

Program structure for B.Sc.Physics- 3 year

Semester-Wise Programme structure for B.Sc. Physics [3 year]						
Sr. No.	Year 1		Year 2		Year 3	
	Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
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}
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}
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 [CU:6; L-4, P-2] {SE}
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]
5	VAC: 3Cr EVS-2Cr BS-1Cr	VAC: 3Cr EVS-2Cr BS-1Cr				
6	AECC : 2Cr FBL-1Cr HCP/Punjabi- 1C	AECC : 2Cr FBL-1Cr HCP/Punjabi- 1Cr	AECC : 2Cr CS-2Cr	AECC : 2Cr CS-2Cr		

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		
8	General Chemistry [CU:3, L-2, P-1] [MD]	Weather Forecasting [CU:3, L-3, P-0] [MD]	MOOC			
Credits	23	23	20	21	22	22
Total Credit: 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
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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 (e) 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 Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.	
Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces.	

conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of Conservation of Energy, Collisions: Elastic and inelastic collisions between 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 <ul style="list-style-type: none"> ● 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 Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence Uniqueness Theorem for Initial Value Problems. Particular Integrals 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. Gradients	

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, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).	
Unit-5- Orthogonal Curvilinear Coordinates	6
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate System. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.	
Unit-6- Dirac Delta function and its Properties	3
Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function	
Practicals	36 hours
List of Experiments -with basic instructions <ul style="list-style-type: none"> • 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, cin and cout, 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 $\alpha = \tan \alpha$, $I = I_0 \left[\frac{\sin \alpha}{\alpha} \right]^2$ 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. $\sin \theta$, $\cos \theta$, $\tan \theta$ 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 $0 \leq t \leq 15$
 - The differential equation describing the motion of a pendulum is. $\frac{d^2\theta}{dt^2} = -\sin \theta$

- $\frac{d^2\theta}{dt^2} = -\sin\theta$ The pendulum is released from rest at an angular displacement α and $\dot{\theta}(0) = 0$. Solve the equation for $\alpha = 0.1, 0.5$ and 1.0 and plot θ as a function of time in the range $0 \leq t \leq 8\pi$. Also plot the analytic solution valid for small α ($\sin\alpha \approx \alpha$)

Text / Reference Books:

Author	Title	Publisher	Year of publication	ISBN
Arfken, G B & Weber, F E	Mathematical Methods for Physicists	Elsevier	7 th 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,	Environmental Science: A global concern,	McGraw-Hill	2021	9781260363821

Barbara Woodworth Saigo				
Gaston K.J. and Spicer, J. I.	Biodiversity – An Introduction 2 nd 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
<ul style="list-style-type: none"> ● 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
<ul style="list-style-type: none"> ● 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 	

<ul style="list-style-type: none"> • A specific person, object and place 	
Unit-III- An interview	4.5 h
<ul style="list-style-type: none"> • Description of objects, people and places • Nationalities • Speaking about one's professions • Expressing Actions using regular –er ending verbs; avoir, être; reflexive verbs – usage, conjugation • Interview of celebrity 	
Unit-IV- At the discotheque	4.5 h
<ul style="list-style-type: none"> • 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
<u>Manjiri Khandekar</u> and <u>Roopa Luktuke</u>	Jumelage – 1 Methode De Fraincis – French	Langers International Private Limited	2020	978- 9380809854

<u>Michael Magne, Marie-Laure Lions-Olivieri</u>	Version Originale 1: Cahier d'exercices	Maison Des Langues	2010	9788484435617
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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
<ul style="list-style-type: none"> 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
<ul style="list-style-type: none"> 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
<ul style="list-style-type: none"> 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) <ul style="list-style-type: none"> • 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
<u>Rolf Bruseke</u>	Starten Wir A 1	Langers Int. Pvt Ltd	2017	978-3190160006
<u>Giorgio Motta</u>	Wir Plus Grundkurs Deutsch fur Junge Lerner Book	Ernst Klelt Verlog	2011	978-8183072120

Heimy Taylor, <u>Werner Haas</u>	Station en Deutsch Self Study Course German Guide	Wiley	2007	978-0470165515
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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

<p>10. Changes in Society in 18th century: social unrest; emergence of misls and other institutions – rakhi, gurmata, dal iophy.</p> <p>11. Society and Culture under Maharaja Ranjit Singh.</p> <p>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.</p>	
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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, 3 rd	-
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) iophysical 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

<p>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</p> <ul style="list-style-type: none"> ● 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 $x=1$ 	
<p>Unit III: Introduction to LaTeX</p>	<p>4.5</p>
<p>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.</p>	
<p>Unit IV: Analysis and Visualization</p>	<p>4.5</p>

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 <ul style="list-style-type: none"> ● 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 the 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.	5 th edition, 2012	978-8120345928
R.C. Verma	Computational Physics	Newage publishers	1 st edition, 2005	978-8122416596

Atkinson, K E	Elementary Numerical analysis	Wiley India	3 rd 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; Nucleophilicity 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
<p>a) <u>Gases</u>: 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. <u>B) Liquids</u>: 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.</p>		
Practical:		36 Hours Total
	<p><u>Inorganic Chemistry Practicals</u></p> <ul style="list-style-type: none"> ● Titrimetric Analysis <ul style="list-style-type: none"> (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 <ul style="list-style-type: none"> (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.

Organic Chemistry Practicals

- 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).

Physical Chemistry Practicals

- 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
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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,	Experiments in Physical Chemistry	McGraw Hill Inc	2008	978-0070570078

C.W Nibler, J.W				
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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
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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
<p>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</p>	

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. 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

Practicals	36 hours
<p>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.</p> <ul style="list-style-type: none"> • Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) 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
<p>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.</p>	

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 and 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
<p>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.</p> <ul style="list-style-type: none"> ● 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 ($J_0(x)$ and $J_1(x)$) 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
<ul style="list-style-type: none"> · 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.	
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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 2 nd edition	Blackwell Publishing	2004	978-1-405-11857-6
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Course Title: PSY111- Individual, Society and Nation (Behavioural Sciences)

L	T	Total Credit
1	0	1

(PSDA):

List of Professional Skill Development Activities

- 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
<ul style="list-style-type: none"> ● 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
<ul style="list-style-type: none"> ● 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
<ul style="list-style-type: none"> ● Nature of Socialization 	

<ul style="list-style-type: none"> ● 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
<ul style="list-style-type: none"> ● 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

- 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

student shall be able to:
Paraphrase; Interpret and

Course Contents/syllabus:

	Teaching Hours
Unit-I : My family and my house	5 H
Descriptors/Topics <ul style="list-style-type: none"> • Talk about your family members • Usage of possessive adjectives • Describe your house/apartment • Prepositions of location • Negation 	
Unit-II- Lifestyle	4 H
Descriptors/Topics <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Talk about your week-end plans • Usage of disjunctive pronouns • Usage of Near Future tense • Talk about weather • Write a simple post card 	
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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; translate.
- Apply information in a new way in a practical context

Paraphrase; Interpret and

- 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
<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> • 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 Für Ausländer	Max Hueber Verlag	1984	978- 3190010066
Hartmut Aufderstrasse, Jutta Müller, Helmut Müller	Themen Aktuell: Glossar Deutsch	Max Hueber Verlag	2003	978- 3190816903
Giorgio Motta	Wir Plus Grundkurs Deutsch für 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

SEC4: Renewable Energy and Energy Harvesting	Theory: 36 h
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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 to 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 diode.
- 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, 2 nd Edn,	Problems of Modern Physics	Co. Ltd.		
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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, Principles 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) 7 th 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
<ul style="list-style-type: none">● 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
<ul style="list-style-type: none">● Introduction of Communication Skills (Listening, Speaking, Reading and Writing)● Nonverbal Communication: Functions and Effective use● KOPPACT (Kinesics, Oculistics, Proxemics, Paralanguage, Artifacts, Chronemics, Tactilics).	
Unit III: Digital Literacy and Social Media	8 h
<ul style="list-style-type: none">● 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

<ul style="list-style-type: none"> ● Resume Writing ● Cover Letter ● Interview Skills ● LinkedIn Profile ● Writing LinkedIn Recommendations 	
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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
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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
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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: Fraunhofer 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, Nicol 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
<p>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</p> <ul style="list-style-type: none"> ● 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, 2 nd 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's Relations, Maxwell's Relations (1) Clausius Clapeyron equation, (2) Values of $C_p - C_v$, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. 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. The Virial Equation. Andrew's Experiments on CO ₂ Gas. Critical	

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

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
<p>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.</p> <ul style="list-style-type: none"> ● 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
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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
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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
<ul style="list-style-type: none"> ● 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
<ul style="list-style-type: none"> ● 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

<ul style="list-style-type: none"> ● Power Dressing ● Telephonic Manners/ Voice mail etiquette ● Business Salutation Etiquette ● Different Cultural Etiquette & Protocol ● Teamwork ● Time-Management 	
Unit IV- Cross Cultural Communication	9 hrs
<ul style="list-style-type: none"> ● 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 Murphy , Herbert Hildebrandt, Jane Thomas	Effective Business Communication	McGraw Hill Education	2017	978-0070187757	640
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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 excited 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 nuclear 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 β^- -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
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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 Bragg'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 Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.	

Atomic 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 FETs, 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 Mechanism in 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, CE and CC Configurations. Current gains α and β Relations between α and β . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. 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 transistor
- 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
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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 metrics	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
<ul style="list-style-type: none"> ● 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 Golemund	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 physics 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^0 , Σ^0 , Σ^\pm , Ξ^0 , 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
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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
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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
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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 Rayleigh-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 μ P 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 Decimal 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 Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method, (2) Product of sums, and (3) Karnaugh Map. Basic idea of Multiplexers, Demultiplexers, 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 JK Flip-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
<p>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.</p> <ul style="list-style-type: none"> ● 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 heterostructures and nanostructures. Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hopping 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
<ul style="list-style-type: none"> ● Synthesis of metal nanoparticles by chemical route. ● Synthesis of semiconductor nanoparticles. ● Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer. ● 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. Strosio	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
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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
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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 Cautey, Sleep Apnea Cpap Machines, Ventilator and its modes.	

Medical Physics	72 h
<ul style="list-style-type: none"> ● 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)