-renewable energy sources, use of alternate energy sources, Growing energy needs, Case studies. .	
Unit-3- Ecosystems	**9 h**
Ecosystem: What is an ecosystem; Structure and function of an ecosystem; Energy flow in the ecosystem; Food chains, food webs and ecological succession. Case studies of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	
Unit-4- Biodiversity and its conservation	**9 h**
Biodiversity: Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; biodiversity patterns and global biodiversity hot spots. India as a mega–biodiversity nation; endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; conservation of biodiversity: in-situ and ex-situ conservation of biodiversity. Ecosystem and biodiversity services: ecological, economic, social, ethical, aesthetic and information value.	

Course Learning Outcomes: At the end of this course, the students will be able to develop:

- Appreciate the multi-disciplinary nature of environmental science
- Understand natural resources and evaluate limitations surrounding renewable and non-renewable resources
- Understand the nuances of ecosystem and learn about behaviour of various ecosystem
- Learn about the types, services and threats to our biodiversity and importance of conserving it.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
William P. Cunningham, Mary Ann Cunningham	Principles of Environmental Science	McGraw-Hill	2019	9781260219715
Dash and Dash	Fundamentals of ecology	Tata McGraw	2009	978-0070083660

William P. Cunningham, Mary Ann Cunningham, Barbara Woodworth Saigo	Environmental Science: A global concern,	McGraw-Hill	2021	9781260363821
Gaston K.J. and Spicer, J. I.	Biodiversity – An Introduction 2nd edition	Blackwell Publishing	2004	978-1-405-11857-6

Course Title: PSY101 (Understanding Self for Effectiveness)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching time
Unit I: Self: Core Competency	**4.5 h**
Understanding of Self, Components of Self – Self identity , Self concept, Self confidence , Self image , BIG5 Factors	
Unit II: Techniques of Self Awareness	**4.5 h**
Exploration through Johari Window, Mapping the key characteristics of self, Framing a charter for self Stages – self awareness, self acceptance	

and self realization	
Unit III: Self Esteem & Effectiveness	**4.5 h**
Meaning, Importance, Components of self esteem, High and low self esteem, Measuring your self esteem	
Unit IV: Building Positive Attitude and Emotional Competence	**4.5 h**
Meaning and nature of attitude, Components and Types of attitude ,Importance and relevance of attitude Emotional Intelligence – Meaning, components, Importance and Relevance Positive and negative emotions, Healthy and Unhealthy expression of emotions	

Course Learning Outcomes: At the end of this course, the students will be able to:

- The student will apply self-introspection as a tool for self-awareness.
- The student will understand self-concept for self-recognition, self-improvement and perception of others.
- The student will be able to analyze their physical self, social self, the competent self and psychological self.

The student will be able to analyze what motivates his/her actions and the actions of others

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Singh A.	Achieving Behavioural Excellence for Success	Wiley Publication	2012	978812658027
Towers, Marc	Self Esteem	American Media	1995	9781884926297
Pedler Mike, Burgoyne John, Boydell Tom	A Manager's Guide to Self-Development	McGraw-Hill	2006	978-0077114701
Covey, R. Stephen	Seven habits of Highly Effective People	Simon & Schuster Ltd	2013	978-1451639612
Khera Shiv	You Can Win	Macmillan	2005	978-0333937402

Gegax Tom	Winning in the Game of Life	Harmony Books	1999	978-0609603925
Singh, Dalip	Emotional Intelligence at Work	Publications	2006	9780761935322
Goleman, Daniel	Emotional Intelligence	Bantam Books	2007	9780553095036
Goleman, Daniel	Working with E.I	Bantam Books	1998	9780553104622

Course Title: FOL101 (Introduction to French Culture & Language)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit-I Introduction to French language	**4 h**
● Brief introduction of French and Francophone countries ● Presenting oneself ● Getting information about someone else ● Greeting and taking leave ● Asking/giving personal information	
Unit-II- A rendez-vous ; Visiting a place	**5 h**
● Pronouncing and writing numbers in French ● Spell and count numbers ● Telling the time ● Temporal expressions ● Communicating in class ● Fixing an hour, place for a meeting. ● Describing a person.	

● Identifying a person, object and place ● Describing relation in a family ● A specific person, object and place	
Unit-III- An interview	**4.5 h**
● Description of objects, people and places ● Nationalities ● Speaking about one's professions ● Expressing Actions using regular –er ending verbs; avoir, être; reflexive verbs – usage, conjuagation ● Interview of celebrity	
Unit-IV- At the discotheque	**4.5 h**
● Portrait by a journalist ● Giving a positive or negative reply ● Asking questions ● Discussion with a person ● Activities in a day	

Course Learning Outcomes: At the end of this course, the students will be able to express themselves in writing and orally in basic French. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
Christine Andant, Chaterine Metton, Annabelle Nachon, Fabienne Nugue	A Propos – A1 Livre De L'Eleve, Cahier D' Exercices	Langers Int. Pvt. Ltd.	2010	978-9380809069

Manjiri Khandekar and Roopa Luktuke	Jumelage – 1 Methode De Fraincais – French	Langers International Private Limited	2020	978-9380809854
Michael Magne, Marie-Laure Lions-Olivieri	Version Originale 1: Cahier d'exercices	Maison Des Langues	2010	9788484435617

Course Title: FOL102 (Introduction to German Culture & Language)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit-I Introduction to German Language (Einführung)	**3 h**
● Introduction to German as a global language, Self-introduction and Greetings, Die Alphabeten, Phonetics: the sound of consonants and vowels, Wie buchstabieren Sie Ihren Name?	
Unit-II- Numbers and everyday conversation (die Zahl und Gespräche)	**6 h**
● Counting in German from 1-100, Simple Calculation and verb 'kosten' – Wie viel kostet das? Plural Forms, Vocabulary: Wochentage, Monate, Jahreszeiten, Ordinal numbers and the question – Wann haben Sie Geburtstag?	

Unit-III- Regular verbs and nominative case: articles and pronouns (Regelmässige Verben und Nominativ Kasus: Artikel und Pronomen)	**4.5 h**
● Introduction to all personal pronouns and conjugation of Regular verbs Detailed exercise on regular verbs. Reading a text on regular verbs. Introduction to definite. Vocabulary: Schulsachen und Getränke, Nominative case/ Articles (der, die, das) Nominative Pronouns: - Applicability of pronouns for both persons and things. Usage of nominative Personal Pronouns Introduction of nominative possessive pronouns usage of nominative possessive pronouns	
Unit-IV- The Family, Work-life and Professions (Familienmitglieder und Berufe) & Interrogative sentences (W-Fragen)	**4.5 h**
The Family, Work-life and Professions (Familienmitglieder und Berufe) ● Vocabulary: Professions and conjugation of the verb 'sein' Introduction to simple possessive pronouns with the help of the verb 'haben' Usage of possessive pronouns. Interrogative sentences (W-Fragen) W-Fragen: who, what, where, when, which, how, how many, how much, etc. Exercises on the question pronouns	

Course Learning Outcomes: At the end of this course, the students will be able to express themselves in writing and orally in basic German. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Year	ISBN
Rolf Bruseke	Starten Wir A 1	Langers Int. Pvt Ltd	2017	978-3190160006

Giorgio Motta	Wir Plus Grundkurs Deutsch fur Junge Lerner Book	Ernst Klelt Verlog	2011	978-8183072120
Heimy Taylor, Werner Haas	Station en Deutsch Self Study Course German Guide	Wiley	2007	978-0470165515

Course Title: INL103 (History and Culture of Punjab)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus

	Teaching hours
Unit I:	**4.5 h**
1. Harappan Civilization: extent and town planning and socio-economic life. 2. Life in Vedic Age: socio-economic and religious; 3. Growth and impact of Jainism and Buddhism in Panjab.	
Unit II:	**4.5 h**
4. Society and Culture under Maurayas and Guptas. 5. Bhakti movement: Main features; prominent saints and their contribution. 6. Origin and development of Sufism	
Unit III:	**4.5 h**
7. Evolution of Sikhism: teaching of Guru Nanak; Institutional Development- Manji, Masand, Sangat and Pangat	

8. Transformation of Sikhism: Martyrdom of Guru Arjan; New policy of Guru Hargobind, martyrdom of Guru Tegh Bahadur. 9. Institution of Khalsa: New baptism; significance	
Unit IV:	**4.5 h**
10. Changes in Society in 18th century: social unrest; emergence of misls and other institutions – rakhi, gurmata, dal iophy. 11. Society and Culture under Maharaja Ranjit Singh. 12. MAP (of undivided physical geographical map of Punjab): Major Historical Places: Harappa, Mohenjodaro, Sanghol, Ropar, Lahore, Amritsar, Kiratpur, Anandpur Sahib, Tarn Taran, Machhiwara, Goindwal, Khadur Sahib.	

Course Learning Outcomes:

- Understand the history of various cultures in Punjab.
- Interpret the importance of Maurayan,Gupta and Bhakti influences on Punjab
- Apply the teaching of Sikhism on the emergence of the Khalsa.
- Examine the impact societal changes on socio-cultural and physical landscape of Punjab

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No
L.M Joshi,	History and Culture of the Punjab, Part-I	Punjabi University, Patiala	1989,3rd	-
Buddha Prakash	Glimpses of Ancient Punjab	Punjabi University, Patiala,	1983	-
Khushwant Singh	A History of the Sikhs, vol I: 1469-1839, .	oxford University Press, Delhi	1991	-

Course Title: PHY106 (Basics of Computational Physics)

L	T	P	Total Credits
1	0	2	3

Course Outcomes

CO1	Learn the basics including the need and design, architecture of the computer system, Learning the possibilities and limitations of computational methods in physics
CO2	Understand the error analysis, approximation errors, interpolations methods
CO3	Understand the methods to analysis the data: Least square method
CO4	Learning the software and languages

Course Contents/syllabus:

	Time (H)
Unit I: Introduction to Fortran	**4.5**
Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) iophysic figures and (2) trajectory of a projectile thrown at an angle with the horizontal. Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment. Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O	

Statements (unformatted/formatted), Executable and Non- Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.	
Unit II: Control Statement and its Types	**4.5**
Types of Logic(Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems as mentioned below ● Exercises on syntax on usage of FORTRAN ● Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN. ● To print out all natural even/ odd numbers between given limits. ● To find maximum, minimum and range of a given set of numbers. ● Calculating Euler number using exp(x) series evaluated at x=1	
Unit III: Introduction to LaTeX	**4.5**
TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography, citation, Making an index and glossary, List making	

environments, Fonts, Picture environment and colors, errors.	
Unit IV: Analysis and Visualization	**4.5**
Introduction to graphical analysis and its limitations. Introduction to Gnuplot. Importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot. Using the above concepts, write a code for the following problems.	
Practicals	**72 hours**

List of Experiments -with basic instructions

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

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
S. Sastry	Introductory Methods of Numerical Analysis	Prentice Hall Pvt. Ltd.	5th edition, 2012	978-8120345928

R.C. Verma	Computational Physic	Newage publishers	1st edition, 2005	978-8122416596
Atkinson, K E	Elementary Numerical analysis	Wiley India	3rd edition, 2003	9780471433378
V. Rajaraman	Computer Programming Fortran 90 and 95	Prentice Hall Pvt. Ltd.	1997	978-8120311817

Course Title: CHE103 (General Chemistry-I)

L	T	P	Total Credits
2	0	1	3

Course Learning Outcomes

CO1	Knowledge of evolution of scientific theories to explain the atomic structure, molecular geometry and physico-chemical behaviour of atomic matter made from elements in periodic table.
CO2	Focus on fundamentals of organic molecules, structure, stereochemistry, bonding, reactivity and reaction mechanisms.
CO3	Familiarization with solid and liquid states of matter and its physical laws related to describe them

Course Contents/syllabus:

	Teaching hours
Unit I: Atomic Structure	**9 h**
Bohr's theory, Wave mechanics: de' Broglie equation, Heisenberg's	

Uncertainty Principle and its significance, Schrödinger's wave equation, Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.	
Unit II: Periodic Properties of Elements	**9 h**
s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (Van'der Waals), (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) I Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge	
Unit III: Basics of Organic Chemistry and Stereochemistry	**9 h**
a)Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and relative stabilities of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Organic reactions and their mechanism: Addition, Elimination and Substitution reactions**.** **b)Stereochemistry:** Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions;	

Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S designations.	
Unit IV: States of matter : Gases and Liquids	**9 h**
a)Gases: Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. Van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states. Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. B)Liquids: Structure and physical properties of liquids; vapour pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension, cleansing action of detergents. Structure of water.	
Practical:	**36 Hours Total**
	Inorganic Chemistry Practicals ● Titrimetric Analysis (i) Calibration and use of apparatus.

	(ii) Preparation of solutions of different Molarity/Normality of titrants. (iii) Use of primary and secondary standard solutions. ● Acid-Base Titrations (i) Estimation of carbonate and hydroxide present together in mixture. (ii) Estimation of carbonate and bicarbonate present together in a mixture. Checking the calibration of the thermometer. <u>Organic Chemistry Practicals</u> ● Determination of the melting points of given organic compounds and unknown organic compounds (using Kjeldahl method and electrically heated melting point apparatus). ● Chromatography a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b. Separation of a mixture of two sugars by ascending paper chromatography c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC). <u>Physical Chemistry Practicals</u> ● Surface tension measurements. a. Determine the surface tension by (i) drop number (ii) drop weight method. b. Study the variation of surface tension of detergent solutions with concentration. ● Viscosity measurements using Ostwald's viscometer. a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature. b. Viscosity of sucrose solution with the concentration of solute.

Text Books/literature

AUTHOR	TITLE	Publisher	Year of publication	ISBN
J.D. Lee	Concise Inorganic Chemistry	John Wiley and Sons	2016	978-8126515547
M. B. Smith, J. March	, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure	Wiley-Interscience	2015	978-8126556588
Atkins P.W, Julio de Paula	Physical Chemistry	Oxford University Press	2018	978-0198814740
J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas	Vogel's Quantitative Chemical Analysis	Longman	1999	978-582226289

Shoemaker, D.P Garland, C.W Nibler, J.W	Experiments in Physical Chemistry	McGraw Hill Inc	2008	978-0070570078

Semester-II

Course Title : Electricity and Magnetism II

L	T	P	Total Credits
3	0	1	4

Electricity and Magnetism II	**Theory: 54h, Pract:36h**

Course Outcomes

CO1	Explanation on the knowledge of mathematics required to learn electrostatics and magnetostatics
CO2	Explanation of differential analysis of the electric force and field vectors as well as on scalar quantities such as potential and potential energy

CO3	Articulate knowledge of capacitance in terms of electric field and electric potential. Demonstrate a working understanding of capacitors
CO4	Understand the dielectric properties, magnetic properties of materials and the phenomena of electromagnetic induction
CO5	Understanding on magnetostatics and its applications

Unit-1- Electric Fields in Matter	**Lectures: 14 h**
Conductors in an electrostatic Field, Method of Images and its application to Plane Infinite Sheet Capacitance of a system of charged conductors, Parallel-plate capacitor, Dielectrics: Polar and non polar Dielectrics,Induced dipole moments, Permanent dipole moments, Polarization, , Gauss law in Dielectrics, capacitor with Dielectrics (series and parallel), polarisability, Susceptibility and Dielectric Constant, Electric Displacement, permittivity Moments of a charge distribution, Potential and field of a dipole, electric field caused by polarized matter, Gauss's law in dielectric medium	
Unit-2- The Fields of Moving Charges	**Lectures: 13 h**
Magnetic forces, Measurement of a charge in motion, invariance of charge, Electric field measured in different frames of reference, Field of a point charge moving with constant velocity, Field of a charge that starts or stops, Force on a moving charge, Interaction between a moving charge and other moving charges.	
Unit-3- Magnetism and materials	**Lectures: 14 h**
Magnetic force due to line, surface and volume currents, Magnetic vector potential, Transformations of electric and magnetic fields. Rowland's experiment, Hall effect, magnetic fields in matter: Response of various substances to magnetic field, Force on a dipole in an external field, Electric currents in Atoms, Electron spin and Magnetic moment,Magnetization, types of magnetic materials (Dia, para and ferro), Magnetic	

susceptibility, magnetic nanoparticles: synthesis and characterization, Effect of a Magnetic Field on Atomic Orbit	
Unit-4- Magnetic circuits	**Lectures: 13 h**
Concept of magnetic circuit and its correspondence with electric circuits, Magnetomotive force (m.m.f.), Reluctance, Permeance, series and parallel magnetic circuits, Magnetic Leakage and Fringing, B-H Curve and Calculations, Hysteresis loop and Loss, Kirchhoff's law for magnetic circuits	

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
Edward M. Purcell	Electricity and Magnetism	McGraw-Hill Education	1986	978-1107014022
D.J. Griffiths	Introduction to Electrodynamics	Benjamin Cummings	1998	978-1108822909
R.P. Feynman, R.B.	Feynman Lectures Vol.2	Pearson Education	1981	978-1842652497

Leighton, M. Sands				
Matthew N.O. Sadiku	Elements of Electromagnetics	Oxford University Press	2010	978-0199461851
S. Mahajan and Choudhury	Electricity, Magnetism & Electromagnetic Theory	Tata McGraw	2012	978-1259004599

Practicals	**36 hours**

Objective: The aim of this section of the course is to build an understanding about various components of an electrical circuit and to develop skill to measure the related physical quantities.

- Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and I Checking electrical fuses.
- To determine an unknown Low Resistance using Potentiometer.
- To determine an unknown Low Resistance using Carey Foster's Bridge.
- Measurement of field strength B and its variation in a solenoid (determine dB/dx)
- To determine the value of an air capacitance by de-Sauty Method and to find permittivity of air. To determine the dielectric constant of a liquid.
- To verify the Thevenin and Norton theorems.
- To verify the Superposition, and Maximum power transfer theorems.
- To determine self-inductance of a coil by Anderson's bridge.
- To study the response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
- Measurement of charge and current sensitivity and CDR of Ballistic

Galvanometer

- Determine a high resistance by leakage method using Ballistic Galvanometer.
- To determine self-inductance of a coil by Rayleigh's method.
- To determine the mutual inductance of two coils by Absolute method.
- To determine the frequency of A.C. mains using sonometer.
- To measure iophys e.m.f. of a thermocouple as a function of temperature and find inversion temperature.
- To study C.R.O. as display and measuring device by recording sines and square waves, output from a rectifier, verification (qualitative) of law of electromagnetic induction and frequency of A.C. mains.
- To plot the Lissajous figures and determine the phase angle by C.R.O.
- To study B-H curves for different ferromagnetic materials using C.R.O.
- Determination of low inductance by Maxwell-Wein bridge.
- Studies based on LCR Board: Impedance of LCR circuit and the phase and between voltage and current.

Course Title : Oscillations and Waves

L	T	P	Total Credits
3	0	1	4

Course Outcomes

CO1	Understand the fundamental principles underlying wave phenomena using a mathematical description for certain systems
CO2	To acquire the fundamental properties of wave and its application in mechanical waves and electromagnetic radiation such as light

CO3	Study of two perpendicular oscillators (Lissajous figures) and behaviour of transverse, longitudinal waves
CO4	Understand the principle of superposition and its role in understanding the interference, diffraction and polarization with their everyday life observation
CO5	Understand the mechanism of few optical instruments like biprism, interferometer, diffraction grating, and holograms

Course Content

Unit-1-Simple Harmonic Free Oscillations	**Lectures: 14 h**
Simple harmonic oscillations (SHO) and its equation, Energy of SHO, spring- mass systems, simple and compound pendulum, torsion pendulum, Electrical Oscillations, Plasma Vibrations, Lattice Vibrations, Superposition Harmonic oscillations:Standing (Stationary) Waves in a String: Fixed and Free Ends of the same period and of periods in ratio 1:2, Lissajous and their uses.	
Unit-2-Damped and forced oscillations	**Lectures: 16 h**
Damped Harmonic oscillations and its equation, different cases of damping: heavy, critical and light, Determination of damping coefficients – Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping, collision damping – Ionosphere and metals. Free and forced oscillations, A forced oscillator, Transient and Steady State Oscillations, velocity versus driving force frequency, Resonance, power supplied to forced oscillator by the driving force, Q-factor of a forced oscillator, Electrical (series and parallel) , nuclear and nuclear-magnetic resonances, coupled oscillations, Normal coordinates and modes of vibrations. Normal frequencies	
Unit-3-Waves in physical media	**Lectures: 18 h**
Wave motion in one dimension, Transverse and longitudinal waves, progressive harmonic waves and their energy, Transverse waves on a string, longitudinal waves on a rod, Electrical transmission lines, characteristic impedance of a string and a transmission line, superposition of harmonic waves: interference and beats, stationary	

waves, Acoustic waves, waves in dispersive and adsorptive media, spherical waves	
Unit-4- Reflection and Transmission	**Lectures: 18 h**
Reflection and transmission of transverse waves on a string at the discontinuity, Energy considerations of reflected and transmitted waves, Impedance matching, eigenfrequencies and eigenfunctions for stationary waves on a string. Normal modes in three dimensions, Planck's Law, Debye's T3 Law, Conduction electrons in a metal, transmission of non-monochromatic waves, Bandwidth Theorem.	

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
Francis Crawford	Waves: Berkeley Physics Course, vol. 3	Tata McGraw-Hill.	2007	9780070048607
H. J. Pain	The Physics of Vibration and Waves	John Wiley and Sons	2013	9780470012956
N.K. Bajaj	The Physics of Waves and Oscillations	Tata McGraw Hill	1998	9780074516102

Ajoy Ghatak	Optics	Tata McGraw Hill	2008	9789339220907
Max Born an Emil Wolf	Principles of Optics	Pergamon Press	1999	978-1108477437
S.P.Puri	Text Book of Vibrations and Waves	Tata McGraw Hill	2004	978-1403924032

Oscillations and Waves	**Practicals: 36 h**

Objective: The aim of this section of the course is to build an understanding about various components of an optical instrument and to develop skill to measure the related physical quantities.

- To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law.
- To investigate the motion of coupled oscillators.
- To study Lissajous Figures.
- Familiarization with: Schuster`s focusing; determination of angle of prism.
- To determine refractive index of the Material of a prism using sodium source.
- To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
- To determine the wavelength of sodium source using Michelson's interferometer.
- To determine wavelength of sodium light using a plane diffraction grating.
- To determine wavelength of sodium light using Newton's Rings.

- To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
- To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
- To determine dispersive power and resolving power of a plane diffraction grating.

Course Title:(PHY201) Mathematical Physics-II

L	T	P	Total Credits
3	0	1	4

Course Outcomes

CO1	Understand the partial differential equation and its applications to physics problems
CO2	Gets familiar to Fourier analysis of periodic functions and Fourier transformation and appreciates its applications to physics problems
CO3	Become familiar to special functions such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions and their differential equations with their applications
CO4	Learning of beta, gamma and the error functions and their applications in doing integrations

Course Contents

Unit-1- Partial Differential Equations and Frobenius Method	**Lectures: 14**
Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation. Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations.	
Unit-2-Fourier Series	**Lectures: 13**
Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.	
Unit-3- Special Functions and Integrals	**Lectures: 14**
Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x)) and Orthogonality. Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).	
Unit-4- Theory of Errors	**Lectures: 13**
Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line.	

Mathematical Physics – II	**Practicals: 36**

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

- Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods developing the skills of writing a program (2)
- Curve fitting: Ohms law to calculate R, Hooke's law to calculate spring constant
- Linear system of equations: Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses) using Gauss elimination method & Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems
- Solution of Ordinary Differential Equations (ODE) :Second Differential Equations for
  - Harmonic oscillator (no friction)
  - Damped Harmonic oscillator (Over damped, Critical damped, Oscillatory)
  - Forced Harmonic oscillator (Transient and • Steady state solution)
  - Apply above to LCR circuits
- Using Scicos / xcos :
  - Generating square wave, sine wave, sawtooth wave
  - Solution to harmonic oscillator
  - Study of beat phenomenon
  - Phase space plots

Text/Reference Books

Authors	Title	Publisher	Ed/year	ISBN No
M.R. Spiegel	Fourier Analysis	Tata McGraw Hill	2004	978-0070588837
George F. Simmons	Differential Equations	Tata McGraw-Hill	2006	978-8126515370
S.J. Farlow	Partial Differential Equations for Scientists & Engineers	Dover Pub	1993	978-0486676203
Arfken, Weber, and Harris,	Mathematical Methods for Physicists	Elsevier	2005	978-9381269558
D.A. McQuarrie	Mathematical methods for	Viva Books	2003	978-8130909974

	Scientists & Engineers			
K.F.Riley M.P.Hobson	Essential Mathematical Methods	Cambridge Univ. Press	2011	978-0521761147
Susan M. Lea,	Mathematics for Physicists	Thomson Brooks/Cole	2004	978-0534424763

Course Title: ENV102 (Environmental Studies-II)

L	T	P	Total Credits
2	0	0	2

Course Contents/syllabus:

	Teaching hours
Unit-1- Environmental Pollution	**11 h**
Environmental Pollution: types, Cause, effects and controls –Air, water, soil, chemical and noise pollution. Nuclear hazard and human health risk. Solid waste Management-control measures of urban and industrial waste. Pollution case studies .	
Unit-2-Environmental Policies and practices:	**11 h**

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment laws: Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act, international agreements: Montreal and Kyoto protocols and convention on biological diversity (CBD), The Chemical Weapons Convention (CWC). Natural reserves, tribal population and rights and Human-wildlife conflict in Indian context	
Unit-3- Human communities and the Environment	**10 h**
Impacts on environment, human health and welfare. Carbon footprint. Resettlements and rehabilitation of project affected persons, case studies. Disaster management: floods, earthquake, cyclone and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi	
Unit-4- Field Work	**4 h**
· Visit to an area to document environmental assets: river/forest/flora/fauna, etc. · Visit to local polluted Site-Urban/Rural/Industrial/Agricultural · Study of common plants, insects, birds and basic principles of identification.	

· Study of simple ecosystems-pond, river, Delhi Ridge, etc. .	

Course Learning Outcomes: At the end of this course, the students will be able to develop:

1. Understanding the types of pollution and their impact on environment and human health.

2. Understand the environmental concerns and their impact on humans and agriculture.

3. Sensitization about the environmental issues and concerns leading to proactive actions to improve the environmental conditions in our daily life.

4. Able to analyze the impacts of natural and manmade disaster on human population and settlements and the role of movements and environmental ethics in minimizing environmental disasters

5. Able to imbibe practical approaches and solution to solve environmental concerns.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
William P. Cunningham, Mary Ann Cunningham	Principles of Environmental Science	McGraw-Hill	2019	9781260219715
Dash and Dash	Fundamentals of ecology	Tata McGraw	2009	978-0070083660
William P. Cunningham, Mary Ann Cunningham, Barbara Woodworth Saigo	Environmental Science: A global concern,	McGraw-Hill	2021	9781260363821

Gaston K.J. and Spicer, J. I.	Biodiversity – An Introduction 2nd edition	Blackwell Publishing	2004	978-1-405-11857-6

Course Title: PSY111- Individual, Society and Nation (Behavioural Sciences)

L	T	Total Credit
1	0	1

List of Professional Skill Development Activities (PSDA):

- Project on Understanding Diversity
- Term Paper on Patriotism among Youth

Course Learning Outcomes: On completion of the course:

- To recognize individual differences
- To manage individual differences
- To develop patriotic feelings
- To recognized their self in relation to society & nation

Course Contents/syllabus:

	Hours
Unit-1- Individual differences & Personality	**5 H**
● Personality: Definition& Relevance ● Importance of nature & nurture in Personality Development ● Importance and Recognition of Individual differences in Persona ● Accepting and Managing Individual differences Intuition Perception & Sensation (MBTI) BIG5 Factors	
Unit-2- Managing Diversity	**5 H**
● Defining Diversity ● Affirmation Action and Managing Diversity ● Increasing Diversity in Work Force ● Barriers and Challenges in Managing Diversity	
Unit-3- Socialization, Patriotism and National Pride	**4 H**
● Nature of Socialization	

• Social Interaction • Interaction of Socialization Process • Contributions to Society and Nation • Sense of pride and patriotism • Importance of discipline and hard work • Integrity and accountability	
Unit-4- Human Rights, Values and Ethics	**4 H**
• Meaning and Importance of human rights • Human rights awareness • Values and Ethics- Learning based on project work on Scriptures like- Ramayana, Mahabharata, Gita etc.	

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Department of English, Univ. of Delhi	The Individual & Society	Pearson Education	2010	978-8131704172
Umang Malhotra	Individual, Society, and the World	Universe	2004	978-0595662401
Tonja R. Conerly & Kathleen Holmes	Introduction to Sociology 3e	Openstax	2015	9781711493978
Daksh Tyagi	"A Nation of Idiots"	Every Protest	2019	978-8194275015

Course Title: French Grammar (FOL-103)

L	T	Total Credit Units
1	0	1

Course Learning Outcomes: At the end of the course, the student shall be able to: Paraphrase; Interpret and

- Understand information; Express in his own words; translate.
- Apply information in a new way in a practical context
- Analyze and break-down information to create new ideas
- Evaluate and express opinion in a given context

Course Contents/syllabus:

	Teaching Hours
Unit-I : My family and my house	**5 H**
Descriptors/Topics ● Talk about your family members ● Usage of possessive adjectives ● Describe your house/apartment ● Prepositions of location ● Negation	
Unit-II- Lifestyle	**4 H**
Descriptors/Topics ● Talk about your hobbies and pastimes ● Usage of appropriate articles : definite and contracted ● Talk about your daily routine ● Usage of pronominal verbs	
Unit-III- In the city	**4 H**
Descriptors/Topics ● Filling up a simple form ● Ask for personal information ● Usage of interrogative adjectives ● Give directions about a place ● Ordinal numbers ● Usage of demonstrative adjectives	
Unit-IV- Week-end	**5 H**

Descriptors/Topics ● Talk about your week-end plans ● Usage of disjunctive pronouns ● Usage of Near Future tense ● Talk about weather ● Write a simple post card	

Text / Reference Books:

Author	Title	Publisher	Year of Publication	ISBN No
Christine Andant, Catherine Metton, Annabelle Nachon, Fabienne Nugue,	A Propos – A1, Livre de l'élève et Cahier d'exercices.	Langers International Pvt. Ltd.	2010	978-9380809069
Collins Dictionaries	Easy Learning French Complete Grammar, Verbs and Vocabulary	Collins	2016	978-0008141721
Nikita Desai, Samapita Dey Sarkar	Apprenons La Grammaire Ensemble – French	Langers International Pvt. Ltd.	2017	978-8193002681

Course Title: German Grammar (FOL-104)

L	T	Total Credit Units
1	0	1

Course Outcome:

At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context

- Analyze and break-down information to create new ideas
- Evaluate and express opinion in a given context

Course Contents/syllabus:

	Teaching Hours
Module I: Time (Uhrzeit); People and the World: Land, Nationalität und Sprache	**5 H**
● Introduction of time ● Read text related to time and teach the students the time expressions ● Exercises related to Time ● Adverbs of time and time related prepositions ● Vocabulary: Countries, Nationalities, and their languages ● Negation: “nicht/ kein” ● Ja/Nein Fragen. ● All the colors and color related vocabulary, adjectives, and opposites ● Exercises and comprehension for the same.	
Module II: Irregular verbs (unregelmässige Verben)	**4 H**
● Introduction to irregular verbs and their conjugation e.g. fahren, essen, iophy etc ● Read a text related to the eating habits of Germans ● Vocabulary: Obst, Gemüse, Kleiderstück with usage of irregular verbs ● Free time and hobbies ● Food and drinks	
Module III: Accusative case: articles and pronouns (Akkusativ Kasus: Artikel und Pronomen)	**5 H**
● Introduction to the concept of object (Akkusativ) ● Formation of sentences along with the translation and difference between nominative and accusative articles ● Usage of accusative Definite articles ● Usage of accusative Indefinite articles	

Module IV: Accusative case: possessive pronouns (Akkusativ Kasus: Possessivpronomen) Family and Relationship	**4 H**
● Accusative Personal Pronouns: - Revision of the nominative personal pronouns and introduction of accusative. Applicability of pronouns for both persons and things. ● Usage of accusative Personal Pronouns ● Introduction of accusative possessive pronouns ● Difference between nominative and accusative possessive pronouns ● usage of accusative possessive pronouns	

Text / Reference Books:

Author	**Title**	**Publisher**	**Year**	**ISBN No**
Dora Schulz, Heinz Griesbach	Deutsche Sprachlehre Fur Auslander	Max Hueber Verlag	1984	978-3190010066
Hartmut Aufderstrasse, Jutta Muller, Helmut Muller	Themen Aktuell: Glossar Deutsch	Max Hueber Verlag	2003	978-3190816903
Giorgio Motta	Wir Plus Grundkurs Deutsch fur Junge Lerner Book German Guide	Goyal Publishers	2011	9788183072120

Course Title: (PHY113) Renewable Energy and Energy Harvesting

L	T	P	Total Credits
3	0	0	3

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SEC4: Renewable Energy and Energy Harvesting	Theory: 36 h

Course Outcomes

CO1	Knowledge of alternative resources of energy.
CO2	Evaluation of the solar energy and its application involving the conversion process.
CO3	Learning the various technologies to generate geothermal and hydro energy.
CO4	Exploring the concept of piezoelectric energy.
CO5	Analyzing the techniques and methods to harvest electromagnetic energy

Course Content:

Unit-1-Alternate Energy Sources	Lectures: 5
Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	
Unit-2-Solar Energy	**Lectures: 7**
Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air	

conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	
Unit-3-Geothermal & Hydro-Energy	**Lectures: 5**
Geothermal Resources, Geothermal Technologies. Hydropower resources, hydropower technologies, environmental impact of hydro power source.	
Unit-4-Wind and Ocean Energy	**Lectures: 8**
Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.	
Unit-5-Piezoelectric Energy	**Lectures: 5**
Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power	
Unit-6-Electromagnetic Energy Harvesting	**Lectures: 6**
Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability.	

Text Books/Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN
G.D Rai	Non-conventional energy sources	Khanna Publishers, New Delhi	1 January 1988	978-8174090737

M P Agarwa	Solar energy	S Chand and Co. Ltd.	January 1, 1983	OCLC Number: 11572325
Suhas P Sukhative	Solar energy	Tata McGraw - Hill Publishing Company Ltd.	1997	9780074624531
Godfrey Boyle	Renewable Energy:Power for a sustainable future	Oxford University Press	2004	978-0199545339
Jan Kleissl	Solar Energy Forecasting and Resource Assessment	Elsevier Publications	2013	9780123977724

Course Title: Weather Forecasting

L	T	P	Total Credits
3	0	0	3

Course Outcomes

CO1	Learning of atmospheric structure and processes related to it.
CO2	Understanding the different weather systems and issues related to them.

CO3	Analyzing the causes of climate change and its impact on the Earth
CO4	Learning the various experimental methods for the measurements of different factors related to atmosphere, weather and climate.
CO5	Knowledge of working principle of weather satellites and weather maps.

Course Content

Unit-1-Introduction to Atmosphere	**Lectures: 10 h**
Elementary idea of atmosphere: physical structure and composition, compositional layering of the atmosphere, variation of pressure and temperature with height, air temperature; requirements to measure air temperature; temperature sensors and types, atmospheric pressure: its measurement, cyclones and anticyclones: its characteristics.	
Unit-2-Weather Systems	**Lectures: 8 h**
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. Global wind systems, air masses and fronts: classifications; jet streams, local thunderstorms, tropical cyclones: classification; tornadoes, hurricanes.	
Unit-3-Climate Change	**Lectures: 8**
Climate: its classification; causes of climate change, global warming and its outcomes, air pollution, aerosols, ozone depletion, acid rain, environmental issues related to climate.	
Unit-4-Weather Forecasting	**Lectures: 10**
Weather forecasting: analysis and its historical background; need of measuring weather, types of weather forecasting; weather forecasting methods, criteria of choosing weather station; basics of choosing site and exposure, satellites observations in weather forecasting, weather maps; uncertainty and predictability, probability forecasts.	

Text Books/ Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Stephen Burt	The weather Observers Hand book	Cambridge University Press	2012	9781139152167
S.R. Ghadekar	Meteorology	Agromet Publishers, Nagpur	2001	1234567159647
Resnick, Halliday and Walker	Fundamentals of Physics, Vol I	Wiley	2008	978-1119801191
G.R. Fowles and G.L. Cassiday	Analytical Mechanics	Cengage Learning	2005	978-0534494926

SEMESTER – III

Course Title: Special Theory of Relativity

L	T	P	Total Credits
3	1	0	4

Course Outcomes

CO1	Revision of coordinate systems and understanding Non-inertial frames of reference
CO2	Learning of the special theory of relativity- postulates of the special theory of relativity involving Lorentz transformations on space-time
CO3	Learn the Relativistic kinematics Lorentz transformations on space-time and other four vectors, four-vector notations, space-time invariant length, length contraction, time dilation, mass-energy relation, Doppler effect,
CO4	light cone and its significance, problems involving energy momentum conservations

Course Content

Unit-1-Non-inertial systems	**Lectures: 18 h**
Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.	

Unit-2-Introduction to Relativity	**Lectures: 18 h**
Origin and significance of Special theory of relativity, Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations, Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Relativistic Doppler effect.	
Unit-3-Relativistic Kinematics	**Lectures: 18 h**
Variation of mass with velocity. Relativistic Momentum, Relativistic kinetic energy, Massless Particles. Mass-energy Equivalence. Rest mass energy, Relativistic Kinematics. Lorentz Transformations, Transformation of Energy and Momentum, Transformation of Force,Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox.	
Unit-4- Relativistic dynamics	**Lectures: 18 h**
Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics: Application to two-body decay of an unstable particle. Acceleration of charged particle by constant electric field, transverse Electric field..	

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
SK Bose	An Introduction t General Relativity	Wiley Eastern Limited, New Delhi	1980	978-0470270547

RK Patharia	Theory of Relativity	Hindustan Pub. Delhi	1974	978-0486428192
R. Resnick	Introduction to Special Relativity	John Wiley and Sons	2005	NA

Course Title: Elements of Modern Physics

L	T	P	Total Credits
3	0	1	4

Course Outcomes

CO1	Have the knowledge of demarcation of classical physics and modern physics, historical development of quantum and relativistic physics
CO2	Appreciates the understanding of plank's theory of radiation and have the fundamental understanding of dual nature of light
CO3	Understand the theory of quantum measurements, wave packets and uncertainty principle
CO4	Learning about the wave mechanics and associated mathematical formulations
CO5	Learning the quantum concepts of particle being in different potentials with a few specific cases of potential shapes

CO6	Understanding the properties of nuclei, radioactive decay and nuclear reactions explained by quantum mechanics
CO7	Understanding of good knowledge of lasing action (stimulated emission of radiation, optical pumping and population inversion), construction of different laser systems and their working with specific examples in various fields

Course Content

Unit-1- Origin of Quantum Theory	**Lectures: 13**
Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions	
Unit-2-Wave-Particle Duality & Schrodinger Wave Equation	**Lectures: 14**
Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle. Energy-time uncertainty principle- application to virtual particles and range of an interaction. Two slit interference experiment with photons, atoms and particles, linear superposition principle as a consequence; Matter waves and wave amplitude. Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.	
Unit-3- One Dimensional Problems	**Lectures: 4**
One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension- across a step potential & rectangular potential barrier.	
Unit-4- Nuclear Physics	**Lectures: 15**
Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of	

an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay-energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion- mass deficit, relativity and generation of energy; Fission – nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Unit-5- Lasers & its applications	**Lectures: 8**
Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. 3-Level and 4-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing. Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.	

Elements of Modern Physics Practical	**Practicals: 36 h**
Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment. ● To determine the wavelength of H-alpha emission line of Hydrogen atom. ● To determine work function of material of filament of directly heated vacuum diod ● To determine the ionization potential of mercury. ● To study the Photo-electric effect. ● To determine the Planck's constant using LEDs of at least 4 different colours. ● To determine the Planck's constant using black body radiation and photo-detector ● Dependence of scattering angle on kinetic energy and impact parameter in Rutherford scattering (mechanical analogue). ● To determine the absorption lines in the rotational spectrum of Iodine vapour ● To determine (i) wavelength and (ii) angular spread of He-Ne laser plane diffraction grating.	

- To setup the Millikan oil drop apparatus and determine the charge of an electron

Text Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Rich Meyer, Kennard, Coop, 2002	Introduction to Modern Physics	Tata Mc-Graw Hill	2002	**978-0070995420**
David J. Griffith	Introduction to Quantum Mechanics	Pearson Education	2005	**978-1316646519**
Arthur Beiser	Concepts of Modern Physics	McGraw-Hill.	2002	**978-0070151550**
J.R. Taylor, C.D. Zafiratos, M.A. Dubson	Modern Physics for Scientists and Engineers	PHI Learning	2004	**978-0138057152**
R. Gautreau and W.	Schaum`s outline of Theory and	Tata McGraw-Hill Publishing	1999	**0070230625**

Savin, 2nd Edn,	Problems of Modern Physics	Co. Ltd.		

Course Title: OOPS using C++

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction	**14 h**
Difference between C and C++, Procedure Oriented and Object-Oriented Approach, Basic Concepts: Objects, classes, Principals like Abstraction, Encapsulation, Inheritance and Polymorphism. Dynamic Binding, Message Passing, Characteristics of Object-Oriented Languages	
Unit II: Classes & Objects	**13 h**
Abstract data types, Object & classes, attributes, methods, C++ class declaration, Scope resolution operator, Friend Functions, Inline functions, Constructors and destructors, instantiation of objects, Types of Constructors, Static Class Data, Array of Objects, Constant member functions and Objects, Memory management Operators	
Unit III: Inheritance and Polymorphism	**17 h**
Inheritance, Types of Inheritance, access modes – public, private & protected, Abstract Classes, Ambiguity resolution using scope resolution	

operator and Virtual base class, Aggregation, composition vs classification hierarchies, Overriding inheritance methods, Constructors in derived classes, Nesting of Classes. Polymorphism, Type of Polymorphism – Compile time and runtime, Function Overloading, Operator Overloading (Unary and Binary), this pointer, Virtual Functions, Pure virtual functions.	
Unit IV: Strings, Files and Exception Handling	**10 h**
Manipulating strings, Streams and files handling, Formatted and Unformatted Input output Exception handling: Try, Catch and Block Introduction to Generic Programming – function template, class Template	

List of Experiments:

1. Creation of objects in programs and solving problems through them
2. WAP in C++ to find the sum of individual digits of a positive integer.
3. WAP in C++ to generate the first n terms of the sequence
4. WAP to find both the largest and smallest number in a list of integers.
5. WAP to illustrate New and Delete Keywords for dynamic memory allocation
6. Different use of private, public member variables and functions and friend functions.
7. Use of constructors and destructors.
8. Operator overloading
9. Use of inheritance and accessing objects of different derived classes.
10. Illustrate the concept of multilevel and multiple inheritance.
11. Programs of pointers
12. Program on array pointer using its own name as pointer.
13. Polymorphism and virtual functions (using pointers).
14. Programs on Exception Handling

Course Learning Outcomes:

The student will be able to

1. Articulate the principles of object-oriented problem solving and programming.
2. Outline the essential features and elements of the C++ programming language.
3. Explain programming fundamentals, including statement and control flow and recursion.

4. Apply the concepts of data abstraction, function abstraction, inheritance, overriding, overloading, and polymorphism.
5. Apply the concepts using objects and data abstraction, class, and methods in function abstraction.
6. Analyze, write, debug, and test basic C++ codes using the approaches introduced in the course.
7. Analyze problems and implement simple C++ applications using an object-oriented software engineering approach.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
E Balagurusamy	Object Oriented Programming with C++ (2017) 7th ed.	McGraw Hill Education	2017	9352607996
Schildt H.	C++: The Complete Reference,	Tata McGraw Hill	2003	007053246X
Robert Lafore	Object Oriented Programming in Turbo C++	Galgotia Publications	1991	8185623228
Walter Savitch	Problem solving with C++ :The Object of Programming	Pearson Education.	2002	0321136640

Course Title: ENG104 (Fundamentals of Communication)

L	T	P	Total Credits
2	0	0	2

Course Contents/syllabus:

	Teaching hours
Unit I: Basic Concepts in Communication	**9 h**
● Definition, Nature and Role of Communication ● Communication Networks: Flow, Medium and Channel ● Barriers to Communication ● SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis	
Unit II: Communication Types	**9 h**
● Introduction of Communication Skills (Listening, Speaking, Reading and Writing) ● Nonverbal Communication: Functions and Effective use ● KOPPACT (Kinesics, Oculesics, Proxemics, Paralanguage, Artifacts, Chronemics, Tactilics).	
Unit III: Digital Literacy and Social Media	**8 h**
● Importance of Digital Literacy ● Netiquette ● E-mail Etiquette ● Advantages/Disadvantages of social media ● Effective ways of using social media ● Blogs/Content writing ● Professional Profile on Web	
Unit IV: Gateway to Industry	**10 h**

• Resume Writing • Cover Letter • Interview Skills • LinkedIn Profile • Writing LinkedIn Recommendations .	

Course Learning Outcomes:

- To help students develop skills in the areas of vocabulary, grammar, presentation, and interactive communication so that any deficiencies in either skills or their application do not interfere with communication.
- Prerequisites: Good Listening, Speaking, Reading, and Writing Skills

Books/literature

AUTHOR	TITLE	Publisher	Year of publication	ISBN
P. D. Chaturvedi Mukesh Chaturvedi	Business Communication: Concepts, Cases and Applications	Pearson Education	2006	9788131701720
Meenakshi Raman and Prakash Singh	Business Communication	Oxford Press	2012	9780198077053
Jeff Butterfield	Soft Skills for Everyone	Cengage Learning	2017	9789353501051

Course Title: Electrical Circuits and Network Skills

L	T	P	Total Credits
3	0	0	3

Course Outcomes

CO1	Learn about different types of circuits, different between AC and DC, and how to define them in scientific terms.
CO2	Define different circuits and how to make them in the lab for different purposes.
CO3	learning about motors and ways to generate AC and DC and how to convert former to the later.
CO4	Learn about the importance of diode and rectifiers and how to connect them to AC and DC
CO5	Determine and learn about the wiring and how to keep home/circuits safe.

Course Content

Unit-1-Introduction to Electrical Principles & Circuits	**Lectures: 10**
Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.	
Unit-2-Electrical Drawing and Symbols	**Lectures: 6 h**
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.	
Unit-3-Generators and Transformers	**Lectures: 5 h**
DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.	

Unit-4-Electrical Motors	**Lectures: 4 h**
Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.	
Unit-5-Solid-State Devices	**Lectures: 3 h**
Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.	
Unit-6-Electrical Protection & Wiring	**Lectures: 8 h**
Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device). Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board	

Text Books

Authors	**Title**	**Publisher**	**Ed/year**	**ISBN No**
K.A. Smith and R.E. Alley	Electrical Circuits	Cambridge University Press	1992	978-1847022721
M G Say	Performance and design of AC machines	CBS Publishers & Distributors Pvt. Ltd.	2002	978-8123910277
B L Theraja	A textbook in Electrical Technology.	S Chand & Co	1959	978-8121924900

SEMESTER – IV

Course Title: Electromagnetic Theory

L	T	P	Total Credits
3	0	1	4

Electromagnetic Theory	**Theory: 54 h, Pract.: 36 h**

Course Outcomes

CO1	Achieve an understanding of Maxwell's equations and applications to deduce wave equation, electromagnetic field energy, momentum and angular momentum density. Understanding of the EM propagations in free space, dielectric and metals
CO2	Understanding the reflections, refraction and polarization of EM waves and calculate their coefficients
CO3	Learning of different type of polarization of EM waves and their production and detection
CO4	Application of the concepts of light propagation in optical fibers, light wave communication systems

Course Content

Unit-1-Maxwell Equations	**Lectures: 10**

Review of Maxwell's equations, Displacement Current, The Continuity Equation, Poynting's Theorem,The Wave Equation, Sinusoidal Waves, Electromagnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density, Boundary Conditions: Reflection and Transmission	
Unit-2-EM Wave Propagation in Various Media	**Lectures: 17**
EM Wave in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)	
Unit-3-Interference, Diffraction and Polarization	**Lectures: 18**
Interference: Theory of interference, Fresnel's Biprism, displacement of fringes, fringes with white light, Stoke's law, interference in thin films, non-reflecting films, Newton's rings, Michelson's interferometer, Fabry-Perot interferometer, Diffraction: Fraunhoffer diffraction: single slit, circular aperture, diffraction grating, Rayleigh's criterion for resolution, resolving power of a diffraction grating, Fresnel diffraction at a single slit and circular aperture, Fresnel's half period zones, zone plate; Polarization: Polarization of plane harmonic waves, linear, circular and elliptical polarization, Malus' law, polarization by scattering, Birefringence, quarter- wave and half-wave plates. Double refraction, Nico prism, an analysis of circularly and elliptically polarized light.analysis of circularly and elliptically	
Unit-4-Wave-Guides and Optical Fibres	**Lectures: 9**

Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission. Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). .

Electromagnetic Theory Practical	**Practicals: 72 h**
Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment ● To study the reflection, refraction of microwaves ● To determine the refractive index of liquid by total internal reflection using Wollaston's air-film ● To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece. ● To verify the law of Malus for plane polarized light. ● To analyze elliptically polarized Light by using a Babinet's compensator ● To study the polarization of light by reflection and determine the polarizing angle for air-glass interface ● To study Polarization and double slit interference in microwaves ● To determine the specific rotation of sugar solution using Polarimeter. ● To verify the Stefan`s law of radiation and to determine Stefan's constant. ● To study dependence of radiation on angle for a simple Dipole antenna	

Text Books

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
D.J. Griffiths	Introduction to Electrodynamics, 4th	Prentice Hall India, New Delhi	2012	**978-1108822909**

	ed.			
A.Z. Capri and P.V. Panat	Introduction to Electrodynamics	Narosa Publishing House	2010	978-8173193293
L. D. Landau and E. M. Lifshitz & L. P. Pitaevskii	Electrodynamics of Continuous Media	Oxford	2005	**978-8181477934**
John David Jackson	Classical Electrodynamics,3rd Ed	Wiley	1998	**978-0471309321**
S. P. Puri	Classical Electrodynamics	Narosa	2011	**978-8184875843**

Course Title: Thermal Physics

L	T	P	Total Credits
3	**0**	**1**	**4**

Course Outcomes

CO1	Comprehend of the basics of thermodynamics, understanding the concept of temperature, work and heat and their mutual conversions within each other, Zeroth law, first law of thermodynamics and its application in calculating the heat flow into and work done by a system
CO2	Second law of thermodynamics and to relate it to the operation of heat engines, particularly the Carnot engine
CO3	Understand the basis of entropy and its relation to the second law of thermodynamics and calculate entropy changes in different processes
CO4	Understand the microscopic picture to link with the microscopic state variables be able to derive and use Maxwell's equations
CO5	Learning of the basic concept of kinetic theory of gases and their distribution pertaining to the gas particles (Maxwell-Boltzman distribution) and calculate properties of gases including the heat capacity and mean free path
CO6	Use the theory of equi-partition to relate the structure of the molecules to the measured heat capacity
CO7	Learn about the real gas equations, Van der Waal equation of state, the Joule-Thompson effect

Course Content

Unit-1-Introduction to Thermodynamics	**Lectures: 18**
Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient.	

Unit-2-Second Law of Thermodynamics & Entropy	**Lectures: 18**
Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin- Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.	
Unit-3-Maxwell's Relations and Thermodynamic Potentials	**Lectures: 18**
Maxwell's Relations: 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. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.	
Unit-4-Kinetic Theory of Gases	**Lectures: 18**
Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. Behavior of Real Gases: Deviations from the Ideal Gas Equation. TheVirial Equation. Andrew's Experiments on CO2 Gas. Critical	

Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

Thermal Physics Practical	**Practicals: 72**

Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment.

- To measure the coefficient of linear expansion for different metals and alloys.
- To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer.
- To measure the thermal conductivity and thermal diffusivity of a conductor.
- To determine Mechanical Equivalent of Heat.
- To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
- To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
- To determine the value of Stefan's Constant of radiation.
- To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee disc method.
- To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its two Junctions.
- To determine thermal conductivity of a bad conductor disc using constant current source for heating and thermocouples for temperature measurements.

Text Books:

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Authors	Title	Publisher	Ed/year	ISBN No
Carl S. Helrich	Modern Thermodynamics with Statistical Mechanics	Springer	2009	978-3642099090

Sears & Salinger	Thermodynamics, Kinetic Theory & Statistical Thermodynamics	Narosa Publishing House	1988	978-8185015712
M.W. Zemansky and Richard Dittman	Heat and Thermodynamics	McGraw-Hill	1981	978-0070700352
S.J. Blundell and K.M. Blundell	Concepts in Thermal Physics	Oxford University Press	2nd Ed. 2012	978-0199562107
C. Kittel and H. Kroemer	Thermal Physics	W. H. Freeman	Second edition, 1980.	978-0716710882

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Course Title: Quantum Physics

L	T	P	Total Credits
3	0	1	4

Course Outcomes

CO1	Review on the inadequacies of classical mechanics in understanding atomic/subatomic physical phenomenon and the introduction of quantum mechanics, learning of quantum formulation with Schrodinger equation
CO2	Learning of the mathematical tools of quantum mechanics; wave function, probabilistic interpretation are exposed to the students
CO3	Through understanding of the behaviour of quantum particle facing step, barrier and potentials, exposure to the solution of non-relativistic hydrogen atom
CO4	Appreciates the influence of electric and magnetic fields on atoms/molecules

Course Contents

Unit-1- The Schrodinger Equation & its Mathematical Implication	**Lectures: 18**
Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle	
Unit-2- One Dimensional Quantum Problems	**Lectures: 18**
General discussion of bound states in an arbitrary potential- continuity of wavefunction, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle	

Unit-3-Quantum Theory of Hydrogen-like Atoms	**Lectures: 18**
Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells.	
Unit-4- Atomic & Molecular Physics	**Lectures: 18**
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. Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). Pauli's Exclusion Principle. Symmetric & Antisymmetric WaveFunctions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J- J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).	
Quantum Mechanics and Applications Practical	**Practicals: 36**
Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment. ● To study Zeeman effect: with external magnetic field. ● To study Quantum efficiency of CCDs. ● To Study Electron spin resonance for determination of magnetic field as a function of the resonance frequency. ● To show the quantum tunneling effect in tunnel diode using I-V characteristics ● Use C/C++/Scilab for solving the following problems based on Quantum Mechanics to solve the s-wave Schrodinger equation for the ground state & the first excited state of the hydrogen atom. Obtain the energy eigenvalues and plot the corresponding wavefunctions. ● Use C/C++/Scilab for solving the following problems based on Quantum Mechanics to solve the s-wave radial Schrodinger equation for an atom for the	

screened coulomb potential. Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction.

- Use C/C++/Scilab for solving the following problems based on Quantum Mechanics to solve the s-wave radial Schrodinger equation for an atom for anharmonic oscillator potential for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function.
- Use C/C++/Scilab for solving the following problems based on Quantum Mechanics to solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule using morse potential. Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Text Books:

Authors	**Title**	**Publisher**	**Ed/year**	**ISBN No**
P.M.Mathews and K.Venkatesan	A Text book of Quantum Mechanics,,	McGraw Hill	2nd Ed.,2017,	978-0070146174
D.J. Griffith,	Introduction to Quantum Mechanics	Cambridge India	2nd Ed. 2016	978-1316646519
Robert Eisberg and Robert Resnick	Quantum Mechanics of Atoms, Molecules,	Wiley	2nd Edn., 2006	978-8126508181

	Solids, Nuclei and Particles			
G. Aruldhas	Quantum Mechanics	PHI Learning of India	2nd Edn. 2008	978-8120336353
Arno Bohm	Quantum Mechanics: Foundations & Applications,	SPRINGER (SIE)	3rd Edn., 2003	978-8181280725

Course Title: Programming in Python

L	T	P	Total Credits
3	0	1	4

Course Contents/syllabus:

		Teaching Hours

Unit I: Introduction		**13 H**
History of Python, Need of Python Programming, Applications, Basics of Python Programming, Using the IDLE, Running Python Scripts, Installation of Jupyter Notebook, Variables, Assignment, Keywords, Input-Output, Indentation, comments		
Unit II: Types, Operators and Expressions		**14 H**
Types – Integers, Strings, Booleans; Operators- Arithmetic, Comparison (Relational), Assignment, Logical, Bitwise, Membership, Identity, Precedence, Control Flow- if, if-elif-else, for, while, break, continue, loops, types of loops.		
Unit III: Data Structures in Python		**14 H**
Lists – Operations, Slicing, Methods; Tuples: Creating, Printing, properties of tuples, Sets, Dictionaries, Sequences and their properties. Defining Functions, Calling Functions, Passing and Returning Arguments, Scope of the Variables in a Function – Global and Local Variables		
Unit IV: Python packages and OOPS		**13 H**
Introduction to PIP, Installing Packages via PIP, Using Python Packages, OOPs in Python, Classes, self-variable, Methods, Constructor Methods.		

List of Experiments **(Total:36 Hours)**

1. Perform installation of python, of jupyter notebook
2. Execute a basic python program with a print message.
3. WAP to Check the Python version on command line
4. WAP to display the current date and time.
5. WAP to get Multiple inputs From a User in One Line
6. WAP which accepts the user's first and last name and print them in reverse order with a space between them.

7. WAP to implement show Operators Precedence and loops.
8. WAP to declare, access and print a dictionary
9. WAP to check whether a given key already exists in a dictionary.
10. WAP to implement functions: call by value
11. WAP to show use of local and global variables
12. WAP to implement classes and objects in python.

Course Learning Outcomes: After studying this course students will be able to:

1. Understand the basics of programming and implement basic python programs, input output functions, types and operators.
2. Develop programs using conditional, branching, iteration.
3. Learn the functions declaration, implementation, arguments.
4. Develop an application using the concepts of list, dictionary, tuples solve engineering and/or scientific problems
5. Implement object-oriented principles via python programming.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Paul Barry	Head First Python	O'Reilly Media, Inc.	2016	9781491919538
John V. Guttag	Introduction to computation and programming using python	PHI Publisher.	2016	978-0262529624
Kenneth A. Lambert	Fundamentals of Python	Cengage	2019	9789353502898

Vamsi Kurama	Python Programming: A Modern Approach	Pearson	2018	978-9332587526

Course Title: Professional Etiquette and Workplace Communication

L	T	P	Total Credits
2	0	0	2

Course Learning Outcomes: At the end of this course, students will be able to:

- Understand the nature, importance, and process of written communication.
- Deliver effective presentations in contexts that may require power point, extemporaneous or impromptu oral presentations
- Acquire and exhibit professional etiquette.
- Respect other cultures and develop rapport in a multicultural society, thereby developing a broadened unbiased perspective.

Course Contents/syllabus:

	Teaching Hours
Unit I—Writing Process & Workplace Communication	**9 hrs**
• Writing process: Pre-writing, writing & post writing • 7Cs of Writing • Business Letters • Notice • Agenda • Minutes of meeting • Virtual Meeting and Video Conferencing • Nuances of conducting effective meetings	
Unit II—Presentation Skills	**10 hrs**
• Planning, preparation, Practice, Performance • Audience analysis • Analyzing the nonverbal communication • Story-Telling • Methods of Delivery: Impromptu, Extemporaneous, Memorisation, Manuscript, Outlining	
Unit III— Professional Etiquette	**8 hrs**

• Power Dressing • Telephonic Manners/ Voice mail etiquette • Business Salutation Etiquette • Different Cultural Etiquette & Protocol • Teamwork • Time-Management	
Unit IV- Cross Cultural Communication	**9 hrs**
• Cross Cultural Communication: meaning and significance • Definition of Culture • Elements of Culture • Characteristics of Culture • Culture and Context • Cultural Shock: Meaning and Stages • Ethnocentrism, Stereotyping, Xenophobia and Cultural Relativism • Strategies for Effective Communication in multicultural context • Acculturation	

Text / Reference Books:

Herta Mur phy , Herbert Hildebrandt, Jane Thomas	Effective Business Communication	McGraw Hill Education	2017	978-0070187757	640

Karen Schneiter Williams, Joyce P Logan, A.C. Buddy Krizan, Patricia Merrier	Communicating in Business	Cengage Learning India Private Limited	2012	978-8182093195	712
Ryan Sharma	The Unwritten Rules of Professional Etiquette	Habile Press	2020	978-1734980509	122

Course Title: Basic Instrumentation Skills

L	T	P	Total Credits
3	0	0	3

Course Outcomes

CO1	Learn error calculation and the importance of errors in scientific instruments.
CO2	Measure voltage-current using multimeter and learn to operate, read and use the multimeter
CO3	Learn techniques about continuous and pulsed signals and learn to use LCR circuit

CO4	Understanding oscilloscope, its working principle, and using it for day-to-day scientific measurements
CO5	Learn to use digital devices and learn ease of working with them.

Course Content

Unit-1-Introduction to Measurements	**Lectures: 5**
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 & resistance. Specifications of a multimeter and their significance	
Unit-2-Electronic Voltmeter	**Lectures: 5**
Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC milli voltmeters. Block diagram ac milli-voltmeter, specifications and their significance.	
Unit-3-Signal Generators and Impedance Bridges	**Lectures: 7**
Block diagram, explanation and specifications of low frequency signal generator and pulse generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. Block diagram of bridge. Working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram and working principles of a Q-Meter. Digital LCR bridges	
Unit-4- Oscilloscope	**Lectures: 9**
Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	
Unit-5-Digital Instruments	**Lectures: 5**
Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.	
Unit-6-Digital Multimeter	**Lectures: 5**

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

Text/ Reference Books

Authors	Title	Publisher	Ed/year	ISBN No
M G Say	Performance and design of AC machines	CBS Publishers & Distributors Pvt. Ltd	ELBS Edn, 2005	978-8123910277
S. Salivahanan & N. S.Kumar	Electronic Devices and circuits	Tata Mc-Graw Hill	4th edition	978-9339219505
B L Theraja	A text book in Electrical Technology	(S Chand & Co.	1959	978-8121902908
Subrata Ghoshal	Digital Electronics	Cengage Learning	2012	978-9386858375

SEMESTER-V

Course Title: Nuclear Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Become familiar with nuclear structure and its fundamental properties, concept of binding energy and binding energy curves explaining the nuclear fission and fusion
CO2	Learning about the nuclear models (liquid drop model, shell model) in explaining different properties of the nucleus
CO3	Revision of the process of radioactivity, decay law and emission of alpha, beta and gamma rays
CO4	Learning the mechanisms of the emission of alpha, beta and gamma rays, outlines of Gamow's theory of alpha decay and Pauli's theory of beta decay with the neutrino hypothesis, the electron capture, the fine structure of alpha particle spectrum, the Geiger-Nuttall law, the radioactive series
CO5	Understand the basics of nuclear reactions, reaction cross sections and types of nuclear reactions

Course Content

Unit-1-General Properties of Nuclei	**Lectures: 18**
Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy & its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.	
Unit-2-Models	**Lectures: 18**

Liquid drop model approach, semi empirical mass formula & significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclea shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.	
Unit-3-Radioactivity	**Lectures: 18**
Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. Beta decay: energy kinematics for -decay, positron emission, electron capture, neutrino hypothesis. Gamma decay: Gamma rays emission & kinematics, internal conversion.	
Unit-4-Nuclear Reactions & Interactions	**Lectures: 18**
Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). 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.	

Text / Reference Books

Authors	Title	Publisher	Ed/year	ISBN No
K. Hyde	Basic Ideas and Concepts in Nuclear Physics	Institute of Physics	2004	978-0750309806
Herald Enge	Introduction to Nuclear Physics	Addison-Wesley	1971	978-0201018707
I.Kaplan	Nuclear Physics	Narosa	2002	978-8185015897

E. Segre	Nuclei and Particles	W.A. Benjamin Inc	1965	978-0805386011

Course Title: Solid State Physics

L	T	P	Total Credits
4	0	2	6

Course Outcomes

CO1	The ability to explain crystalline and amorphous structures, understanding about lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones
CO2	Understanding of the concept of Brang's X-ray diffraction by crystalline materials
CO3	Knowledge of lattice vibrations, phonons and specific heat of solids in view Einstein and Debye theory
CO4	Secured an understanding about the dielectric and ferroelectric properties of materials
CO5	Learning of the band theory of solids in understanding to differentiate conductors, insulators and semiconductors
CO6	Learning of the basic knowledge of the superconducting nature of the materials and their classifications

Course Contents

Unit-1- Crystal Physics	**Lectures: 18**
Solids: Amorphous and Crystalline Materials. Lattice TranslationVectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.	

Atomic and Geometrical Factor.	
Unit-2-Elementary Lattice Dynamics and their Properties	**Lectures: 18**
Lattice Vibrations and Phonons: Linear Monoatomic-Diatomic Chains. Acoustical and Optical Phonons. Qualitative description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein, Debye theories of specific heat of solids. T^3 law. Dia-, Para-, Ferri- and Ferromagnetic Materials.Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.	
Unit-3- Dielectrics and Related Properties	**Lectures: 18**
Polarization. Local Electric Field at an Atom.Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.	
Unit-4- Elementary Band Theory and Superconductivity	**Lectures: 18**
Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. 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)	

Solid State Physics Practical	**Practicals: 72 h**

Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment

- To measure the Magnetic susceptibility of Solids.
- Measurement of susceptibility of paramagnetic solution
- To measure the Dielectric Constant of a dielectric Materials with frequency
- To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance
- To determine the refractive index of a dielectric layer using Surface Plasmon resonance.
- To draw the BH curve of Fe using Solenoid and determination of energy loss using Hysteresis loop.
- To study the PE Hysteresis loop of a Ferroelectric Crystal
- To measure the resistivity and band gap energy of a semiconductor (Ge/Si) with temperature using four-probe method
- To determine the Hall coefficient of a semiconductor sample
- To determine the Coupling Coefficient of a Piezoelectric crystal.

Text/Reference Books:

Authors	**Title**	**Publisher**	**Ed/year**	**ISBN No**
Charles Kittel	Introduction to Solid State Physics	Wiley	2004	9788126535187
N.W. Ashcroft, N.D. Mermin	Solid State Physics	Cengage Learning	1976	8131500527
M.A. Wahab	Solid State Physics	Narosa Publications	2011	8184874936

Course Title: Analog Systems and Applications

L	T	P	Total Credits
4	0	2	6

Course Outcomes

CO1	Concept of N and P type semiconductors, learning of the carrier action (mobility and drift) and learning of the basic p-n junction device fabrication and characteristics under different biasing with its applications in rectifiers and voltage regulator systems
CO2	Learning of transistors NPN and PNP basic biasing configurations namely common base, common emitter and common collector, and also about current and voltage gain.
CO3	Biasing and equivalent circuits coupled amplifiers and feedback in amplifiers and oscillators
CO4	Learning the characterization of various devices namely PN junction diodes, LEDs, Zener diode, solar cells, PNP and NPN transistors. Also construct amplifiers and oscillators using discrete components
CO5	Demonstrate inverting and non-inverting amplifiers using op-amps
CO6	Learning of FETS as junction field effect transistors and metal oxide semiconduction FETSs, and their characteristics

Course Content

Unit-1-Semiconductor Diodes and their Applications	**Lectures: 18**
P and N type semiconductors. Energy Level Diagram. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction. Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Current Flow Mechanismin Forward and Reverse Biased Diode, V-I characteristics of pn junction diode. (1) Zener Diode and Voltage Regulation. (5) Rectifier Diode: Half-	

waveRectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, Types of filters: L-filter, C-filter, LC and pi-filter	
Unit-2-Bipolar Junction Transistors	**Lectures: 18**
N-P-N and P-N-P Transistors. Characteristics of CB, CEand CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains.	
Unit-3-Amplifiers and Oscillators	**Lectures: 18**
Classification of Class A, B & C Amplifiers. Two stage RC-coupled amplifier and its frequency response. Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Oscillators: Components of oscillator: tank circuit, transistor amplifier, feedback circuit. Classification of oscillators based on method, nature of waveform, frequency of generated voltage Barkhausen's Criterion for self-sustained oscillations. Hartley & Colpitts oscillators.	
Unit-4- Field effect Transistors and Operational Amplifiers	**Lectures: 18**
Black Box approach: Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Slew Rate and concept of Virtual ground. Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, FETs and its classification, Advantages and disadvantages of FET; JFET: Fabrication, Working mechanism, Drain and transconductance characteristics, pinch-off voltage, JFET biasing, FET as amplifier, Difference between BJT and FET; MOSFET: Types, characteristics: enhancement and depletion MOSFET, Complementary MOS inverter.	

Analog Systems and Applications Practical	**Practicals: 72**

Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment.

- To study I-V characteristics of semiconductor diode.
- To Study I-V & power curves of solar cells, find maximum power point & efficiency.
- To study voltage regulation of zener diode
- To study the ripple factor for a half-wave rectifier with L filter, C-filter, pi-filter.
- To study the ripple factor for a full-wave rectifier with L filter, C-filter, pi-filter.
- To study the ripple factor for a bridge rectifier with L filter, C-filter, pi-filter.
- To study common emitter characteristics of a given transistor.
- To study the VI characteristics of PN junction diode
- To study the VI characteristics of Zener junction diode
- To determine the DC Load line and Q-point using Load line analysis of transister
- To add two dc voltages using Op-amp in inverting and non-inverting mode
- To analyse the use of an op-amp as an Integrator.
- To analyse the use of an op-amp as an Differentiator.

Text Books:

Authors	**Title**	**Publisher**	**year**	**ISBN No**
J. Millman and C.C. Halkias	Integrated Electronics	Tata Mc-Graw Hill	1991	978-0070151420

J.D. Ryder	Electronics: Fundamentals and Applications	Prentice Hall	5th edition	978-0132513715
R.A. Gayakwad	OP-Amps and Linear Integrated Circuit,	Prentice Hall	4th edition, 2000	978-9332549913
A.S. Sedra, K.C. Smith, A.N. Chandorkar	Microelectronic circuits	Oxford University Press	7th edn, 2014	9780199476299
B.G.Streetman & S.K.Banerjee	Solid State Electronic Devices	PHI Learning	7th edn	978-9332555082
U.Tietze, C.Schenk	Electronic circuits: Handbook of design & applications	Springer	2008	978-3540004295
S.M. Sze	Semiconductor Devices: Physics and Technology	Wiley India	2002	978-0470537947
M.H. Rashid	Microelectronic Circuits	Cengage Learning	2nd Edn	978-1305635166

Thomas L. Floyd	Electronic Devices	Pearson India	9th edition	978-0132549851

Course Title: Data Science and Analytics

L	T	P	Total Credits
4	0	2	6

Course Outcomes

CO1	Understand the basics principles and concepts of data science.
CO2	Implement techniques to manage, manipulate, cleanse and analyse data.
CO3	Analyze on the performance of various models and the quality of the results.
CO4	Gain the insights from the data with the help of statistical inferences.
CO5	Transform the real time data for performing data analysis.

Course Content

Unit I: Introduction	**11 H**
Introduction to Data Science, Sources of Data, Information Commons, Data Science Project Life Cycle, Data Definitions and Analysis Techniques: Elements, Variables, and Data categorization,Levels of Measurement, Data management and indexing	
Unit II: Data Preprocessing	**11 H**
Introduction to Data Preprocessing, Reading, Selecting, Filtering Data, Filtering Missing Values, Manipulating, Sorting, Grouping, Rearranging, Ranking Data	
Unit III: R programming	**12 H**
R Basics- data types and objects, control structures, data frames, Feature Engineering - scaling, encoding, Model fitting using R, Formulation of Hypothesis.	
Unit IV: Statistical Measures and Performance metrices	**11 H**
Handling of CSV, Measures of Central Tendency (Mean, Median, and Mode), Measures of Variability. Loss Function and Error: Mean Squared Error, Root Mean Squared Error, Model Selection and Evaluation criteria: Accuracy, Precision, F1 score, Recall Score, Sensitivity, Specificity.	

Data Science and Analytics Practical	**Practicals: 72**
● Perform linear regression using a dataset. ● Perform data pre-processing techniques on real datasets. ● Analyze behavior of customers for any online purchase model. ● Implement performance evaluation of compared models for real-life dataset. ● Automate email classification task. ● Analyze twitter data for real and fake news. ● Implement data frames for collection of series.	

Text / Reference Books:

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
Hadley Wickham, Garrett Grolemund	R for data science: Import, Tidy, Transform, Visualize, And Model Data	O'Reilly Media	2017	978-1491910399
Carl Shan, Henry Wang, William Chen, Max Song.	The Data Science Handbook: Advice and Insight from 25 Amazing Data Scientists.	The Data Science Bookshelf.	2016	978-0692434871

Roger Peng	R Programming for Data Science	Lulu.com	2012	978-1365056826
James, G., Witten, D., T., Tibshirani, R.	An Introduction to statistical learning with applications in R	Springer.	2013	978-1461471370

SEMESTER – VI

Core course: Particle Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Become familiar with interaction of radiation with charged particles and detection
CO2	Learning about the elementary particles

CO3	Understanding the properties and reaction mechanism of elementary particles
CO4	Learning the physics behind the particle detectors and accelerators

Course Content

Unit-1-Interaction of radiation and detection	**Lectures: 18**
Interaction of radiation and charged particles with matter : Energy loss of electrons and positrons, Positron annihilation in condensed media, Stopping power and range of heavier charged particles, derivation of Bethe-Bloch formula, interaction of gamma rays with matter and Gas-filled detectors, proportional and Geiger-Muller counters, Scintillation detectors, solid-state detectors, Cherenkov effect, calorimeter-electromagnetic and hadron, specialized detectors, solid state nuclear track detectors, bubble chambers, nuclear emulsions.	
Unit-2-Elementary Particles	**Lectures: 18**
Historical introduction, fermions and bosons, particles and antiparticles, Classification of particles, types of interactions, electromagnetic, weak, strong interactions, gravitational interactions, Quantum numbers and conservation laws, isospin, charge conjugation, Yukawa theory, Introduction to quarks and qualitative discussion of the quark model, high energy physic units.	
Unit-3-Particle Properties	**Lectures: 18**
Properties and life time of muon, pions: Determination of mass, spin and parity. Lifetime of neutral pion and isotopic spin. Strange particles: V particles, charged K-mesons, mass and life time for charged K-mesons. Observations of different strange particles (Λ°, Σ°, Σ± , Ξ°, Ξ+, Ω), strange particle production and decay. Strangeness and Hypercharge.	
Unit-4- -Particle Accelerators	**Lectures: 18**

Accelerators, linear accelerators, cyclic accelerators, ion sources, focussing, stability, electron synchrotron, colliding beam machines, particle beams for fixed target experiments, CERN Super Proton Synchrotron (SPS) and Fermilab Tevatron.

Text Books

Authors	**Title**	**Publisher**	**Ed/year**	**ISBN No**
Griffiths D	Introduction to Elementary Particles	Wiley	2008	978-3527406012
D.H. Perkins	Introduction to High Energy Physics	Cambridge University	2000	978-0521621960
I.S. Hughes	Elementary Particles	Cambridge University	1991	978-0140802771
R. P. Feynman, S. Weinberg	Elementary Particles and the Laws of Physics	Cambridge University	1999	978-0521658621
M.P. Khanna	Introduction to Particle Physics	Prentice Hall India Learning Private Limited	1999	978-8120312685

Course Title: Statistical Physics

L	T	P	Total Credits
4	0	2	6

Course Outcomes

CO1	Understand the basic concept of mathematical statistics and classical statistics defining the concepts of micro/macro states, ensembles, phase space and thermodynamic probability and partition function
CO2	Learning the derivations for classical black body radiation. Wien's law, Rayleigh Jeans law, ultraviolet catastrophe. Saha ionization formula
CO3	Understanding of the three different distribution schemes of particles in terms of their distinguishably or indistinguishably nature distribution laws e.g. Maxwell-Boltzmann distribution, Bose-Einstein distribution and Fermi-Dirac distribution laws of particles and their derivation
CO4	Comprehend and articulate the connection as well as dichotomy between classical statistical mechanics and quantum statistical mechanics

Course Content

Unit-1-Classical Statistics	**Lectures: 18**
Macrostate & Microstate, Elementary Concept of Ensemble, PhaseSpace, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature	
Unit-2-Theory of Radiation	**Lectures: 18**

Properties of Thermal Radiation. Blackbody Radiation.Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. Spectral Distribution of Black Body Radiation.Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.
Unit-3-Bose-Einstein Statistics **Lectures: 18**
B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.
Unit-4-Fermi-Dirac Statistics **Lectures: 18**
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.

Statistical Physics Practical	**Practicals: 72 h**
Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment. ● To Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature. ● To Plot Specific Heat of Solids for ○ Dulong-Petit law ○ Einstein distribution function ○ Debye distribution function for high temperature and low temperature and compare them for these two cases. ● 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 for Study of local number density in the equilibrium state (i) average; (ii) fluctuations	

- 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 for study of transient behavior of the system (i.e. approach to equilibrium).
- Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
- Computation and study of mean molecular speed and its dependence on particle mass
- Computation of fraction of molecules in an ideal gas having speed near the most probable speed
- To Plot Maxwell-Boltzmann distribution function versus temperature.
- To Plot Bose-Einstein distribution function versus temperature.
- To Plot Fermi-Dirac distribution function versus temperature.

Text Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

Reference Books:

- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press
- Elementary Statistical Physics, C. Kittel, Dover Publications, 2012

Course Title: Digital Systems and Applications

L	T	P	Total Credits
4	0	2	6

Course Outcomes

CO1	Understand the IC packaging and signal levels for TTL, ECL and CMOS technologies
CO2	Learn to synthesize the Boolean functions, simplification and construction of digital circuits by employing Boolean algebra
CO3	Sequential systems by choosing Flip-Flop as a building block- construct multivibrators, counters to provide a basic idea about memory including RAM, ROM and also about memory organization
CO4	Microprocessor and assembly language programming with special reference to Intel µP 8085

Course Contents

Unit-1-Digital Principles and Circuits	**Lectures: 18**
Definition of digital signals and waveforms, digital logic, digital integrated circuits: TTL, ECL and CMOS, IC signal levels and IC packaging. Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers.Decimal to Binary and Binary to Decima Conversion. ~~BCD,~~ Octal and Hexadecimal numbers. Signed and unsigned binary numbers, Binary Addition. Binary Subtraction using 2's Complement. Weighted and Non-weighted Binary codes: BCD, Excess-3, Gray code, ASCII.AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates. XOR and XNOR Gates	
Unit-2-Boolean algebra and Combinational Logic Circuits	**Lectures: 18**
De Morgan's Theorems. Boolean Laws. Universal Gates, Simplification of LogicCircuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method, (2) Product of sums, and (3) Karnaugh Map. Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor, BCD Adder, Parity Generator and checker IC 555: block diagram and applications: Astable multivibrator and Monostable	

multivibrator.	
Unit-3-Sequential Logic Circuits	**Lectures: 18**
SR, D, T and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip- Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JKFlip-Flop. Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel- in-Parallel-out Shift Registers (only up to 4 bits). Universal shift register, Asynchronous counters, Decade Counter. Synchronous Counter. Ring Counter. Design of Synchronous and Asynchronous sequential circuits: Model selection, state transition diagram, design equation and circuit diagram	
Unit-4-Memory, 8085 Microprocessor & Assembly Language	**Lectures: 18**
Memory devices: RAM and ROM, memory cell, read/write cycle, PLDs, CAM, CCD memory. Memory Map. Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing And Control circuitry. Timing states. Instruction cycle, Memory organization & addressing. Memory Interfacing. Timing diagram of MOV and MVI. 1 byte, 2 byte & 3 byte instructions	

Digital Systems and Applications Practical	**Practicals: 72 h**
Objective: The laboratory exercises in this section have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipment. ● To test a Diode and Transistor using a Multimeter. ● To verify binary addition and subtraction using basic logic gates ● To verify the function of basic logic gates (AND, OR, NOT) ● To verify and design various logic gates using NAND gate (AND, OR, NOT and XOR gates) ● To minimize a given logic circuit ● Half Adder, Full Adder and 4-bit binary Adder ● To build Flip-Flop circuits using NAND gates ● To build a 4-bit Counter using D-type/JK Flip-Flop Ics and study timing diagram	

- To design an astable multivibrator of given specifications using 555 Timer.
- To design a monostable multivibrator of given specifications using 555 Time
- To Write various programs using 8085 Microprocessor

Text Books:

Authors	Title	Publisher	Year	ISBN No
A.P.Malvio, D.P.Leach and Saha	Digital Principles and Applications	Tata McGraw	7th Ed., 2011	978-9339203405
R.S. Goankar	Microprocessor Architecture Programming & applications with 8085	Prentice Hall	2002	978-8187972884
R.J.Tocci, N.S.Widmer and Greg Moss	Digital Systems: Principles & Applications	PHI Learning	2001	978-0134220130
Anand Kumar, 2nd Edn,	Fundamentals of Digital Circuits	PHI Learning Pvt. Ltd.	2009,	978-8120352681
G K Kharate	Digital Electronics	Oxford University Press	2010	978-0198061830

Course Title: Astronomy and Astrophysics

L	T	P	Total Credits
5	1	0	6

Course Outcomes

CO1	Ability to comprehend the tools of studying the universe, planetary systems and stars defining astronomical scales and understand the basic concept of positional astronomy (Astronomical Coordinate Systems)
CO2	Understand the basic properties of stars (brightness, mass, luminosity, flux and spectral classification) and learning of the astronomical techniques, various types of optical telescopes, telescope mountings and detectors.
CO3	Understanding the composition of the universe in terms of the Sun and solar system: photosphere, chromosphere, corona, solar activity. Solar MHD, helioseismology, solar system and its origin. Nebular model. Tidal forces and planetary rings
CO4	Acquire basic knowledge about the composition of the universe in terms of galaxies and their classification, intrinsic stages of galaxies, galactic halo, Milky Way, gas and dust in galaxy, spiral arm, rotation of galaxy and dark matter. Star clusters in Milky Way, galactic nucleus and its properties
CO5	Learning of the large scale structure and expanding universe and learning of the measurement of distances, time and temperature and radius of star

Course Content

Unit-1-Introduction to Astronomy	**Lectures: 26**
Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and	

Luminosity, Measurement of Astronomical Quantities, Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. 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 Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram. Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium.	
Unit-2-Solar System and Spectra	**Lectures: 10**
Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces Planetary Rings, Extra-Solar Planets. Atomic Spectra Revisited, Stellar Spectra, Spectral Types & Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification	
Unit-3-Galaxy and Properties	**Lectures: 20**
Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral & Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms. 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.	
Unit-4-Expanding Universe & Astronomical Techniques	**Lectures: 16**
Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter). 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

Text/Reference Books

Authors	Title	Publisher	Ed/year	ISBN No
M. Zeilik and S.A. Gregory	Introductory Astronomy and Astrophysics	Saunders College Publishing.		
H. Karttunen et al. Springer	Fundamental of Astronomy (Fourth Edition)	Springer		
Baidyanath Basu	An introduction to Astrophysics	Prentice Hall of India Pvt. Ltd.	2001	
Arny and Stephen Schneider	Explorations: Introduction to Astronomy	McGraw Hill	2014	
B.W. Carroll & D.A. Ostlie	Modern Astrophysics	Addison-Wesley Publishing Co		

Course Title: Nano Materials and Applications

L	T	P	Total Credits
4	0	2	6

Course Outcomes

CO1	Become familiar to Nano systems, learning of quantum confinement, surface to volume effect and introduction to different Nanostructures in 0D, 1D, 2D and 3D
CO2	Learning of the methods of synthesis of Nano Materials such as Bottom-up and Top-down approaches and other instrumentation used in synthesis as well as in characterization processes
CO3	Understand the optical properties of nanostructured materials, modification of band gap, excitonic confinement and different transport mechanisms
CO4	Applications of nanostructured materials in making devices namely MEMS, NEMS and other heterostructures for solar cell and LEDs

Course Content

Unit-1-Nanoscale Structure	**Lectures: 16**
Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.	
Unit-2-Synthesis & Characterization	**Lectures: 20**
Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy.	

Atomic Force Microscopy. Scanning Tunneling Microscopy.	
Unit-3-Properties	**Lectures: 18**
Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure.Quasi-particles and excitons. Excitons in direct & indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.	
Unit-4-Applications	**Lectures: 18**
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 & optical data storage. Magnetic quantum well, magnetic dots-magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	

Nano Materials and Applications Practical	**72 h**
● Synthesis of metal nanoparticles by chemical route. ● Synthesis of semiconductor nanoparticles. ● Surface Plasmon study of metal nanoparticles by UV-Visible spectro-photometer. ● XRD pattern of nanomaterials and estimation of particle size. ● To study the effect of size on color of nanomaterials. ● To prepare composite of CNTs with other materials. ● Growth of quantum dots by thermal evaporation. ● Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD. ● Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.	

- Prepare a thin film capacitor-measure capacitance as a function of temperature or frequency.
- Fabricate a PN diode by diffusing Al over the N-type Si and study its V-I characteristic.

Text/ Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN
C.P. Poole, Jr. Frank J. Owens	Introduction to Nanotechnology	Wiley India Pvt. Ltd	2003	978-0471079354
S.K. Kulkarni	Nanotechnology: Principles & Practices	Capital Publishing Company	2014	978-3319091709
K.K. Chattopadhyay and A. N. Banerjee	Introduction to Nanoscience and Technology	PHI Learning Private Limited	2009	978-8120336087
V.V. Mitin, V.A. Kochelap and M.A. Stroscio	Introduction to Nanoelectronics	Cambridge University Press.	2009	978-0521166843
Richard Booker, Earl Boysen	Nanotechnology: The Fun and Easy Way to Explore the science of Matter's Smallest Particles	John Wiley and Sons	2005	978-8126506255

Course Title: Medical-Physics

L	T	P	Total Credits
4	0	2	6

Course Outcomes

CO1	Become familiar of the concepts of physics applicable in clinical medicine or in particular expertise in medical applications
CO2	Learn about human anatomy, physiology and iophysics, exploring its performance as a physical machine and understanding of the senses
CO3	Understanding about the radiation physics, its kind and various instrumentation in diagnostic tools, imaging techniques, matter interaction, detection and safety practices
CO4	Imparts functional knowledge regarding need for radiological protection and the sources of an approximate level of radiation exposure for treatment purposes

Course Content

Unit-1-Physics of the Human Body	**Lectures: 18**
Basic Anatomical Terminology: Standard Anatomical Position, Planes. Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal. Skeleton, forces, and body stability. Muscles and dynamics of body movement. Physics of Locomotors Systems: joints and movements, Stability and Equilibrium. Energy	

balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation. Physics of breathing, Physics of cardiovascular system. 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. Physics of the nervous system, Electrical signals and information transfer.	
Unit-2-Radiation Physics	**Lectures: 18**
Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose- Rem & Sievert, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, linear attenuation coefficient. Radiation Detectors: ionization (Thimble chamber, condenser chamber), chamber. Geiger Muller counter, Scintillation counters and Solid State detectors, TFT. Electromagnetic spectrum, production of x-rays, x-ray spectra, Brehmsstrahlung, Characteristic x-ray. X-ray tubes and types: 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. Single and three phase electric supply. Power ratings. Types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables.	
Unit-3-Radiation Oncology Physics	**Lectures: 18**
External Beam Therapy (Basic Idea): Telecobalt, Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife. Contact Beam Therapy (Basic Idea): Brachytherapy- LDR and HDR, Intra Operative Brachytherapy. Radiotherapy, kilo voltage machines, deep therapy machines, Telecobalt machines, Medical linear accelerator. Basics of Teletherapy units, deep X-ray, Telecobalt units, Radiation protection, external beam characteristics, dose maximum and build up – bolus, percentage depth dose, tissue maximum ratio and tissue phantom ratio, Planned target Volume and Gross Tumour Volume. Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler. Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy. Computed tomography scanner- principle and function, display, generations,	

mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display)	
Unit-4-Radiation Protection	**Lectures: 18**
Principles of radiation protection, protective materials-radiation effects, somatic, genetic stochastic and deterministic effect. Personal monitoring devices: TLD film badge, pocket dosimeter, OSL dosimeter. Radiation dosimeter. Natural radioactivity, Biological effects of radiation, Radiation monitors. Steps to reduce radiation to Patient, Staff and Public. Dose Limits for Occupational workers and Public. AERB: Existence & Purpose. 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. Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnea Cpap Machines, Ventilator and its modes.	

Medical Physics	**72 h**
● Understanding the working of a manual Hg Blood Pressure monitor, Stethoscope and to measure the Blood Pressure. ● Understanding the working of a manual optical eye-testing machine and to learn eye-testing procedure. ● Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard. ● Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard. ● To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation. ● Familiarization with Geiger-Muller (GM) Counter & to measure background radiation ● Familiarization with Radiation meter and to measure background radiation. ● Familiarization with the Use of a Vascular Doppler.	

Text Books

- Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry – Lippincot Williams and Wilkins (1990)
- Physics of the human body, Irving P. Herman, Springer (2007).

- Physics of Radiation Therapy: F M Khan – Williams and Wilkins, 3 rd edition (2003)

Reference Books

- Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
- Basic Radiological Physics Dr. K.Thayalan- Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)

Semester-VII

Course Title: Classical Mechanics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Learning the knowledge of Newtonian physics from a single particle to a system of particles, generalized coordinates and D'Alembert's Principle and the Lagrangian formulations of classical mechanics, applications in appropriate physical problems
CO2	Learn about the Hamilton's Principle, variational principle, cyclic coordinates and Hamilton's equations
CO3	Understand the Canonical variables. Legendre transformation, Poisson and Lagrange brackets and their properties.
CO4	Learning of rigid body dynamics and small oscillations based normal modes and frequencies for different examples

Course Content

Unit-1-Lagrangian Formulation	**Lectures: 20**

Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity - dependent forces and the dissipation function, Applications of Lagrangian formulation	
Unit-2- Hamilton's Principles & Equations	**Lectures: 16**
Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems. Legendre Transformation, Hamilton's equations of motion, Cyclic-co-ordinates, Hamilton's equations from variational principle, Principle of least action	
Unit-3- Canonical Transformation:	**Lectures: 20**
Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton-Jacobi equations for principal and characteristic functions, Harmonic oscillator problem, Action-angle variables for systems with one-degree of freedom.	
Unit-4- Rigid Body Dynamics and Small Oscillation	**Lectures: 16**
Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top. Eigen value equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule.	

Text/Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN
H. Goldstein	Classical Mechanics	Pearson Education	2014	9781292038933

G.R. Fowles and G.L. Cassiday	Analytical Mechanics,	Cengage Learnings	2004	9788131501115
L.D. Landau and E.M. Lifshitz	Mechanics	Pergamon	1976	0750628960
N. C. Rana and P. S. Jaog	Classical Mechanics	McGraw-Hill,	1991	9780074603154

Course Title: PHY601 (Quantum Mechanics)

L	T	P	Total Credits
4	0	0	4

Course Contents/syllabus:

	Time(h)
Unit-I-Linear Vector Space	**16**

Linear vector spaces, Inner product, norm, Schwarz inequality, linear operators, eigenvalue and eigenvector, adjoint of a linear operator, Hermitian or self-adjoint operators and their properties, unitary operators, ortho-normal basis –discrete and continuous. Dirac's bra and ket notation, commutators, Simultaneous eigenvectors	
Unit-II-Matrix Mechanics & Angular Momentum	**20**
Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator and identical particles. Density Matrix and Mixed Ensemble. Commutation relations of angular momentum operators. Eigenvalues, eigenvectors. Ladder operators and their matrix representations. Orbital angular momentum operator, Spin angular momentum and Pauli matrices. General angular momentum & its representation. Clebsch-Gordan coefficients. Wigner - Eckart theorem	
Unit III: Perturbation and Scattering Theory	**20**
Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator and other sample systems. General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light. Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.	
Unit IV: Introduction to Relativistic Quantum Mechanics	**16**
Quantum mechanics of many particle systems. The need for QFT (relativity, many-body and interactions), Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle.	

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
P.M. Mathews K. Venkatesan	A Text book of Quantum Mechanics: 2nd edition	Tata McGraw Hill, New Delhi	2004	978-0070146174
J.L. Powell an B. Crasemann	Quantum Mechanics	Narosa, New Delhi	1995	978-0201059205
J.J. Sakurai	Modern Quantum Mechanics	Addison Wesley	2004	978-0201539295
E. Merzbacher	Quantum Mechanics	John Wiley, Singapore	2004	978-0471887027
M.P. Khanna	Quantum Mechanics	Har Anand, New Delhi	2006	978-8124113684
R. Shankar	Principles of Quantum Mechanics: 3rd Ed.	Springer	2008	978-1475705768

Course Title: Statistical Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Ability to understand fundamentals of thermodynamics and revision of laws of thermodynamics

CO2	Knowledge of statistical ensemble, probability distributions, partition function and classification of ensemble theory on the basis of thermodynamic quantities
CO3	Implementation of quantum concepts on Statistical mechanics.
CO4	Understanding of phase transition concepts/rules and their implementation to describe spin interactions and Ising model
CO5	Learning of Brownian motion and random walk problems.

Course Contents

Unit-1- Review of Thermodynamics	**Lectures: 12**
Laws of thermodynamics, macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.	
Unit-2- Classical Ensemble Theory	**Lectures: 24**
Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles, Boltzmann relation for entropy, The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory.	
Unit-3- Quantum Statistical Mechanics	**Lectures: 18**
Indistinguishable particles in quantum mechanics. Bosons and Fermions. Bose-Einstein statistics, ideal Bose gas, photons, Bose-Einstein condensation. BoseEinstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field), Fermi-Dirac statistics, Fermi energy, ideal Fermi gas. discussion of heat capacity of a free-electron gas at low temperatures.	
Unit-4- Phase Transitions and Fluctuations	**Lectures: 18**
First- and second-order phase transitions, Interacting spin systems. The Ising model. Exact solution of Ising model in 1-dimension, mean-field solution in higher dimensions.	

Diamagnetic, Paramagnetic and ferromagnetic phases. Thermodynamic fluctuations, random walk and Brownian motion, introduction to nonequilibrium processes, diffusion equation

Text/Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN
C. Kittel	Elementary Statistical Physics	Dover Publications	2004	978-0486435145
R.K. Pathria	Statistical Mechanics	Elsevier	2021	9351073971
F. Reif,	Statistical Physics	Tata McGraw-Hill	2008	978-0070048621
K. Huang	Statistical Mechanics	Wiley	2023	9354247736

Course Title: PHY603 (Electronics)

L	T	P	Total Credits
4	0	0	4

Course Contents/syllabus:

	Time (h)
Unit I: Circuit Analysis	**16**
Thevenin and Norton theorems, Mesh and Node analysis. Admittance, impedance, scattering and hybrid matrices for two and three port networks and their cascade & parallel combinations. Laplace Transforms.	
Unit II: Physics of Semiconductor Devices	**20**
Energy band diagrams, Direct and indirect semiconductors, Metal-semiconductor junctions, Semiconductor junctions p-n junction, Zener diode, Schottky diode, switching diodes, Tunnel diode, LEDs, Solar cell, Photoconductors, Photodiodes, Semiconductor laser, JFET and MOSFET, Liquid crystal displays, UJT, Gunn diode, IMPATT devices, pn devices and applications	
Unit III: Analog Circuits and its Applications	**18**
Differential amplifiers, common mode rejection ratio, Transfer characteristics, OPAMP configurations, open loop and close loop gain, inverting, non-inverting and differential amplifier, Basic characteristics with detailed internal circuit of IC Opamp, slew rate, Comparators with hysteresis, Window comparator, wave generators, Summing amplifier, Analogue computation, Logarithmic and antilogarithmic amplifiers. Current-to-voltage and Voltage-to-current converter, Voltage regulation circuits, Precision rectifiers, Instrumentation amplifiers, True RMS voltage measurements. 555 timer based circuits.	
Unit IV: Oscillators and Filter	**18**
Phase shift oscillator, Wien-bridge oscillator, Sample and hold circuits, Phase Locking Loop basics and applications. Lock-in-detector, box-car integrator. Sallen and Key configuration and Multifeedback configuration, Low Pass, High Pass, Band Pass and Band Reject active filters, Delay equalizers.	

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN

W.D. Stanley	Network Analysis with Applications	Pearson	2003	978-0130602466
Chua, Desoer and Kuh	Linear and Non-linear Circuits	Tata McGraw	1987	978-9339220686
S.M. Sze	Semiconductor Devices - Physics and Technology	John Wiley	2002	978-8126556755
J. Millman C. C. Halkias and S. Jit	Electronic Devices and Circuits, 4th Ed.	McGraw-Hill	2015	978-9339219543
Boylested and Nashelsky	Electronic Devices and Circuits Theory, 10th ed	Pearson Education,	2009	978-9332542600
Ben Streetman, Sanjay Banerjee	Solid State Electronic Devices: 6th Edition	Prentice Hall India	2005	978-0131497269

Course Title: PHY604 (Physics Labortary)

L	T	P	Total Credits
0	0	4	4

Lab/ Practical details:
List of Experiments -with basic instructions

- To study the characteristics of a regulated power supply and voltage multiplier circuits.

- To study the characteristics of a PN junction with varying temperature & the capacitance of the junction.
- To study the characteristics of a LED and determine activation energy.
- To study the frequency response of an operational amplifier & to use operational amplifier for different mathematical operations
- To study the power dissipation in the SSB and DSB side bands of AM wave. To study the demodulation of AM wave.
- To study various aspects of frequency modulation and demodulation.
- To study Hartley and Wien-Bridge oscillators.
- FET/MOSFET characteristics, biasing and its applications as an amplifier..
- UJT characteristics and its application as relaxation oscillator or triggering of triac.
- To study logic gates and flip flop circuits using on a bread-board.
- To design (i) Low pass filter (ii) High pass filter (iii) All-pass filter (iv) Band pass filter (v) Band-reject passive filter.
- Use of timer IC 555 in astable & monostable modes and applications involving relays, LDR.
- To design a rectangular/triangular waveform generator using Comparators and IC8038.
- Hybrid parameters of a transistor and design an amplifier. Determination of k/e ratio.
- To determine Planck's constant using photocell.
- To determine the electric charge of an electron using Millikan drop experiment

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Flint, B L and Worsnop, H T	Advanced practical physics for students	Asia Publishing	1971	978-0423738902
J. Millman & C. C. Halkias	Electronic Devices and Circuits	McGraw-Hill	4th Ed., 2015	9780137246830

Course Title: (Numerical Methods and Analysis)

L	T	P	Total Credits

2	**0**	**2**	**4**

Course Contents/syllabus:

	Time(h)
Unit I: Introduction	**9**
Introduction to computational physics, Need of computational physics, Computer hardware, basic computer architecture, hierarchical memory, cache, latency and bandwidth, Moores law, power bottleneck, Software: compiled (Fortran, C) vs. interpreted languages (MATLAB, python); software management	
Unit II: Errors and Precision	**9**
Error analysis for round-off and truncation errors. Elements of Numerical Integration, Error estimates of Trapezoidal rule, Simpson midpoint and 3/8 rules, Integer representation; floating-point representation, Machine precision, error calculation	
Unit III: Interpolation	**9**
Composite Numerical Integration. Gaussian Quadrature using interpolating polynomials, special polynomials like Legendre polynomials, Multidimensional integrals - Two and three dimensional integration. Interpolation – Introduction, Polynomial interpolation; Lagrange Interpolatiion polynomial; Cubic Spline Interpolation, Neville's algorithm	
Unit IV: Data Analysis	**9**
Modeling of Data, Maximum Likelihood Estimator; Pearson chi square; Least Squares method – both without and with errors in dependent variable; Parameter estimations and errors; General Linear Least square.	

Text / Reference Books:

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
S. Sastry	Introductory Methods of Numerical Analysis	PHI Learning Pvt. Ltd.	5th edition, 2012	9788120345928

R.C. Verma	Computational Physics: An Introduction	New Age International	1st ed., 2005	9788122416596
Atkinson, K E	Elementary Numerical analysis	Wiley India	3rd edition, 2003	9780471433378
Humming, R W	Numerical methods for scientists and engineers	Dover Publications	2nd edition, 1987	9780486652412
Walker, Darren	Computational Physics	Mercury Learning and Information	Revised edition, 2016	9781942270737

Numerical Methods and Analysis Laboratory-I	

Objectives: The major objective of this course is intended to be an Introduction to a programming Language (C/C++) as well as application for general mathematical problems**.**

- Introduction to Linux and Computer Programming Language (C/C++)
- Introduction to Graphics (Gnuplot etc.)s.
- Data and Statements : Data Types. Constants and Variables. Mathematical, Relational, Logical and Bitwise Operators. Expressions and Statements. Block, Local and Global variables. Auto, Static and External Variables
- I/O Statements : printf, scanf, getc, getch, getchar, getche, etc. Streams: cin and cout.
- Control Statements : If-statement. If-else Statement. Nested if Structure. Else-if Statement
- Unconditional and Conditional Looping. While Loop. Do-while Loop. For Loop. Break and Continue Statements.
- Loops.
- Arrays and Structures : One and Two Dimensional Arrays. Idea of Structures.

- Functions and Classes: Standard Library Functions, User-defined Functions. Void Functions and Functions returning Values,
- Classes, Objects, Idea of Strings and Pointer
- C++ program of matrix multiplication.
- C++ Programs on Random number generation and tests of randomness.
- C++ program to find reverse of number by defining functions outside class.
- C++ Program to calculate Volume of Cube using constructor and destructor.
- C++ program for various Mathematical Operations using Switch case.
- C++ Programs on Measurement of central moment, correlation coefficients using classes.
- C++ Programs on Least squares fitting for linear and general equations.
- C++ Programs on Numerical Differentiation
- C++ Programs on Interpolation – Lagrange interpolating polynomial Lagrange interpolation.
- C++ Programs on Cubic spline interpolation.
- C++ Programs on Root Finding (Bisection, Secant and Newton-Raphson Methods)

Semester-VIII

Course Title: Advanced Mathematical Methods

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Acquire knowledge of methods to solve partial differential equations specifically variable separation method with the examples of important partial differential equations in Physics
CO2	Learn the Fourier analysis of periodic functions and their applications in physical problems, understand the Fourier, Laplace transform and their applications
CO3	Learn about the special functions Bessel, Legendre, Hermite and Laguerre, their differential equations and their applications in various physical problems
CO4	Learn about the properties of complex functions such as analyticity, and evaluating integrals using Cauchy's Integral formula and series (Taylor and Laurent) expansion

Course Content

Unit-1-Integral Transformations	**Lectures: 22**
Fourier series, Dirichlet conditions. General properties. Convolution and correlation, Advantages and applications, Gibbs phenomenon. Fourier transforms, Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives; Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation. Applications	
Unit-2- Complex Variables	**Lectures: 14**
Cauchy-Riemann conditions, analyticity, Cauchy-Goursat theorem, Cauchy's Integral formula, branch points and branch cuts, multivalued functions, Taylor and Laurent expansion, singularities and convergence, calculus of residues, evaluation of definite integrals, Dispersion relation.	
Unit-3- Group Theory	**Lectures: 20**
Multiplication table, conjugate elements and classes, Abstract groups: subgroups, classes, cosets, factor groups, normal subgroups, direct product of groups; Examples, Homomorphism & isomorphism. Representations: reducible and irreducible, unitary representations, Schur's lemma and orthogonality theorems, characters of representation, direct product of representations. Introduction to continuous groups: Lie	

groups, rotation and unitary groups. Representation of SO(3), SU(2), SU(3) and SO(3,1)	
Unit-4- Theory of Probability and Statistics	**Lectures: 16**
Introduction to probability theory, Random Variables, Binomial, Poisson and Normal Distributions. Central Limit Theorem, Hypothesis Testing and Data Analysis in Statistics	

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
G.B. Arfken	Mathematical Methods for Physicists	Elsevier	2012	9381269556
George F. Simmons,	Differential Equations	McGraw Hill.	2007	978-8173193293
A.S.Fokas & M.J.Ablowitz	Complex Variables	Cambridge Univ. Press	2011	978-0521534291
K.F Riley, M.P. Hobson and S. J. Bence	Mathematical Methods for Physics and Engineers	Cambridge University Press	2006	978-0521890670

Course Title: PHY602 (Classical Electrodynamics)

L	T	P	Total Credits

4	**0**	**0**	**4**

Course Contents/syllabus:

	Time (h)
Unit I: Electrostatics & Boundary Value Problems	**18**
Gauss's law, Poisson and Laplace equation, Green's theorem, Dirichlet and Neuman boundary conditions, Formal solution of electrostatic boundary value problems with Green function, Electrostatic potential energy and energy density. Method of Images , Point Charge in the Presence of a Grounded Conducting Sphere, Point Charge in the Presence of a Charged, Insulated, Conducting Sphere, Point Charge Near a Conducting Sphere at Fixed Potential , Conducting Sphere in a Uniform Electric Field by Method of Images, Green Function for the Sphere; General Solution for the Potential , Conducting Sphere with Hemispheres at Different Potentials, Separation of Variables; Laplace Equation in Rectangular coordinates, Laplace Equation in Spherical Coordinates, Legendre Equation and Legendre Polynomials, Boundary-Value Problems with Azimuthal Symmetry. Multipole Expansion, Multipole Expansion of the Energy of a Charge Distribution in an External Field, Elementary Treatment of Electrostatics with Ponderable Media, Boundary-Value Problems with Dielectrics, Electrostatic energy in dielectric media	
Unit II: Magnetostatics	**18**
Biot and Savart Law, Ampere's Law, Vector potential, Magnetic Fields of a Localized Current Distribution, Magnetic Moment , Force and Torque on and Energy of a Localized Current Distribution in an External Magnetic Induction, Singularity in dipole field, Fermi-contact term, Macroscopic Equations, Boundary Conditions on B and H, Methods of Solving Boundary-Value Problems in Magnetostatics, Uniformly Magnetized Sphere, Magnetized Sphere in an External Field; Permanent Magnets, Magnetic Shielding, Spherical Shell of Permeable Material in a Uniform Field.	

Unit III: Maxwell's Equations & waveguides	**18**
Maxwell's Displacement Current; Maxwell Equations, Vector and Scalar Potentials, Gauge Transformations, Lorenz Gauge, Coulomb Gauge, Hertz potential. Cylindrical Cavities and Waveguides, Waveguides, Modes in a Rectangular Waveguide, Energy Flow and Attenuation in Waveguides, Coaxial cable, Resonant Cavities, Power Losses in a Cavity; Q of a Cavity , Earth and Ionosphere as a Resonant Cavity: Schumann Resonances, Multimode Propagation in Optical Fibers, Modes in Dielectric Waveguides.	
Unit IV: Electromagnetic Waves	**18**
Green Functions for the Wave Equation, plane waves in free space and isotropic dielectrics, waves in conducting media, skin depth, Plane waves in a non conducting medium, Reflection and Refraction of Electromagnetic Waves at a Plane Interface Between two Dielectrics, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, Stoke's parameters, Waves in rarefied plasma (ionosphere) and cold magneto-plasma, Frequency Dispersion Characteristics of Dielectrics, Conductors, and Plasmas, Simplified Model of Propagation in the Ionosphere and Magnetosphere. Fields at the Surface of and within a Conductor,	

Text / Reference Books:

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
D.J. Griffiths	Introduction to Electrodynamics, 4th ed.	Prentice Hall India, New Delhi	2012	978-1108822909
A.Z. Capri and P.V. Panat	Introduction to Electrodynamics	Narosa Publishing House	2010	978-8173193293
L. D. Landau E. M. Lifshitz L. P.	Electrodynamics of Continuous Media	Oxford	2005	978-8181477934

Pitaevskii				
John David Jackson	Classical Electrodynamics,3rd Ed	Wiley	1998	978-0471309321
S. P. Puri	Classical Electrodynamics	Narosa	2011	978-8184875843

Course Title: Research Methodology

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Ability to understand the basic characteristics of research and importance of various techniques while performing research.
CO2	Understand the types of data and measurement methods.
CO3	To develop numerical methods aided by technology to solve algebraic equations, calculate derivatives and integrals, curve fitting and optimization techniques
CO4	Understanding the role of hypothesis formulation in research.

Course Content

Unit I: Introduction	**Lectures: 18**
Research meaning and significance, Characteristics of scientific Research Type of	

research: pure, applied, analytical, exploratory, descriptive, surveys, Case-study Conceptual or theoretical models Research process Limitations of Social science research Role of computer technology in research.	
Unit II: Data: Types and Measurement	**Lectures: 18**
Data information and statistics Data types Qualitative and Quantitative; Cross and Time series Scales of measurement :nominal, ordinal, interval, ratio Sources of data: Primary and secondary Census and sample survey-criterion of good sample, choice of sample, probability and non-probability sampling methods, sampling and non-sampling errors.	
Unit III: Numerical Techniques in Defence Research	**Lectures: 18**
Introduction to defence related numerical data, solution of non-linear equations, solution of linear systems. Introduction and polynomial approximation, curve fitting, Numerical applications & integrations, numerical optimization. Matrices and types of linear systems, direct elimination methods, conditioning and stability of solutions, Simulation for Computer Graphics, Modelling techniques.	
Unit IV: Hypothesis: Nature and Role in Research	**Lectures: 18**
Definition of a Hypothesis Role of Hypothesis Types of Hypothesis Criteria of Good Hypothesis Null and Alternative Hypothesis, parameter and statistic, Type- I and type ii errors, Level of significance, Critical region	

Text/Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Kothari R.C	Research Methodology, Methods and Techniques.	New Age International Publishers	2008	9389802555

O.R.Krishnaswamy, House, 1993	Methodology of Research In Social Sciences	Himalya publishing	1993	9350975696
P.V. Young	Scientific Social Survey and Research,	Prentice Hall of India Ltd,	1984	8120300858
S.S. Sastry.	Introductory Methods of Numerical Analysis	Prentice Hall India Learning Private Limited Pvt. Ltd	2009	9788120345928

Course Title: Computational Physics

L	T	P	Total Credits
2	0	2	4

Course Outcomes

CO1	Review of C++ programming including arrays, pointers and functions
CO2	Learning of various methods to find the roots of equations
CO3	Understanding of Gauss elimination methods to solve linear algebraic equations
CO4	Understanding the differential equation to solve complex physics equations like heat equation and wave equation

Course Content

Unit-1-Review of C++ Programming	**Lectures: 9**
Data types, C programming syntax for Input/Output, Control statements: if, if-else and nested-if statements. Looping: while, for do while loops, Functions: Call by values and by references, Arrays and structures: one dimensional two-dimensional arrays, Pointers, Idea of string and structures	
Unit-2-Roots of Equations	**Lectures:9**
Real roots of single variable function; iterative approach; qualitative behavior of the function; Closed domain methods (bracketing): Bisection; False position method; Open domain methods: Newton-Raphson, Secant method; Muller's method; Complications; Roots of polynomials; Roots of non-linear equations.	
Unit-3-Linear Algebraic Equations	**Lectures: 9**
Introduction, Augmented Matrix, Gaussian Elimination with Backward substitution, Pivoting strategies – partial and complete, Gauss Jordan Elimination Method, Operation Counts, Tridiagonal Systems of Linear Equations, Inverse of a matrix, LU Decomposition	
Unit-4- Differential Equations	**Lectures: 9**
Numerical Differentiation, Partial differential equations – elliptic equations; boundary conditions; Finite Difference method; Forward and Backward difference methods, Few examples: Heat equations, Wave equations; Introduction to Finite Element method	

Computational Programming Laboratory	
	Objectives: The major objective of this course is intended to be an Introduction to a programming Language (C/C++) as well as application for general mathematical problems**.** ● C++ Programs on Cubic spline interpolation. ● C++ Programs on Root Finding (Bisection, Secant and Newton-Raphson Methods) ● C++ Programs to solve First & Second Order differential Equations including Simultaneous Equations (Euler & Runge Kutta) ● C++ Programs on Numerical Integration (Trapezoidal, Simpson and Quadrature methods). ● C++ Programs on Numerical Differentiation ● C++ Programs on Solution of algebraic equations using Gauss elimination with back substitution. ● C++ Programs on Implementing random walk problem in 1-, 2- and 3-dimensions. ● To study graphically the motion of falling spherical body under various effects of medium using Euler method i.e. viscous drag, buoyancy and air drag. ● To study graphically the EM oscillations in a LCR circuit using Runge-Kutta Method

	• To study the motion of an artificial satellite. • To obtain the energy eigenvalues of a quantum oscillator using the Runge-Kutta method • To study the motion of a charged particle in: (a) Uniform electric field, (b) Uniform Magnetic field, (c) in combined uniform electric and magnetic fields. • To study phase trajectory of a Chaotic Pendulum. • To study the motion of 1-D harmonic oscillator (without and with damping effects). • To study graphically the path of a projectile with and without air drag using FN method. • To study convection in fluids using Lorenz system • Use Monte Carlo techniques to simulate phenomenon of Nuclear Radioactivity.

Text/Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Nicholas J. Giordano and Hisao Nakanishi	Computational Physics	Prentice Hall,India	2005	0131469908

R.C. Verma	Computational Physics: An Introduction	New Age International Publishers	1999	9393159169
Richard L. Burden, J. Douglas Faires, Annette M. Burden	Numerical Analysis	Cengage Learning	2016	9788131516546
Binder, Kurt, Heermann, Dieter	Monte Carlo Simulation in Statistical Physics: An Introduction	Springer	2010	3030107574

Course Title: Physics Laboratory-II

L	T	P	Total Credits
0	0	4	4

Objective: The main objective of this laboratory is to understand the basic concepts of electronics physics through standard set of experiments. Students are expected to perform at least 08 experiments in each semester. In addition, performance of the and the continuous evaluation process allows each and every student to correlate these experiments with the corresponding theory.

- To study the characteristic of J-H curve using ferromagnetic standards.

- To determine the Hall coefficient for a given semi-conductor
- To study temperature-dependence of conductivity of a given semiconductor crystal using four probe method.
- To determine dipole moment of an organic molecule, Acetone
- Tracking of the Ferromagnetic-paramagnetic transition in Nickel through electrical resistivity.
- Temperature dependence of a ceramic capacitor - Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material.
- To determine the velocity of ultrasonic waves using interferometer as a function of temperature.
- To study the lattice dynamics using LC analog kit.
- To study the characteristics and dead time of a GM Counter
- To study Poisson and Gaussian distributions using a GM Counter.
- To determine the gamma-ray absorption coefficient for different elements.
- To study the alpha spectrum from natural sources Th and U.
- To calibrate the given gamma-ray spectrometer and determine its energy resolution
- To study polarization by reflection - Determination of Brewester's angle.
- To study the Magnetorestriction effect using Michelson interferometer.
- To measure numerical aperture and propagation loss and bending losses for optical fibre as function of bending angle and at various wavelengths

Text/Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
B. L. Flint and H.T. Worsnop	Advanced Practical Physics for students	Asia Publishing House	1971	B097NDTRKR
W.R. Leo 1987.	Techniques for Nuclear and Particle Physics Experiments:	Springer Verlag	1987	978-3540572800

G. F. Knoll (John Wiley & Sons, Inc. 3rd Ed.)	Radiation Detection and Measurement	John Wiley & Sons, Inc	2000	9780470131480

Course Title: Quantum Field Theory

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Have the knowledge of the founding principles of relativistic quantum mechanics, Klein-Gordon equation, Dirac equation
CO2	Implementation of Lagrangian and Hamiltonina on scalar fields.
CO3	Understand the basic Feynman rules and its applications
CO4	Significance of decay rates in Field theory

CO5	Understanding the different order of processes and calculation of matrix elements and cross sections.

Course Content

	Unit-1-Dirac Equation	**Lectures: 15**
	The nonrelativistic limit of Dirac equation, Electron in electromagnetic fields, spin magnetic moment , spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lambshift	
	Unit-2- Quantum Field Theory	**Lectures: 15**
	Resume of Lagrangian and Hamiltonian formalism of a classical field, Noether theorem. Quantization of real scalar field, complex scalar field, Dirac field and e.m. field, Covariant perturbation theory, Wick's Theorem, Smatrix, Feynman rules, Feynman diagrams and their applications	
	Unit-3- Yukawa Field Theory	**Lectures: 15**
	Yukawa field theory, calculation of scattering cross sections, decay rates, with examples.	
	Unit-4- Yukawa Field Theory & QED	**Lectures: 15**
	Quantum Electrodynamics, calculation of matrix elements - for first order and second order processes	

Text/Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
M. E. Peskin & D.V. Schroeder	An Introduction to Quantum Field Theory	Westview Press)	1995	978-0367320560
L. H. Ryder	Quantum Field Theory	Cambridge University Press	1996	978-0521478144
A. Das (), 2008	Lectures on Quantum Field Theory	World Scientific	2008	978-9811220869
A. Lahiri & P. Pal	A first book of Quantum Field Theory	Narosa Publishers	2005	8173196540

VALUE-ADDED COURSES

Course Title: Individual, Society and Nation (Behavioural Sciences)
List of Professional Skill Development Activities (PSDA):

- Project on Understanding Diversity
- Term Paper on Patriotism among Youth

Course Learning Outcomes: On completion of the course:

- To recognize individual differences
- To manage individual differences
- To develop patriotic feelings
- To recognized their self in relation to society & nation

Course Contents/syllabus:

	Time (h)
Unit-1- Individual differences & Personality	**4 H**
● Personality: Definition& Relevance ● Importance of nature & nurture in Personality Development ● Importance and Recognition of Individual differences in Persona ● Accepting and Managing Individual differences Intuition Perception & Sensation (MBTI) BIG5 Factors	
Unit-2- Managing Diversity	**4 H**
● Defining Diversity ● Affirmation Action and Managing Diversity ● Increasing Diversity in Work Force ● Barriers and Challenges in Managing Diversity	
Unit-3- Socialization, Patriotism and National Pride	**4 H**
● Nature of Socialization ● Social Interaction ● Interaction of Socialization Process ● Contributions to Society and Nation ● Sense of pride and patriotism ● Importance of discipline and hard work ● Integrity and accountability	
Unit-4- Human Rights, Values and Ethics	**4 H**
● Meaning and Importance of human rights ● Human rights awareness ● Values and Ethics- Learning based on project work on Scriptures like- Ramayana, Mahabharata, Gita etc.	

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Department of English, Univ. of Delhi	The Individual & Society	Pearson Education	2010	978-8131704172

Umang Malhotra	Individual, Society, and the World	Universe	2004	978-0595662401
Tonja R. Conerly & Kathleen Holmes	Introduction to Sociology 3e	Openstax	2015	9781711493978
Daksh Tyagi	"A Nation of Idiots"	Every Protest	2019	978-8194275015

Course Title: French Grammar (INL-101)

L	T	Total Credit Units
1	0	1

Course Learning Outcomes: At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyze and break-down information to create new ideas
- Evaluate and express opinion in a given context

Course Contents/syllabus:

	Teaching Hours
Unit-I : My family and my house	**4 H**
Descriptors/Topics ● Talk about your family members ● Usage of possessive adjectives ● Describe your house/apartment ● Prepositions of location ● Negation	
Unit-II- Lifestyle	**4 H**
Descriptors/Topics ● Talk about your hobbies and pastimes ● Usage of appropriate articles : definite and contracted ● Talk about your daily routine	

● Usage of pronominal verbs	
Unit-III- In the city	**4 H**
Descriptors/Topics ● Filling up a simple form ● Ask for personal information ● Usage of interrogative adjectives ● Give directions about a place ● Ordinal numbers ● Usage of demonstrative adjectives	
Unit-IV- Week-end	**4 H**
Descriptors/Topics ● Talk about your week-end plans ● Usage of disjunctive pronouns ● Usage of Near Future tense ● Talk about weather ● Write a simple post card	

Text / Reference Books:

Author	**Title**	**Publisher**	**Year of Publication**	**ISBN No**
Christine Andant, Catherine Metton, Annabelle Nachon, Fabienne Nugue,	A Propos - A1, Livre de l'élève et Cahier d'exercices.	Langers International Pvt. Ltd.	2010	978-9380809069
Collins Dictionaries	Easy Learning French Complete Grammar, Verbs and Vocabulary	Collins	2016	978-0008141721

Nikita Desai, Samapita Dey Sarkar	Apprenons La Grammaire Ensemble - French	Langers International Pvt. Ltd.	2017	978-8193002681

Course Title: German Grammar (INL-102)

L	T	Total Credit Units
1	0	1

Course Outcome:

At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyze and break-down information to create new ideas
- Evaluate and express opinion in a given context

Course Contents/syllabus:

	Teaching Hours
Module I: Time (Uhrzeit); People and the World: Land, Nationalität und Sprache	**4 H**
● Introduction of time ● Read text related to time and teach the students the time expressions ● Exercises related to Time ● Adverbs of time and time related prepositions Vocabulary: Countries, Nationalities, and their languages Negation: “nicht/ kein” Ja/Nein Fragen.	

All the colors and color related vocabulary, adjectives, and opposites ● Exercises and comprehension for the same.	
Module II: Irregular verbs (unregelmässige Verben)	**4 H**
● Introduction to irregular verbs and their conjugation e.g. fahren, essen, lesen etc ● Read a text related to the eating habits of Germans ● Vocabulary: Obst, Gemüse, Kleiderstück with usage of irregular verbs ● Free time and hobbies ● Food and drinks	
Module III: Accusative case: articles and pronouns (Akkusativ Kasus: Artikel und Pronomen)	**4 H**
● Introduction to the concept of object (Akkusativ) ● Formation of sentences along with the translation and difference between nominative and accusative articles ● Usage of accusative Definite articles ● Usage of accusative Indefinite articles	
Module IV: Accusative case: possessive pronouns (Akkusativ Kasus: Possessivpronomen) Family and Relationship	**4 H**
● Accusative Personal Pronouns: - Revision of the nominative personal pronouns and introduction of accusative. Applicability of pronouns for both persons and things. ● Usage of accusative Personal Pronouns ● Introduction of accusative possessive pronouns ● Difference between nominative and accusative possessive pronouns ● usage of accusative possessive pronouns	

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
Dora Schulz, Heinz Griesbach	Deutsche Sprachlehre Fur Auslander	Max Hueber Verlag	1984	978-3190010066
Hartmut Aufderstrasse, Jutta Muller, Helmut Muller	Themen Aktuell: Glossar Deutsch	Max Hueber Verlag	2003	978-3190816903
Giorgio Motta	Wir Plus Grundkurs Deutsch fur Junge Lerner Book German Guide	Goyal Publishers	2011	9788183072120

Semester-IX

Course Title: Nuclear Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Become familiar with nuclear structure and its fundamental properties, effect of external magnetic field, NMR
CO2	Gains knowledge on radioactive decay and its application

CO3	Understanding of nuclear force and its implementation on nucleons.
CO4	Learning of characteristics of neutron and various kind of nuclear reactions

Course Contents

Unit-1-Nuclei Properties	**Lectures: 16**
Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfine structure, effect of external magnetic field, Nuclear magnetic resonance.	
Unit-2-Radioactive Decays	**Lectures: 20**
Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Double beta decay, Neutrino,detection of neutrinos, measurement of the neutrino helicity. Multipolarity of gamma transitions, internal conversion process, transition rates, Production of nuclear orientation, angular distribution of gamma rays from oriented nuclei.	
Unit-3-Nuclear Forces	**Lectures: 18**
Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, n-p scattering at low energies, partial wave analysis, scattering length, spin-dependence of n-p scattering, effective-range theory, coherent and incoherent scattering, central and tensor forces, p-p scattering, exchange forces & single and triplet potentials, meson theory of nuclear forces	
Unit-4-Neutron Physics & Nuclear Reactions	**Lectures: 18**
Neutron production, slowing down power and moderating ratio, neutron detection. Nuclear reactions and cross-sections, Resonance, Breit–Wigner dispersion formula for l=0 and higher values, compound nucleus, Coulomb excitation, nuclear kinematics and radioactive nuclear beams	

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
K. Hyde	Basic Ideas and Concepts in Nuclear Physics	CRC Press	2004	0750309806
Herald Enge	Introduction to Nuclear Physics ;	Addison-Wesley	1971	0201018705
Irving Kaplan	Nuclear Physics	Narosa Publishers	2002	8185015899
R.R. Roy and B.P. Nigam	Theory of Nuclear Structure	New Age, New Delhi	2005	812243410

Course Title: Particle Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Classification of elementary particles on the basis of fundamental interactions and their properties, quantum numbers, various reactions and decay processes
CO2	Hadron-hadron interactions and its fundamentals
CO3	Implementation of relativity to understand the kinematics of the elementary particle
CO4	Learning of characteristics of weak interactions; beta decay and Fermi theory, parity violation

Course Content

Unit-1- Introduction to Particle Physics	Lectures: 18

Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions - electromagnetic, weak, strong and gravitational, units. Invariance in CCT422: classical mechanics and in quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay. Time reversal invariance, CPT theorem.	
Unit-2-Hadron-Hadron Interactions	**Lectures: 18**
Cross section and decay rates, Pion spin, Isospin, Twonucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy	
Unit-3-Relativistic Kinematics and Phase Space	**Lectures: 18**
Introduction to relativistic kinematics, particle reactions, Lorentz invariant phase space, two-body and three-body phase space, recursion relation, effective mass, dalitz, K-3 π-decay, τ-θ puzzle, dalitz plots for dissimilar particles, Breit-Wigner resonance formula, Mandelstam variables.	
Unit-4-Quark Model and Weak Interaction	**Lectures: 18**
The Baryon decuplet, quark spin and color, baryon octer, quark-antiquark combination. Classification of weak interactions, Fermi theory, Parity nonconservation in β-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K- decay and its experimental determination.	

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
Griffiths D.	Introduction to Elementary Particles	Wiley Press	2008	**9783527406012**
D.H. Perkins (), 4th ed. 2000	Introduction to High Energy Physics	Cambridge University	2000	0521138469
I.S. Hughes	Elementary Particles	Cambridge University Press	1991	B01FIX1JNA

R. P. Feynman and S. Weinberg	Elementary Particles and the Laws of Physics	CambridgeUniversity Press	1999	0521658624

Course Title: Condensed Matter Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Knowledge of lattice vibrations, phonons and in depth of knowledge of Einstein and Debye theory of specific heat of solids
CO2	Understanding above the band theory of solids in the view of periodic potential and must be able to differentiate insulators, conductors and semiconductors.
CO3	Study and learn the transport properties of charge carriers under electric and magnetic fields
CO4	Secured an understanding about the dielectric and ferroelectric properties of materials
CO5	Understand the liquid crystals, classification, properties and their behaviour in electric and magnetic fields

Course Content

Unit-1-Lattice Dynamics	**Lectures: 18**
Lattice vibrations, adiabatic and harmonic approximation, vibrations of linear mono-atomic lattice, one-dimensional lattice with basis, models of three dimensional lattices,	

quantization of lattice vibrations, Einstein and Debye theories of specific heat, phonon density of states.	
Unit-2-Band theory of Solids	**Lectures: 18**
Periodic potential and Bloch's theorem, weak potential approximation, density of states in different dimensions, energy gaps, Fermi surface and Brillouin zones. Origin of energy bands and band gaps, effective mass, tight-binding approximation, Semiconductor Crystals, Band theory of pure and doped semiconductors.	
Unit-3-Transport Properties of Solids	**Lectures: 18**
Electronic transport from classical kinetic theory, Boltzmann transport equation, resistivity of metals and semiconductors, Fermi surfaces – determination, Landau levels, Quantum Hall effect- Integral quantum Hall effect and. Magnetoresistance	
Unit-4-Dielectric Properties of Solids	**Lectures: 18**
Dielectrics and ferroelectrics, macroscopic electric field, local field at an atom, dielectric constant and polarizability, Clausius-Mosotti relation, ferroelectricity, antiferroelectricity, piezoelectric crystals, ferroelasticity, electrostriction	
Superconductivity	
Basic phenomenology and experimental evidence, BCS pairing mechanism and nature of BCS ground state, Flux quantization, Vortex state of a Type II superconductors, Tunneling Experiments, High Tc superconductors and current work on superconductivity**.**	

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
J. Ziman	Principles of the Theory of Solids	University Press	1972	1107641349
C. Kittel	Introduction to Solid State Physics	Wiley, NewYork	2005	8126578432
P.M. Chaikin and T.C. Lubensky	Principles of Condensed Matter Physics	Cambridge University Press	1995	9788175960251

H. Ibach and H. Luth () 3rd. ed. 2002	Solid State Physics	Springer Berlin	2002	9783540585732

Course Title:Atomic and Molecular Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Students will learn the details of atomic and diatomic molecular (diatomic) structures in terms of quantum mechanical treatment elaborately beyond the basic models
CO2	It will give the descriptions of fine structure of atoms and rotational, vibrational and electronic energies of molecules manifesting in their respective spectroscopies Understand the basic Feynman rules and its applications
CO3	The details of these spectroscopies would serve as the fundamentals for various concerned experimental results
CO4	The basic principles of light coherence as laser with their types and variants will also be covered exposing the students to the important modern spectroscopic tool

Course Contents

	Unit I: Atomic Physics	**Lectures: 15**
	Fine structure of hydrogenic atoms, Mass correction, spin-orbit term, Darwin term. Intensity of fine structure lines. Effect of magnetic and electric fields: Zeeman, Paschen-Bach and Stark effects. The ground state of two-electron atoms – perturbation theory and variational methods. Many-electron atoms – Central Field Approximation-LS and jj coupling schemes, Lande interval rule. The Hartrec-Fock equations. The spectra of alkalis using quantum defect theory. Selection rules for electric and magnetic multipole radiation. Auger process.	
	Unit II: Molecular Structure	**Lectures: 15**
	Born-Oppenheimer approximation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Spectroscopic terms. Centrifugal distortion. Electronic structure-Molecular symmetry and the states. Molecular orbital and valence bond methods for H_2^+ and H2. Morse potential. Basic concepts of correlation diagrams for heteronuclear molecules	
	Unit III: Molecular Spectra	**Lectures: 15**

	Rotational spectra of diatomic molecules-rigid and non-rigid rotors, isotope effect, Vibrational spectra of diatomic molecules-harmonic and anharmonic vibrators, Intensity of spectral lines, dissociation energy, vibration-rotation spectra, Electronic spectra of diatomic molecules- vibrational structure of electronic transitions (coarse structure)-progressions and sequences. Rotational structure of electronic bands (Fine structure)-P,Q,R branches. Intensities in electronic bands-The Franck Condon principle. The electron spin and Hund's cases. Raman Effect. Electron Spin Resonance. Nuclear Magnetic Resonance	
	Unit IV: Laser	**Lectures: 15**
	Life time of atomic and molecular states. Multilevel rate equations and saturation. Coherence and profile of spectral lines. Rabi frequency. Laser pumping and population inversion. He-Ne Laser, Solid State laser, Free-electron laser. Non-linear phenomenon. Harmonic generation. Liquid and gas lasers, semiconductor lasers	

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
Raj Kumar	Atomic & Molecular Spectra: Laser	Knrn	2012	**9380803303**
J Michael Hollas	Basic Atomic and Molecular Spectroscopy	Royal Society of Chemistry	2002	**9781107063884**
C.J. Foot ,, 2004	Atomic Physics	Oxford University	2004	978817596025**1**
B. H. Brensden and C. J. Jochain,; 2nd edition 2003	Physics of Atoms and Molecules	Pearson Education India	2003	0582356924

Semester – X

Course Title: Advanced Nuclear Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Understanding the concept of angular momentum and calculation of C.G and Racah Coefficients and their properties.
CO2	Knowledge of Shell model and implementation of learning to understand the properties of nucleus
CO3	Learning of Collective model and Nilsson model of nucleus to describe its kinematics
CO4	Classification of nuclear reactions.

Course Contents

Unit-1- Angular Momentum	**Lectures: 16**
Coupling of angular momenta, LS & jj coupling, spin-orbit coupling, C.G. and Racah coefficients, Wigner' 3j,6j and 9j symbols and properties	
Unit-2- Shell Model	**Lectures: 20**

Extreme particle model with square-well & harmonic oscillator potentials, shell model predictions, static electromagnetic moments of nuclei, seniority wave function, magnetic moment-Schmidt lines, Single particle model, Total spin 'J' for various configurations, electric quadrupole moment, configuration mixing, independent particle model, coefficient of fractional parentage, Two nucleon wavefunction, Matrix elements of one and two body operators, Correlation in nuclear matter.	
Unit-3- Collective Model	**Lectures: 18**
Rotation-D matrices and properties, Collective modes of motion, nuclear vibrations, isoscalar vibrations, Giant resonance, derivation of collective Hamiltonian and applications, Rotation and vibration of even-even nuclei, β and γ vibrations, Rotational-vibrational coupling, odd-mass nuclei - coupling of particle to even-even core, Nilsson model, Rotational motion at high spin, Kinematic and dynamic moment of inertia, Routhian and alignment plots.	
Unit-4- Compound Nucleus and Nuclear Reactions:	**Lectures: 18**
Statistical and Optical model for compound nucleus, Direct reactions, Kinematics and theory of stripping, pick up and reverse reactions, Fusion evaporation & transfer reactions and various models, Heavy-ion induced nuclear reactions at various energies.	

Text Books

- Basic Ideas and Concepts in Nuclear Physics : K. Hyde (Institute of Physics) 2004
- Introduction to Nuclear Physics ; Herald Enge (Addison-Wesley) 1971

Reference books:

- Nuclear Physics : Irving Kaplan (Narosa), 2002
- Nuclei and Particles : E. Segre (W.A. Benjamin Inc), 1965
- Theory of Nuclear Structure : R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.

Course Title: Advanced Particle Physics

L	T	P	Total Credits
4	0	0	4

Course Outcomes

CO1	Classification of scattering types in particle physics
CO2	Knowledge of symmetries, fields and groups to understand field theorems
CO3	Significance of field theories in describing the mathematical structure of Standard Model
CO4	Understanding the basic nature of quantum chromodynamics including confinement theory and asymptotic freedom to describe the particle behaviour at high energies.

Course Contents

Unit-1- Deep Inelastic Scattering	**Lectures: 16**
Types of scattering, elastic and inelastic scattering, Form factors of nucleons, Parton model, Deep inelastic scattering structure functions.	
Unit-2- Symmetries and Fields	**Lectures: 20**
Abelian and Non-Abelian groups, U(1), SO(2), SO(3), SU(2), SU(3) and Unitary groups. Lorentz group SO(1,3) and its representations. Dirac, Weyl and Majorana fermions. Approximate symmetries. Noether's theorem. Spontaneous breaking of symmetry and Goldstone theorem. Higgs mechanism. Abelian and Non-Abelian gauge fields. Lagrangian and gauge invariant coupling to matter fields. Elements of Quantization and Feynman rules	
Unit-3- Standard Model of Particle Physics	**Lectures: 18**
SU(3) x SU(2) x U(1) gauge theory, Coupling to Higgs and Matter fields of 3 generations. Gauge boson and fermion mass generation via spontaneous symmetry breaking, CKM matrix . Low energy Electroweak effective theory and the V-A 4-fermion	

interactions. Elementary electroweak scattering processes. Neutrino masses and Neutrino oscillations.	
Unit-4- Quantum Chromo-Dynamics	**Lectures: 18**
Asymptotic freedom and Infrared slavery, confinement hypothesis. Approximate flavor symmetries of the QCD Lagrangian: Chiral symmetry and it's breaking. Classification of hadrons by flavor symmetry: SU(2) and SU(3) multiplets of Mesons and Baryons	

Text Books

- Elementary Particles and the Laws of Physics: R. P. Feynman and S. Weinberg (CambridgeUniversity Press), 1999
- Introduction to Quarks and Partons : F.E. Close (Academic Press, London), 1979
- Gauge Theories of Weak, Strong and Electromagnetic Interactions: C. Quigg (AddisonWesley), 1994.

Reference books:

- Introduction to Elementary Particles: Griffiths D. (Wiley), 2008.
- Introduction to High Energy Physics : D.H. Perkins (Cambridge University Press), 4th ed. 2000.
- First Book of Quantum Field Theory , A. Lahiri and P. Pal , (Narosa, New Delhi), 2nd ed. 2007.

Course Title: Specialized Elective

L	T	P	Total Credits
4	0	0	4

Course Title: PHY605 (Radiation Physics and Technology)

Course Contents/syllabus:

	Time(h)
Unit I: Atomic and Nuclear Physics	**18**
Basic concept of atomic structure; characteristic X rays and production; concept of bremsstrahlung and auger electron, The composition of nucleus	

and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission.	
Unit II: Interaction of Radiation with Matter	**18**
Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Photoelectric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles, Heavy charged particles, Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation.	
Unit III: Radiation Detection	**18**
Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derive Air Concentration (DAC). Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry. Biological effects of ionizing radiation, Operational limits and basics of radiation hazard evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, and limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management.	
Unit IV: Application of Nuclear Techniques	**18**
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, Brief idea about Accelerator driven Subcritical system (ADS) for waste management., Polymer cross-linking Sterlization	

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
K. Hyde	Basic Ideas and Concepts in Nuclear Physics	CRC Press	3rd edition, 2004	978-0750309806
Herald Enge	Introduction to Nuclear Physics	Addison Wesley Publishing	1966	978-0201018707
E. Segre	Nuclei and Particles	Basic Books	2nd edition,1977	978-0805386011
G. F. Knoll	Radiation Detection and Measurement	John Wiley & Sons, Inc	3rd Ed., 2000	978-0470131480

Course Title: PHY607 (Physics of Nanomaterials)

Course Contents/syllabus:

	Time(h)
Unit I: Introduction to Nano-Materials	**18**
Band structure, Failure of Classical Mechanics; Brief discussion of general ideas such as “Wave particle duality”, Uncertainty principle, Superposition principle etc.; Solutions of Schrodinger Equation for 1-D and 3-D square wells and potential barriers, H-atom.	
Unit II: Properties of Nano-Structured Materials	**18**
Size and shape dependent properties, color, melting point, magnetism, density of states, conductivity and band gap, metal to insulator transition. Mechanical properties of nano-materials, Magnetic and electronic transport properties of nano-structured materials.	
Unit III: Optical Properties	**18**

Optical properties and radiative processes: General formulation absorption, emission and luminescence; Optical properties of heterostructures and nanostructures. Carrier transport in nanostructures: Coulomb blockade effect, scattering and tunneling of 1D particle; applications of tunneling, single electron transistors. Defects and impurities: Deep level and surface defects.	
Unit IV: Dielectric Properties	**18**
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 quasiparticles and excitons. Charging effects.	

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
C. P. Poole Jr. & F. J. Owens	Introduction to Nanotechnology	Wiley-Interscience	2003	978-0471079354
H. S. Nalwa	Nanostructured Materials and Nanotechnology	Academic Press	2002	978-0-12-513920-5
A. L. Rogach	Semiconductor Nanocrystal Quantum Dots	Springer Wien NY	2008	978-3-211-75237-1
D. Bimerg, M. Grundmann N.N. Ledentsov	Quantum Dot Heterostructures	Wiley	1998	9780471973881
H.C. Hoch, H.G. Craighead L. Jelinski	Nanofabrication and Bio-system.	Cambridge Univ. Press	1996	9780521462648

Course Title: Astro Physics

Course Outcomes

CO1	Conceptual understanding of various basic principles involved in astronomy
CO2	Understanding of the structure of galaxies, interstellar dust and formation of molecular clouds.
CO3	Knowledge and learning of theoretical models that explain the origin of elements in the universe and nucleosynthesis processes.
CO4	Learn about relevant nuclear and astrophysical measurements and observations

Course Content

Unit I: Introduction	**Lectures: 18**
Basic concepts of celestial sphere, Co-ordinate systems; Alt-azimuth, Equatorial, Right Ascension, Ecliptic, Basic stellar properties; Luminosity, apparent and absolute magnitude, photo visual and photographic magnitude system, estimation of distance using parallax method and Cepheid variables, stellar masses in binary system. Spectral classification of stars, Origin of emission and absorption spectra, Doppler effect and its applications, Mass-Luminosity relation, free electron scattering and bound-free scattering, HR diagram. Basic concepts of astronomical observations in -rays, X-rays, UV, visible, infra-red, radio waves	
Unit II: Interstellar medium and molecular clouds	**Lectures: 18**
Structure of our galaxy, Globular clusters, velocity distribution of stars, origin of 21-cm radiation and interstellar gas, fine structure of Carbon, Origin of spiral arms and its basic features, Interstellar dust and theory of extinction of stellar light, molecules and molecular clouds, the galactic magnetic field, the active star forming molecular clouds.	
Unit III: Stellar evolution and nucleosynthesis	**Lectures: 18**
Origin of the solar system, Jean's criteria, Shedding excess of angular momentum and magnetic field, T Tauri phase, Quasi-hydrostatic equilibrium, Virial theorem, Radiative	

and convective heat transfer, the sun on the main sequence, rates of nuclear energy generation, the standard solar model, evolution of low, intermediate and high mass stars on HR diagram, late stage evolution of stars, red giant phase, white dwarf, supernova (type Ia, Ib/c, II), neutron star, black hole, stellar nucleosynthesis, hydrostatic and explosive nucleosynthesis, sprocess, r- process, the galactic chemical evolution.	
Unit IV: Cosmology	**Lectures: 18**
Simple extragalactic observations, Olber's paradox, Hubble's constant and its implications, the steady state universe, Evolution of the Big Bang, hadron era, lepton era, primordial nucleosynthesis, the radiation era, the matter era, time evolution of the future universe.spacecrafts and missions; Elements of hyperspectral imaging, SAR (Synthetic Aperture Radar), onboard optical, IR, UV, X-ray, γ-ray spectrometers and particle detectors	

Text Books

- Physics of stellar evolution and cosmology: H.S. Goldberg and M.D. Scadron (Gordon and Breach), 1986.

Reference Books

- Theoretical Astrophysics (Vol. I, II, III) : T. Padmanabhan (Cambridge University Press), 2005.

Course Title: Advanced Electrodynamics and General Theory of Relativity

Course Outcomes

CO1	Understanding of radiations and its application to describe electromagnetic fields and potentials.
CO2	Learning the dynamics of charged particles from the relativistic view point
CO3	Concepts of four vectors and formulation of Maxwell's equations in the terms of covariant and contravariant vectors.
CO4	Detailed knowledge of relativistic physics and its implementation to understand Einstein's field equations, Riemann curvature and Ricci tensors.

Course Contents

Unit-1- Radiations	**Lectures: 20**
Fields and Radiation of a Localized Oscillating Source, Electric Dipole Fields and Radiation, Magnetic Dipole and Electric Quadrupole Fields, Center-Fed Linear Antenna, Multipole Expansion of the Electromagnetic Fields, Angular Distribution of Multipole Radiation. Sources of multipole radiation, mutipole radiations in atoms and nuclei. Lienard-Wiechert Potentials, Field of a charge in arbitrary motion and uniform motion, Radiated power from an accelerated charge at low velocities-Larmor-Power formula. Radiation from a charged particle with collinear velocity and acceleration. Radiation from a charged particle in a circular orbit, Radiation from anultra-relativistic particle, Radiation reaction. Line-width and level shift of an oscillator. Thomson scattering, Rayleigh scattering, absorption of radiation by bound electron.	
Unit-2- Charged Particle Dynamics in Electromagnetic Fields	**Lectures: 16**
Non-relativistic motion in uniform constant fields, Slowly varying magnetic field : Time varying magnetic field, space varying magnetic field, Adiabatic invariance of flux through an orbit, magnetic mirroring, Crossed electrostatic and magnetic fields and applications, Relativistic motion of a charged particle in electrostatic and magnetic fields.	
Unit-3- Covariant Formulation	**Lectures: 18**
Four vectors in Electrodynamics, 4-current density, 4-potential, covariant continuity equation, wave equation, covariance of Maxwell equations. Electromagnetic field tensor, transformation of EM fields. Invariants of the EM fields. Energy momentum tensor of the EM fields and the conservation laws. Lagrangian and Hamiltonian of a charged particle in an EM field	
Unit-4- Theory of Relativity	**Lectures: 18**
Lorentz transformation as orthogonal transformation in 4- dimension, relativistic equation of motion, applications of energy momentum conservation, particle disintegration, Motion of free particle in curvilinear coordinates : Variational Principle, Principle of equivalence, Riemann curvature tensor, Bianchi identities, Ricci tensor, Einstein field equations, Electromagnetic field in Riemann space time.	

Text Books

- Classical Electrodynamics : J.D. Jackson (New Age, New Delhi), 2009.
- Introduction to Electrodynamics : D.J. Griffiths (Prentice-Hall Learning), 2009

Reference books:

- Classical Electrodynamics: S.P. Puri (Narosa Publishing House) 2011..
- Classical Electromagnetic Radiation : J.B. Marion and M.A. Heald (Saunders college Publishing House), 3rd ed. 1995..
- An Introduction to General Relativity : S.K. Bose (Wiley Eastern Limited, New Delhi), 1980..
- Theory of Relativity : R.K. Patharia (Hindustan Pub., Delhi) 2nd ed., 1974