B.Sc. Honors Physics syllabus

CHOICE BASED CREDIT SYSTEM

School of Studies in Physics, Jiwaji University, Gwalior

Complete Syllabus

SESSION 2022-26

JIWAJI UNIVERSITY GWALIOR

B.Sc. Honors Physics syllabus CHOICE BASED CREDIT SYSTEM

Structure for Undergraduate Program **SESSION 2022-26**

Sem	Subject			Any other Faculty	Vocational (SEC)	Ability Enhancement (AEC) (4-Credits)	Subject		Field Project/ Internship (6 /10 Credits)	Total Credits
	Major Core Course Theory (4-Credits)	Major DSE Theory (4-Credits)	Minor Theory (4-Credits)	Generic Elective (GE) Theory (4-Credits)	Theory (4-Credits)		Lab –I (2-Credits)	Lab-II (2-Credits)		
I	101	--	102	--	103	104	105	106	--	20
	Mathematical Physics-I		Mechanics		Computer Fundamentals	General English communication skill	Mathematical Physics-I	Mechanics		
II	201	--	202	--	203	204	205	206	--	20
	Electricity & Magnetism		Waves and Optics		Quantum Chemistry & Spectroscopy	Environmental Science	Electricity & Magnetism	Waves and Optics		
III	301	--	302	304	303	--	304	305	--	20
	Mathematical Physics-II		Digital Systems and Applications	Computational skills	Introduction to Data Base system		Mathematical Physics-II	Digital Systems and Applications		
IV	401	--	402	404	403	--	404	405	--	20
	Thermal Physics		Analog Systems and Applications	Physics Workshop Skills	Integral Transform, Special Functions		Thermal Physics	Analog Systems and Applications		
V	501	502	--	503	--		504		505	20
	Quantum Mechanics & Applications	Elements of Modern Physics		Electrical Circuit Network Skills			Quantum Mechanics & Applications		FP-1 (6 Credits)	
VI	601	602 / 603	--	--	--	--	603		604	20
	Electro-magnetic Theory	Statistical Mechanics / Solid State Physics					Electro-magnetic Theory		FP-2 (6 Credits)	
VII	701	702	703				704		705	20
	Numerical Computational Method	Tensor and quantum mechanics	Research Methodology				Numerical Computational Method		FP/RP-1 (6 Credits)	
VIII	801		802				803		804	20
	Basic elements of solid state physics/ materials science		Classical Electrodynamics and Antennae Physics				Materials science		FP/RP-2 (10 Credits)	
Total	32	16	24	12	16	8	16	8	28	160

PHYSICS-CORE COURSE

101 – CPT : MATHEMATICAL PHYSICS-I

THEORY: Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Calculus**: ***Recapitulation:*** Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series statements only. First Order Differential Equations and Integrating Factor.
2	***Second Order Differential equations:*** Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. ***Calculus of functions of more than one variable:*** Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.
3	**Vector Calculus**: ***Recapitulation of vectors:*** Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. ***Vector Differentiation:*** Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates
4	***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.
5	**Orthogonal Curvilinear Coordinates:** Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **Dirac Delta function and its properties**: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Reference Books:

- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, WileyIndia.
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7thEdn.,Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHIlearning
- Differential Equations, George F. Simmons, 2007, McGrawHill.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, VivaBook

PHYSICS-CORE COURSE

102-CPT: MECHANICS

Theory: Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topics
1	**Fundamentals of Dynamics:** Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket. **Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy **Collisions:** Elastic and inelastic collisions between particles. COM and Laboratory frames.
2	**Rotational Dynamics**: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. **Elasticity:**RelationbetweenElasticconstants.TwistingtorqueonaCylinderorWire. **Fluid Motion:** Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.
3	**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. **Two-body problem and its reduction to one-**body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system GPS. Physiological effects on astronauts.
4	**Oscillations:** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **Non-Inertial Systems:** Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.
5	**Special Theory of Relativity:** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy- Momentum Four Vector.

Reference Books:

- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008,Wiley.
- Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

Additional Books for Reference

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

103 - GE-1: COMPUTER FUNDAMENTALS

THEORY Credit : 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topics
1	**Introduction:** Introduction to computer system, uses, types. **Data Representation:** Number systems, Binary, Octal, Hexadecimal and their inter-conversion, binary arithmetic and character representation,
2	**Human Computer Interface:** Types of software, Operating system as user interface, utility programs. **Devices:** Input and output devices (with connections and practical demo), keyboard, mouse, joystick, scanner, OCR, OMR, bar code reader, web camera, monitor, printer, plotter
3	**Memory:** Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks, pen drive
4	**Computer Organization and Architecture:** C.P.U., registers, system bus, main memory unit, cache memory, Inside a computer, SMPS, Motherboard, Ports and Interfaces, expansion cards, ribbon cables, memory chips, processors.
5	**Overview of Emerging Technologies**: applications of computer, Bluetooth, cloud computing, big data, data mining, mobile computing and embedded systems.

Reference Books:

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

104 - AEC-1 : ENGLISH LANGUAGE

Theory: Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	Part of speech (a brief study) Sentence and its type- • Simple, compound and complex sentences. • Declarative, imperative, interrogative and exclamatory sentences
2	Tenses- • Simple present, progressive and present perfect • Simple past, progressive and past perfect. • Indication of Futurity. • Voice : Active and passive • Sentence structure: Direct and indirect
3	An introduction to communication skills- • Communication • Its types • Process • Barriers • Removals • 7C's for efficient communication
4	• Listening and its type • Reading and its important in human life • Presentation • Group discussion and debate • Qualities of a good speaker
5	• Indian Literature: A brief study of Ramayana and its characters • Science Fiction: The time Machine- H.G. Well **Note:** Questions on this unit shall be asked from the prescribed text, which will comprise/specimens of popular creative writing about situation and characters..

PHYSICS-CORE COURSE

201 - CPT: ELECTRICITY AND MAGNETISM

Theory : Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topics
1	**Electric Field and Electric Potential** Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.
2	**Electrostatic energy and Capacitance of a system** Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. **Dielectric Properties of Matter:** Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor parallel plate, spherical, cylindrical filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.
3	**Magnetic Field:** Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Dipole Moment and its analogy with Electric Dipole. Ampere's Circuital Law and its application to Solenoid. Curl and divergence of magnetic field **B**. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis
4	**Electromagnetic Induction:** Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. **Electrical Circuits:** Kirchhoff's laws. Complex Reactance and Impedance. Serial and Parallel LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width.
5	**Network theorems:** Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. **Ballistic Galvanometer:** Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping.

Reference Books:

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

PHYSICS-CORE COURSE

202 - CPT: WAVES AND OPTICS

THEORY Credits -04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Superposition of Collinear Harmonic oscillations**: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies Beats. **Superposition of two perpendicular Harmonic Oscillations**: Graphical and Analytical Methods. Lissajous Figures 1:1 and 1:2 and their uses. **Wave Motion:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive Travelling Waves. Wave Equation. Particle and Wave Velocities.
2	**Velocity of Waves:** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **Superposition of Two Harmonic Waves**: Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Waves and Normal Modes. Waves in open and Closed Pipes.
3	**Wave Optics:** Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. **Interference:** Division of amplitude and wave front. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination Haidinger Fringes; Fringes of equal thickness Fizeau Fringes. Newton's Rings: Measurement of wavelength and refractive index.
4	**Interferometer**: Michelson Interferometer- (1) Determination of Wavelength, (2) Wavelength Difference, (3) Refractive Index, and (4) Visibility of Fringes. **Fraunhofer diffraction**: Single slit. Circular aperture, Resolving Power of a telescope. Diffraction grating. Resolving power of grating.
5	**Fresnel Diffraction**: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

ReferenceBooks

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

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203 – GE-2 : QUANTUM CHEMISTRY AND SPECTROSCOPY

Theory Credits: 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	**Topic**
1	Postulates of quantum mechanics, energy and momentum operators, Schrödinger equation and its application to free particle, Heisenberg Uncertainty principle; wave-functions, probability distribution functions.
2	Qualitative treatment of hydrogen atom: Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+(Qualitative only)..
3	Interaction of electromagnetic radiation with molecules and various types of spectra; Rigid rotator model of rotation of diatomic molecule. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Raman spectroscopy: Qualitative treatment of Rotational Raman effect.
4	Simple harmonic oscillator model of vibrational motion: Vibrational energy of diatomic molecules and zero-point energy. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference.
5	Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence. Larmor precession, chemical shift.

Reference Books:

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

204 - AEC-II: ENVIRONMENTAL SCIENCE

THEORY Credit : 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	The Environment: The Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecology, Ecosystem, Biogeochemical Cycle (Carbon Cycle, Nitrogen Cycle).
2	Environment Pollution: Air Pollution, Water Pollution, Soil Pollution, Noise Pollution, Thermal Pollution, Radiation Pollution, Natural Disasters and their Management.
3	Population Ecology: Individuals, Species, Pollution, Community, Control Methods of Population, Urbanization and its effects on Society, Communicable Diseases and its Transmission, Non Communicable Diseases.
4	Environmental Movements in India: Grass root Environmental movements in India, Role of women, Environmental Movements in Madhya Pradesh, State Pollution Control Board, Central Pollution Control Board.
5	Natural Resources: Conservation of Natural Resources, Management and Conservation of Wildlife, Soil Erosion and Conservation, Environmental Laws: Water Act, 1974, Air Act, 1981, The Wildlife (Protection) Act, 1972, Environment Protection, 1986.

PHYSICS-CORE COURSE

301 - CPT: MATHEMATICAL PHYSICS

THEORY: Credits -04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	*Topic*
1	**Fourier Series**: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions Statement only. Expansion of periodic functions in a series of sine and cosine functions, and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period.
2	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. **Some Special Integrals:** Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function Probability Integral. **Theory of Errors:** Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.
3	**Complex Analysis**: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Cauchy's Integral formula.
4	Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.
5	**Partial Differential Equations**: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes.

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris,Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, TataMcGraw-Hill.
- Advanced engineering mathematics, Erwin Kreyszig.
- Differential Equations, George F. Simmons, 2006, TataMcGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, DoverPub.

PHYSICS-CORE COURSE

302 - CPT: DIGITAL SYSTEMS AND APPLICATIONS

THEORY Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates realization using Diodes and Transistor. NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. **Boolean algebra:** De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (I) Sum of Products Method and (II) KarnaughMap.
2	**Data processing circuits**: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **Arithmetic Circuits:** Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors. **Sequential Circuits:** SR, D, and JK Flip-Flops. Clocked Level and Edge Triggered Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.
3	**Timers**: IC 555: block diagram and applications: Astablemultivibrator and Monostable multivibrator. **Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers only up to4bits. **Counters 4 bits:** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter
4	**Introduction to CRO:** Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: 1 Study of Waveform, 2 Measurement of Voltage, Current, Frequency, and Phase Difference. **Integrated Circuits** Qualitative treatment only: Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI basic idea and definitions only. Classification of ICs. Examples of Linear and Digital lCs.
5	**Computer Organization**: Input/ Output Devices. Data storage idea of RAM and ROM. Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. **Intel 8085 Microprocessor Architecture:** Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. **Introduction to Assembly Language:** 1 byte, 2 byte& 3 byte instructions.

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, TataMcGraw
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

303 - GE-3 : INTRODUCTION TO DATABASE SYSTEM

Theory Credit: 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**INTRODUCTION TO DATABASE** Data, Information, Meta-data, Database, Database Management System, Components of database environment, advantages of database approaches, disadvantages of database approach, range of database application and type of users
2	**DATABASE ENVIRONMENT** Database environment, three level architecture, mapping, data independency, data model and their types, relational data model and terminology, Functions of DBMS, Database development process, file organization
3	**ENTITY RELATION MODEL** E-R model, elements of E-R model, E-R diagram, Types of entities, Degree of relationship: unary, binary, ternary
4	**RELATIONAL MODEL AND NORMALIZATION** Relational model: concept, terminology, advantages; Keys and their types; RDBMS; Normalization: functionale dependencies, 1NF, 2NF, 3NF.
5	**STRUCTURED QUERY LANGUAGE(SQL)** SQL and its features, basic SQL statements to create table, operators in SQL to create relationships between database tables, modify and manage table, queries and creating queries, creating forms, creating report, filter and view data.

Reference Books :

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

304 -SEC-1: COMPUTATIONAL PHYSICS SKILLS

Theory Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

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

Unit	
1	**Introduction:** Importance of computers in Physics, paradigm for solving physics problems for solution**.** **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sinx as a series, algorithm for plotting 1 lissajous figures and 2 trajectory of a projectile thrown at an angle withthehorizontal.
2	**Scientific Programming**: Some fundamental Linux Commands Internal and External commands. Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements unformatted/formatted, Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.
3	**Control Statements:** Types of Logic Sequential, Selection, Repetition, Branching Statements Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements, Looping Statements DO-CONTINUE, DO-ENDDO, DO- WHILE, Implied and Nested DO Loops, Jumping Statements Unconditional GOTO, Computed GOTO, Assigned GOTO Subscripted Variables Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays, Functions and Subroutines Arithmetic Statement Function, Function Subprogram and Subroutine, RETURN, CALL, COMMON and EQUIVALENCE Statements, Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.
4	**Scientific word processing: Introduction to LaTeX:** TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.
5	**Visualization:** Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot equations, building functions, user defined variables and functions, Understanding data with Gnuplot

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt.Ltd.
- Computer Programming in Fortran 77". V. Rajaraman Publisher:PHI.
- LaTeX–A Document Preparation System", Leslie Lamport IIEdition, Addison-Wesley,1994.
- Gnuplot in action: understanding data with graphs, Philip K Janert, Manning2010

PHYSICS-CORE COURSE

401 - CPT: THERMAL PHYSICS

Theory Credits: -04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Zeroth and First Law of Thermodynamics**: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility andExpansionCo-efficient. **Second Law of Thermodynamics**: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem..
2	**Applications of Second Law of Thermodynamics**: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale **Entropy**: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.
3	**Thermodynamic Potentials**: Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehren fest equations. **Maxwell's Thermodynamic Relations**: Derivations and applications of Maxwell's Relations, (1) ClausiusClapeyronequation, (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.
4	**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. **Molecular Collisions**: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: 1 Viscosity, 2 Thermal Conductivity and 3 Diffusion. Brownian Motion and its Significance.
5	**Real 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.

Reference Books:

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

PHYSICS-CORE COURSE

402 - CPT: ANALOG SYSTEMS AND APPLICATIONS

THEORY Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Semiconductor Diodes:** P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication Simple Idea. Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential and Barrier Width.
2	**Two-terminal Devices and their Applications: (1)** Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, and (3) Solar Cell.
3	**Bipolar Junction transistors:** n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.
4	**Amplifiers:** 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. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. RC-coupled amplifier and its frequency response.
5	**Feedback in Amplifiers:** Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **Sinusoidal Oscillators:** Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-GrawHill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, PrenticeHall.
- Electronic Devices & circuits, S.Salivahanan&N.S.Kumar, 3rd Ed., 2012, Tata Mc-GrawHill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, PrenticeHall
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, WileyIndia
- Electronic Devices, 7/e Thomas L. Floyd, 2008, PearsonIndia

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403 - GE-4 : INTEGRAL TRANSFORM, SPECIAL FUNCTIONS

THEOTY Credits: 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Integrals Transforms**: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms translation, change of scale, complex conjugation, etc.. Three dimensional Fourier transforms with examples.
2	**Laplace Transforms:** Laplace Transform LT of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem.
3	**Application of transforms:** Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/ Heat Flow Equations Inverse Laplace Transforms. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.
4	**Frobenius Method and Special Functions** : Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations.
5	**Properties of Legendre Polynomials**: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris,Elsevier.
- Advanced engineering mathematics, Erwin Kreyszig.

404- SEC -2 PHYSICS WORKSHOP SKILL

Theory Credits: 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

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

Unit	
1	**Introduction:** Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.
2	**Mechanical Skill 1**: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood.
3	**Mechanical Skill** 2 : Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.
4	**Electrical and Electronic Skill**: Use of Multimeter. Soldering of electrical circuits having discrete components R, L, C, diode and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay.
5	**Introduction to prime movers**: Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment.

Reference Books:

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

PHYSICS-CORE COURSE

501 - CPT: QUANTUM MECHANICS AND APPLICATIONS

Theory: Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Time dependent Schrodinger equation**: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of aFree Particle.
2	**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.
3	**General discussion of bound states in an arbitrary potential**- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle.
4	**Quantum theory of hydrogen-like atoms**: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells.
5	**Atoms in Electric & Magnetic Fields**: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **Atoms in External Magnetic Fields**:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect Qualitative Discussiononly.

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGrawHill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002,Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGrawHill.
- Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning ofIndia.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rdEdn., 1993,Springer

Additional Books for Reference

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

PHYSICS-CORE COURSE

502- CPT: ELEMENTS OF MODERN PHYSICS

THEORY: Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	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.
2	**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.
3	**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.
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.
5	**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.

Reference Books:

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

Additional Books for Reference

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

503 - SEC-3 ELECTRICAL CIRCUIT NETWORK SKILLS

Theory Credits: 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

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

Unit	
1	**Basic Electricity Principles**: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **Understanding Electrical Circuits**: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.
2	**Electrical Drawing and Symbols**: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.
3	**Generators and Transformers**: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **Electric Motors**: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.
4	**Solid-State Devices**: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **Electrical Protection**: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements relay protection device
5	**Electrical Wiring**: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

Reference Books:

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

PHYSICS-CORE COURSE

601 - CPT : ELECTROMAGNETIC THEORY

Theory: Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Maxwell Equations:** Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic EM Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.
2	**EM Wave Propagation in Unbounded Media:** Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.
3	**EM Wave in Bounded Media:** Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection normal Incidence
4	**Polarization of Electromagnetic Waves:** Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light
5	**Rotatory Polarization:** Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. **Wave Guides:** Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.

Reference Books:

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

- Electromagnetic Fields & Waves, P.Lorrain&D.Corson, 1970, W.H.Freeman&Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGrawHill.

PHYSICS-CORE COURSE

602 - CPT: STATISTICAL MECHANICS

THEORY : Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Classical Statistics:** Macrostate& Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy with proof – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System,NegativeTemperature.
2	**Classical Theory of Radiation:** Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law.UltravioletCatastrophe.
3	**Quantum Theory of Radiation:** Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of 1 Wien's Distribution Law, 2 Rayleigh-Jeans Law, 3 Stefan-Boltzmann Law, 4 Wien's Displacement law from Planck's law.
4	**Bose-Einstein Statistics:** B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He qualitative description, Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.
5	**Fermi-Dirac Statistics:** Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford UniversityPress.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, TataMcGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, PrenticeHall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986,Narosa.
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ.Press

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PHYSICS-CORE COURSE

603 - CPT: SOLID STATE PHYSICS

THEORY: Credits - 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.
2	**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Mono-atomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.T^3law
3	**Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.
4	**Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TOmodes. **Ferroelectric Properties of Materials:** Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresisloop.
5	**Elementary band theory:** Kronig Penny model. Band Gap. Conductor, Semiconductor P and N type and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity four probe method &Hall coefficient. **Introduction to Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory **(No derivation)**

Reference Books:

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

PHYSICS-CORE COURSE

701 - CPT: NUMERICAL COMPUTATIONAL METHOD

THEORY: Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

In this paper, derivation of formula, algorithm for writing program and application will be taught.

Unit	Topic
1	**Numerical Solutions of nonlinear and a set of linear equations.** Concept of numerical solution, Numerical solutions of Transcendental equations: Iterative method, Bisection method, False Position and Newton Raphson method; Numerical solutions of simultaneous linear equations: Gauss Elimination and Gauss Seidel method,
2	**Least Square Fits and Error Analysis** Concept of best fit and least square fit. Linear regression of a function (based on the least Square fit) related to one variable, Linear regression based on two variable. Non-linear regression: Polynomial fit, exponential function fit; Error analysis: Basic concepts of errors and their types with special reference to numerical methods
3	**Interpolation, Numerical Integration** Introduction to interpolation, equally spaced argument data and unequally spaced argument data; Forward, Backward and Central difference operators and their symbolic relation with shift operator, forward difference table, Newton 's forward and backward interpolation, Gauss central difference interpolation formula, Lagrange interpolation formula.
4	**Numerical solution of integrals:** Trapezoidal formula and Simpson 1/3 rule. Monte Carlo Method. Numerical Solution of 2-Dimensional integrals. Solution of Fredholm Integral of first and second kind.
5	**Numerical Solution of Differential Equations** Ordinary differential equation, solution of ordinary differential equation: Picard's method, Euler method, second orders Runge-Kutta method, fourth order Runge-Kutta method. Numerical solution of second order differential equation with reference to Schrodinger equation.

BOOKS RECOMMENDED

1. Numerical Computational methods by Patil and Verma
2. Numerical Analysis: Rajaraman
3. Computer programming by S.S. Sastri
5. Numerical methods : Balaguruswami

PHYSICS-CORE COURSE

702 - CPT: TENSOR and QUANTUM MECHANICS

Theory: Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**

Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Tensor Analysis** Definition of Tensor and its rank, Transformation laws of covariant, contravariant and mixed tensors, Fundamental Operations with tensors (addition, subtraction and multiplication), Inner and outer product, Contraction of tensors, Associated tensors, Christoffel symbols, covariant differentiation of tensor
2	**Quantum Mechanics Fundamentals recap** Correspondence principle, Complementarity Principle, Uncertainty principle, Schrödinger wave equation, Separation of the time dependent wave equation, Eigenfunctions and eigenvalues, Stationary states, Probability density, Normalization of wavefunction, Expectation value of an observable, Ehrenfest's theorem, Free particle solution, Boundary and Continuity conditions, One-dimensional step potential (finite and infinite), Particle in a one-dimensional square potential well (finite and infinite), The rectangular potential barrier, parity of wave function, Orthonormality, Schmidt orthogonalization, Schwarz inequality, Linear harmonic oscillator. Dynamical variables as operators, Hermitian operators and their properties,
3	**Three-dimensional Systems** Particle in a three-dimensional box, The Dirac delta-function, , Central force problem in three dimensions, Separation of the wave equation, Bound states in a three-dimensional square potential well, Solution for *1=0*, Interior and exterior solutions for arbitrary *'l'*, The hydrogen atom wave functions, Energy levels, Degeneracy Energy eigenvalues of a three-dimensional harmonic oscillator, Energy eigenvalues of (a) plane rigid rotator (b) 3-D rigid rotator, Partial wave expansion of a free particle wave function. angular momentum operators, orbital angular momentum, Commutation relations, Eigenfunctions and Eigenvalues of L^2 and L_z
4	**Matrix Theory** Hilber Space, Linear Vector Space, dimensions and basis, operators, commutator algebra, derivation of uncertainty relation through operators, postulates of quantum mechanics. Matrix formulation of quantum theory (representation in discrete basis) – matrix representation of vector and operators, Bra and Ket notations, projection operators, matrix theory of Linear harmonic oscillator, matrices for *a, x, p* and H Angular momentum: Matrix formulation of angular momentum, matrices for $\mathbf{J^2}$ and $\mathbf{j_z}$, addition of two angular momentum. Spin-Pauli spin matrices and their algebra.
5	**Approximation Methods** Formulation of variational approximation method, application of variational method: (1) ground state of helium atom, (2) Zero point energy of Simple Harmonic Oscillator. The WKB approximation, Application of WKB approximation: (1) Connection formulas for penetration though a barrier, (2) bound energy levels in a potential well.

Books Recommended:

1. Schaum Series for Transforms, Complex Variables and Tensors
2. Mathematical Methods: Arfken
3. Intro. to quantum mechanics David j Griffith
4. Quantum Mechanics: L.I. Schiff.
5. Quantum Mechanics: J.T. Powell and Crasemann
6. Quantum Mech. & Field Theory By " B. K. Agrawal.
7. Quantum Mechanics A. K. Ghatak & S.Loknathan
8. Intro. to quantum mechanics by *Pauling & Wilson*

PHYSICS-CORE COURSE

Theory PHYSICS-C 703: RESEARCH METHODOLOGY

THEORY: Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Mode of study includes assigning the topic to students based on their basic background and presentation in the form of seminar which will be followed by discussion and submission of the write-up. There may not be any formal classroom teaching.

Unit	Topic
1	**Principles of Scientific Research:** Definition – History – Evolution of Scientific Inquiry Meaning and importance of research – Types of Research, Research Design – Need – Features – Inductive, Deductive and Development models Analysis of Literature Review – Primary and Secondary Sources, Web sources –Critical Literature Review Hypothesis – Different Types – Significance – Development of Working Hypothesis Research Methods: Scientific method vs. Arbitrary Method, Logical Scientific Methods
2	**Collection and Analysis:** Sources of data: Primary, Secondary and Tertiary. Methods of collecting data: Observation, field investigations, direct studies – Reports, Records of Experimental observations. Sampling methods: Data Processing and Analysis strategies, Graphical representation – Descriptive Analysis – Inferential Analysis- Correlation analysis – Least square method - Data Analysis using statistical package – Hypothesis – testing – Generalization and Interpretation – Modeling.
3	**Scientific Writing:** Structure and components of Scientific Reports, types of report: Technical Reports and Thesis. Different steps in the preparation: Layout, structure and language of typical reports, illustrations and tables; Bibliography, referencing and foot notes. **Oral presentation:** Planning, preparation and practice, making presentation; use of visual aids; importance of effective communication. **Preparing Research papers:** for journals, seminars and conferences; design of paper using TEMPLATE; Impact factor of a journal, citation index, ISBN & ISSN. Preparation of Project Proposal: Title, Abstract, Introduction – Rationale, Objectives, Methodology; Time frame and work plan; Budget and Justification
4	**Intellectual Property Rights and Ethical Issues:** Intellectual Property rights and patent law; copy right – royalty related aspects of intellectual property rights, commercialization; Ethical Issues, Ethical Committees. Reproduction of published material: plagiarism, citation and acknowledgement; reproducibility and accountability.
5	Application of Computer in Research: MS office and its application in Research: MS Word, MS Power point and MS Excel; statistical computation using SPSS. Use of Internet in Research – Websites, searches engines, E-journal and E-Library, INFLIBNET.

Essential Readings:

1. An introduction to Research Methodology,. Garg.B.L. Karadia, R., Agarwal,F. and Agarwal, RBSA Publishers U.K., 2002
2. Research Methodology: Methods and Techniques. Kothari, C.R.Second Edition. New Age International Publishers, New Delhi.2008
3. Research Methodology, Sinha, S.C. and Dhiman, A.K.Ess Ess Publications, 2002
4. How to write and publish a scientific paper. Day, R.A. Cambridge Univ. Press. London, 1992
5. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing. Wadehra, B.L., 2000.
6. Computer Fundamentals, Sinha P.K. BPB Publications, New Delhi. 1992.

PHYSICS-CORE COURSE

801 - CPT: CLASSICAL ELECTRODYNAMICS AND ANTENNAE PHYSICS

Theory: Credits - 04

Max. Marks: 40 (internal) + 60 (Sem. End Exam.)
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Dipole Radiation** Maxwell's equations in terms of scalar and vector potential, Gauge transformations: Lorentz gauge and Coulomb gauge, Retarded potentials, Radiation from oscillating electric and magnetic dipoles with simple applications.
2	**Radiation from a Point Charge** Lienard - Wiechart potentials, Fields due to point charge in uniform and accelerated motions, Power radiated by a point charge (in non relativistic limit), Radiation reaction: Abraham Lorentz formula, Physical origin of the radiation reaction.
3	**Plasma physics and Wave Propagation** Definition of plasma, Plasma fusion and confinement by Magnetic mirrors, Kink and Sausage instability, Motion of charged particle in E and B fields, Gravitational field, time varying fields, Phase velocity, Group velocity, Cutoff and resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field., Idea of fusion reactors
4	**Antenna Arrays** Two element array, Horizontal pattern in broadcast array, Linear array, Multiplication of patterns, Binomial arrays, Antenna gain, Effective area, Antenna terminal Impedance, Mathematics of linear arrays, antenna synthesis, Tchebyscheff distribution, Idea of super directive arrays, Radiation from current sheet.
5	**Nonlinear Optics** Nonlinear optical media, Second order nonlinear optics, Second harmonic generation, The electro-optics effect, Three-wave mixing, Third order nonlinear optics, Third harmonic generation and self phase modulation, four wave mixing, optical phase conjugation. Raman gain.

Books Recommended:

1. Classical Electrodynamics by J.D. Jakson
2. E.M. Waves and Radiating systems by Jorden and Ballman
3. Introduction to Classical Electrodynamics by Griffth
4. Controlled thermonuclear reaction, by S Glastone
5. Plasma Physics by F F Chen

PHYSICS-CORE COURSE

802 - -CPT: BASIC ELEMENTS OF SOLID STATE PHYSICS/ MATERIALS SCIENCE

Theory: Credits - 04 **Max. Marks: 40 (internal) + 60 (Sem. End Exam.)**
Pass Marks: 14 (internal) + 21 (Sem. End Exam.)

Unit	Topic
1	**Crystal Structure** A review of concepts of space and crystal lattice, Primitive vectors and cells; Symmetry elements, Miller indices for planes and axes, Space groups and point groups, Bragg's law, Construction of reciprocal lattice, reciprocal lattice vectors, Brillion zones, Reciprocal lattice of SC, BCC and FCC, Structure and atomic factors
2	**Lattice Dynamics and Thermal Properties** Vibrations of one dimensional monoatomic and diatomic lattices, Quantization of lattice vibrations, Phonon momentum, Qualitative description of phonons in three dimensional lattice, phonon density of states, Einstein and Debye models of lattice specific heat, Anharmonic effects in crystals: thermal expansion of solids, Equation of states of solids, Phonon-phonon interaction and thermal conductivity
3	**Electronic Energy Bands** A brief review of properties of free electron gas, Hall effect and quantised Hall effect, The periodic potential, Bloch theorem and Born-von Kramer boundary conditions, Fermi surface, Electron density of states, Kroning-Penny model, Equation for electron wave in a periodic potential: solution of central equation, approximate solution near zone boundary.
4	Construction of Fermi surfaces, The tight binding approximation for bond structure, Orthoganalized Plane-Wave (OPW) method and idea of pseudo potential. Introduction to density functional theory : many body system and born openheimer approximation, the Hohenberg-Kohn Theorems, Kohen Sham equation, exchange correlation terms, local density approximation
5	**Elements of Semiconductor Physics** Examples of semiconductors, Typical band structure of a semiconductor, Effective mass in solids, Number of carriers in thermal equilibrium, Intrinsic (non-degenerate) semiconductors, Extrinsic semiconductors, Effect of doping, Impurity levels, Population of impurity levels, Fields and carrier densities in equilibrium, p-n junctions, Elementary picture of rectification by p-n junction.

BOOKS RECOMMENDED

1. Introduction to solid state physics: Kittel
2. Solid State Physics: Ashcroff and Mermin
3. An introduction to x-ray crystallography: woolfson
4. Solid state Physics: Azaroff
5. Intermediate quantum theory of crystalline solids: Aniamalu
6. Solid state Physics: Epifanov