Master of Science – PHYSICS, SEM-I

Course:	**PH-411: Mathematical Methods of Physics**
Course Outcomes	CO1 : At the end of the course, the students will be able to use different mathematical methods to study problems in non-linear sciences. CO2 : Understand the methods to ordinary differential equations. understand the methods to solve Nonlinear Schrodinger type equations CO3 : Uunderstand the concepts and application of solutions.

Mapping between COs with PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						

Pre-requisite

Course Content

Unit 1:
Linear spaces Vector spaces and subspaces, Linear dependence and independence, Basis and Dimensions, linear operators, linear transformations

Unit 2:
Matrices and Eigen values: Review of algebraic operations on Matrices, matrix representation, Similarity transformations, Inner product, Orthogonality, Unitary transformations, Eigen values and eigenvectors, Diagonalization using Jacobi method

Unit 3:
Ordinary Differential Equations Solution in closed form: First order differential equations, Linear equations, Bernoulli's equation, Exact equation, Clearout's equation Second order differential equation: Homogeneous and inhomogeneous forms, variation of parameters method, changes of variable. Power series solution: General consideration, Legendre' equations, Bessel's equation, miscellaneous approximation methods, the W K B method.

Unit 4:
Special functions Legendre functions,: Rodriguez's formula, Integral representation, Generating function, recursion relations, orthogonality of Legendre's polynomial, Associated Legendre's polynomial ,it's recursion relations and orthogonality. Bessel functions: Generating function, recursion relations and orthogonality of Bessel's function, Hermite functions, spherical harmonics, Lagaurre's functions.

Unit 5:
Integral transforms Fourier transform, Parseval's theorem, Laplace transforms, Properties of Fourier and Laplace's transforms ,Convolution theorem, other transform pairs, applications of integral transforms. Complex integration: Residue and residue theorem, contour integration.

Unit 6:
Probability distributions Binomial, poison and Gaussian distribution, properties of distributions Group theory :an introduction, Subgroup and classes, Group representation, Applications**:**

Reference Books

1. J. Mathews and R.L.Walker Mathematical Methods of Physics Benjamin (IBH) (1979)
2. H. Margenau and G.M. Murphy, Mathematics of Physics and Chemistry, East-West Press (1975).

	3. P.M. Morse and H. Feshbach, Methods of Theoretical Physics, Vols. 1-2, McGraw Hill-Kogekusha (1953). 4. R.V. Churchill, Complex Variables and Applications, McGraw Hill, (1960). 5. Mathematical Methods - B S Rajput Pragati Prakashan, (1997) 6. Mathematical Methods for Physicists George Arfken, Hans Weber, Frank E. Harris, Academic Press, 7th Edition (2012)
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH-412: Classical Mechanics**
Course Outcomes	CO1 : The end of the course, the students will be able to understand. CO2 : The basic concepts on Classical Mechanics CO3 : The theorems relating to the nonlinear bodies. CO4: The various aspects of dynamics and oscillations of bodies.
Mapping between COs with PSOs	(see table below)
Pre-requisite	
Course Content	**Unit 1**: Newtonian Mechanics of Many Particle Systems: Review mainly through examples of Newton's laws of motion; mechanics of system of particles; conservation laws. Motion in a Non-Inertial Reference Frame: Rotating coordinate systems; Carioles force; motion relative to earth; limitations of Newton's programme. **Unit 2:** Lagrangian Formulation Constraints; their classification; generalized coordinates; Calculus of variations; Hamilton's principle; Lagrange's equations of motion; cyclic coordinates; conservation theorems and symmetry properties; Rayleigh dissipation function; Lagrange equation with undetermined multipliers. **Unit 3:** Central Force Problem: Reduction of two body problem to one body problem; equation of motion and first integrals; equivalent one-dimensional problem; classification of orbits; differential equation for the orbit; power law potentials; Bertrand's theorem; Kelper's laws; Scattering in a central force field; Rutherford scattering cross section. **Unit 4:** Rigid Body Motion: Independent coordinates of a rigid body; Orthogonal transformations; transformation matrix; Euler-angles; Euler theorem; angular momentum; kinetic energy; moment of Inertia tensor; principal axis transformation; Euler's and Lagrangian treatment of rigid body motion; force free motion of a symmetrical top; motion of a heavy symmetrical top with one point fixed. **Unit 5:**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

	Small Oscillations: Eigen-value equation and principal axis transformation; normal modes and normal coordinates for small oscillations; examples: Free vibrations of a linear tri-atomic molecule, coupled pendulums, double pendulum. Hamilton's Equations of Motion: Legendre transformation and Hamiltonian function; canonical equations of motion; examples; ignorable coordinates and conservation theorems; Cyclic coordinates and Routh's procedure; modified Hamilton's Principle. **Unit 6:** Canonical Transformations: I Generators of Canonical transformations, Equations of canonical transformations; examples; the Harmonic oscillator; The integral invariance of Poincare and Lagrange and Poisson Brackets; Equation of Motion in Poisson bracket; Infinitesimal canonical transformation; constant of motion and symmetry properties; angular momentum Poisson brackets. Hamilton-Jacobi Theory: Hamilton-Jacobi equation; Hamilton's principal and characteristic function; examples; separation of variables in Hamilton-Jacobi equation; orbit equation for central force problem; periodicity and action angle variables, frequencies of periodic motion.
Reference Books	1. H. Goldstein, Classical Mechanics, 3rd ed., Pearson education, 2nd ed., Addison Wesley, (2002). 2. J.B. Marion and S.T. Thronton, Classical Dynamics of Particles and Systems, 4th ed., Saunders College Publishing, (1995) 3. N.C. Rana and P.S. Joag, Classical Mechanics, TMH, (1991). 4. Y. R. Waghmare, Classical Mechanics, PHI, (1990). 5. V. B. Bhatia, Classical Mechanics, Narosa Pub. House, (1997). 6. R. G. Takwale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGrawHill, (1990). 7. M. R. Spiegel, Theory and Problems of Theoretical Mechanics, Schaum's Outline Series. (2006)
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH-413: Measurement, Instrumentation and Experimental Planning**
Course Outcomes	CO1 : At the end of the course, the students will be able to acquire the knowledge about the different errors occurring during measurement. CO2 : Understand the principle behind the instrumentation for measurement. CO3 : Identify the various transducers involved in measurement .
Mapping between COs with PSOs	see table below
Pre-requisite	
Course Content	**Unit 1**: Measurement System Measurement, Definition of basic Terms, Calibration, The Generalized Measurement Systems, Static Characteristics - Some basic statistics, Static Sensitivity, Linearity, Threshold, Noise Floor,

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2		■				
CO3					■	

	Resolution, Hysteresis Scale Readability, spam, Dynamic Characteristics. Generalized Mathematical Model of Measurement System. **Unit 2:** Transducers: Transducers, The Variable-Resistance Transducer, The Differential Transformer (LVDT), Capacitive Transducer, Piezoelectric Transducer, Photoconductive Transducer, Photovoltaic Transducer, Ionization Transducers, Hall-Effect Transducer, Digital Displacement Transducers, Problems. **Unit 3:** Measurements of Different Physical quantity: Mechanical Pressure Measurement Devices, Low Pressure measurement, Ionization Gages, Dimensional Measurement, Force Measurement. Measurement of Viscosity, Humidity Measurement, pH Measurement, Detection of Nuclear radiation, Neutron Detection, Air Pollution standards. **Unit 4:** Instrumentation and Experimental Planning Instrument - Zero order Instrument, Second order, Third order instrument, Their step, Ramp, Frequency, Impulse Responses. **Unit 5:** Electrodes, Sensors & Transducers Sensor error source Tactics & signal processing for improved sensing, Electrodes for biophysical sensing, Medical surface electrodes, Micro electrodes, Temperature transducers. ECG Machine, Overview of Clinical instrumentation, Blood Cell Counters. **Unit 6:** Report Writing Report Writing, Function of Research Report, Types of Report, Contents of a Report, Mechanics of writing a Report, Challenges of a Good writing, Graphical Presentations, Processing of Reports, Oral and Poster Presentations.
Reference Books	1. Measurement Systems - Application and Design. Earnest O. Doebein, Tata McGraw Hill Publication (5th Edition) (2004) 2. Experimental Methods for Engineers J.P. Holman. Tata McGraw Hill Publication (7th Edition) (2004). 3. B.E. Jones, Instrumentation measurement & feedback: TMH 4. A.K.Sawhney, A course in mechanical measurements & Instrumentation: Dhanpat Rai & sons. 5. C.S.Rangan, G.R.Sharma, V.S.V.Mani, Instrumentation, Devices & Systems: TMH. 6. R.S.Khandpur, Handbook of Analytical Instruments: TMH. 7. A.James, Diefenderfer, Principles of Electronic Instrumentation: W.B.Saunders. 8. M.Sayer & A. Mansingh, Measurement, Instrumentation & Experiment design in Physics & Engineering: PHI.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH-414: General Electronics**
Course Outcomes	CO1 : At the end of the course, the students will be able to understand the fundamentals of working of semiconductor and special devices CO2 : Applications of electronic devices.

<table>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td bgcolor="gray"></td><td bgcolor="gray"></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td bgcolor="gray"></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Unit 1: Network analysis: Review of Thevenion, Norton and Superposition theorems, Mesh and Node circuit analysis, T-Network analysis, π-Network analysis, conversions between T-Network section and π-Network section, Bridged-T network, Matrices method, Determinants method.
Unit 2:
Bipolar Junction Transistor DC Model, BJT as Switch, BJT as an Amplifier, BJT Small-Signal Model, Frequency response of an amplifier, Low frequency response, High frequency response, Bandwidth, Step response of an amplifier.
Unit 3:
Operational Amplifier: Basic operational amplifier, Operational amplifier with negative feedback, Voltage series feedback amplifier: close loop voltage gain, input resistance, output resistance, voltage follower. Voltage shunt feedback amplifier: close loop voltage gain, input resistance, output resistance, Inverter. Application of operational amplifier: Summing, Scaling and Averaging amplifier, Integrator and Differentiator circuit. Active filters: First order Low pass, High pass, and Band pass filters.
Unit 4:
Oscillators and Generators: Oscillators, Phase shift oscillator, Wien-Bridge oscillator, Basic Comparator, Comparator characteristic, Square wave generator, Triangular wave generator, Saw tooth wave generator, Voltage regulators.
Unit 5:
Combinational digital circuit design: Standard Gate Assemblies, Arithmetic Functions, Digital Comparator, Parity CheckerGenerator, Multiplexer, De-multiplexer, Encoder, Decoder, Digital to Analog Converter, Analog to Digital Converter Tri-State buffer, Read Only Memory (ROM), ROM applications.
Unit 6:
Sequential digital circuit design: The clocked S-R flip-flop, D flip-flop, J-K flip-flop T flip-flop and M-S flip-flop, Shift Registers, A-stable Multivibrator, Bi-stable Multivibrator, Mono-stable Multivibrator, Counters, Applications of counters, 7-Segment display, Alpha-Numeric display, Multiplexed display system.</td></tr>
<tr><td>Reference Books</td><td>1. J.D. Ryder, Electronic Fundamentals and Applications Prentice Hall of India, (1981).
2. A Mottershed, Electron Devices and Circuits Prentice Hall of India, (1981).
3. J. Millmann and A grabel, Microelectronics, Mc Graw Hill, (1987).
4. A.S. Sedra and R.C. Smith, Microelectronics Circuits Oxford Press (1996).
5. R.A. Gaikwad, Op. Amps and linear Integrated circuits, Prentice Hall of India. (2002)</td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study, Seminars and/or Assignment</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, participation, class test,</td></tr>
</table>

	quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course:</td><td>PH-415: PRACTICALS</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : At the end of the course, the students will be able to understand the fundamentals of working of semiconductor and special devices
CO2 : Applications of electronic devices</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Group-A
1. Numerical Analysis-I
2. Numerical Analysis-II
3. Computer Experiment –I
4. Normal Mode
5. Fourier Analysis
6. e/m Helical Method
7. Hall Effect
8. Ultrasonic Interferometer
9. Transducers-I
10. Michelson’s Interferometer
11. Measurement of Electrical Conductivity of Graphite.
12. Measurement of Energy Band Gap of a Semiconductor.
Group-B
13. Characteristics of DIAC, TRIAC
14. Study of Inter conversion of 'π' and 'Ţ' Network
15. To design, build & Test relaxation Oscillator using UJT.
16. To design, build & Test Inverting and non-inverting Amplifier using Operational Amplifiers.
17. To design, build & Test combinational Logic circuit using only NAND / NOR Gates.
18. To design, build & Test 04- bit Up/Down counter using IC 7493.</td></tr>
<tr><td>Reference Books</td><td></td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study, Seminars and/or Assignment</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination</td></tr>
</table>

Master of Science – PHYSICS, SEM-II

<table>
<tr><td>Course:</td><td>PH-421: QUANTUM MECHANICS - I</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : At the end of the course, the students will be able to understand the basics of quantum mechanics.
CO2 : various physics concepts in the light of quantum mechanics.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Unit 1:
Origin of Quantum Physics: Particle aspect of radiation, wave aspect of particles, wave-particle duality, wave packets, wave packets and uncertainty relations, motion of wave packets.
Mathematical Tools of Quantum Mechanics: The Hilbert space and Wave functions, Dimension and basis of vector space, Dirac notation, Operators, Hermitian ad joint, projection operators, parity operator, commentator algebra, uncertainty relations between two operators, Eigen values and Eigen vectors, unitary transformations, Matrix representation of kits, bras and operators, Change of basis and unitary transformations, wave functions in position and momentum space, Matrix representation of Eigen value problem, Dirac delta function.
Unit 2:
Postulates of Quantum Mechanics: The basic postulates of Quantum Mechanics, Representation of state, representation of dynamical variables, Observables and operators, measurement in Quantum Mechanics, time evolution, stationary state, Schrodinger equation and wave packets, conservation of probability, expectation value, Ehrenfest theorem, symmetries and conservation laws
Unit 3:
One-dimensional and three-dimensional Problems The free particle, the particle in a box, The potential step, infinite square well, finite square well, The Harmonic oscillator by analytic and operator method, Hermite polynomials, harmonic oscillator wave functions, correspondence with classical theory, Spherically symmetric potentials in three dimensions, the spherical square well potential, the hydrogen atom, energy quantization, quantum numbers
Unit 4:
Angular Momentum Orbital angular momentum, general formalism of angular momentum, raising and lowering operators, matrix representation of angular momentum, Eigen functions and Eigen values of L2 and LZ using operator method, spherical harmonics, experimental evidence of spin, general theory of spin, spin ½ and Pauli spin matrices.
Unit 5:
Addition of Angular Momenta Rotations in Classical Physics, rotations in Quantum Mechanics, Addition of two angular momenta, Clebsch-Gordon coefficients, coupling of orbital and spin angular momenta, tensor operators, spherical tensors, Wigner-Eckert theorem.
Unit 6:
The principle of in distinguishibility; Symmetric and anti-symmetric wave</td></tr>
</table>

	functions; Spin and statistics of identical particles; The Slater determinant; The Pauli exclusion principle; Spin states of a two electron system; States of the helium atom; Collision of identical particles.
Reference Books	1. Quantum Mechanics by Nouredine Zettili (Wiley) 2nd Ed., (2004) 2. Quantum Mechanics by Franz Schawbl Springer 4th Ed. (2007) 3. Introductory Quantum Mechanics by Liboff, Pearson Education India, 4th Ed. (2003) 4. Quantum Mechanics by Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe Vol. I & II, Wiley-CH, (1997) 5. Quantum Mechanics, by L. I. Schiff, McGraw-Hill Inc.,US, 3rd Revised Ed.(1968) 6. Introduction to Quantum Mechanics by David Griffiths, Pearson Education; 2nd Ed. (2015) 7. Quantum Mechanics, by A. K. Ghatak and S. Lokanathan (Macmillan - India), 5th Ed. (2004) 8. Quantum Mechanics by Mathews and Venkatesan, 2nd Ed. (2010)
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH-422: Solid State Physics**
Course Outcomes	CO1 : At the end of the course, the students will be able to understand the basic concepts on properties of materials in solid state physics. CO2 : phenomenon of superconductivity and its properties. CO3 : different techniques used for synthesis and fabrication of nano-materials.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2		■		■		
CO3	■	■				

Pre-requisite	
Course Content	**Unit 1**: Crystal Physics Crystal classes and Systems, Lattice, Lattice Points and space lattice, unit cells and lattice parameters, 2D and 3D lattices, Symmetry and Symmetry operations, Directions, Planes, and Miller Indices, Reciprocal lattices, Brillion Zones, Ideal and real crystal, Temperature dependence of reflection lines. Elastic scattering from Surfaces; Elastic scattering from amorphous solids. **Unit 2:** Crystal Defects Different type of imperfections, Schottky and Frenkel defects, edge and screw dislocations, Grain boundaries and stacking fault. X-Ray diffraction, Powder Crystal method, Rotating Crystal method, Laue methods, other probes for Crystal Structure determination. **Unit 3:** Lattice vibrations and thermal properties Vibrations of Mono-atomic Lattice, normal mode frequencies, dispersion relation. Lattice with two atoms per unit cell, normal mode frequencies, dispersion relation.,

	Quantization of lattice vibrations, phonon momentum, Inelastic scattering of neutrons by phonons, Surface vibrations, Inelastic Neutron scattering. Enharmonic Crystal Interaction. Thermal conductivity - Lattice Thermal Resistivity. **Unit 4:** Diamagnetism and Para magnetism Langevin diamagnetic equation, diamagnetic response, Quantum mechanical formulation, core diamagnetism. Quantum Theory of Para magnetism, Rare Earth lons, Hund's Rule, Iron Group ions, Crystal Field Splitting and Quenching of orbital angular momentum; Adiabatic Demagnetisation of a paramagnetic Salt, Paramagnetic susceptibility of conduction electrons. **Unit 5:** Magnetic ordering Ferromagnetic order- Exchange Integral, Saturation magnetisation, Magnons, neutron magnetic scattering; Ferri magnetic order, spinals, Yttrium Iron Granets, Anti Ferromagnetic order. Ferromagnetic Domains - Anisotropy energy, origin of domains, transition region between domains, Bloch wall, Coercive force and hysteresis. **Unit 6:** Superconductivity Historical Introduction, Superconducting Materials, Josephson effect, The London Education, Ginsburg-Landau theory, The BCS theory, HTSC cuprate Material Characterizations properties of HTSC Oxides, Potential Applications of Super Conductivity.
Reference Books	1. Introduction to Solid State Physics by Kittle, John Wiley & sons, 8th ed. (2004) 2. Fundamentals of Solid State Physics by J.Richard Chistman John Wiley & sons (1987). 3. Solid State Physics - Structure and properties of Materials by M.A. Wahab, Narosa Publications (1999). 4. Elementary Solid State Physics by M. Ali Omar, Addison Wesley (LPE), (1994). 5. Solid State Physics- S.O. Pillai (3rd edition), New Age International Ltd. (2015).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH-423: Classical Electrodynamics and Plasma Physics**
Course Outcomes	CO1 : At the end of the course, the students will be able to understand the basic concepts nucleus and its properties. CO2 : To gain the knowledge on elementary particles.
Mapping between COs with PSOs	(see mapping table below)
Pre-requisite	
Course Content	**Unit 1**: Multipole expansion: Multipole expansions for a localised charge

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

	distribution in free space, Linear quadrupole potential and field, static electric and magnetic fields in material media, Boundary conditions. **Unit 2:** Maxwell's equations: Displacement current, Maxwell's equations, Maxwell's equations in matter, boundary conditions, The continuity condition, Poynting's theorem, Maxwell's stress tensor. **Unit 3:** Electromagnetic waves: Waves in one dimension, boundary conditions: reflection and transmission, polarization, Electromagnetic waves in Vacuum, energy and momentum in electromagnetic wave, Electromagnetic waves in matter, Reflection and transmission at normal and oblique incidence, Electromagnetic waves in conductors, frequency dependence of permittivity, skin depth. **Unit 4:** Potentials and fields: Scalar and vector potential, Gauge transformations, Coulomb and Lorentz gauge, Retarded potentials and Lienard-Wiechert potentials, the fields of a moving point charge. **Unit 5:** Wave Guides Rectangular wave guides, Transverse magnetic waves in rectangular wave guides, transverse electric waves in rectangular wave guides, TM and TE waves in circular wave guides. **Unit 6:** Plasma Physics and magneto hydrodynamics Introduction of plasma physics and magneto hydrodynamics, magneto-hydrodynamic equations, magnetic diffusion, viscosity and pressure, magneto hydrodynamic flow between boundaries with crossed electric and magnetic fields, pinch effect, instabilities in a pinched plasma column, magneto hydrodynamic waves, plasma oscillations, De bye screening. Applications of plasma physics and controlled thermonuclear reactions.
Reference Books	1. Introduction to Solid State Physics by Kittel, John Wiley & sons, 8th ed. (2004) 2. Fundamentals of Solid State Physics by J.Richard Chistman John Wiley & sons (1987). 3. Solid State Physics - Structure and properties of Materials by M.A. Wahab, Narosa Publications (1999). 4. Elementary Solid State Physics by M. Ali Omar, Addison Wesley (LPE), (1994). 5. Solid State Physics- S.O. Pillai (3rd edition), New Age International Ltd. (2015).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH-424: Numerical Analysis, Computer Programming**
Course Outcomes	CO1 : Numerical methods & programming At the end of course, students will be able to understand some numerical methods to solve physical problems and simulate that problems by knowing some compiler languages. CO2 : At the end of the course, the students will be able to understand the basic concepts of numerical methods and programming

<table>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>
Unit 1:
Numerical Integration: Newton-Cote's formula, Trapezoidal, Simpson $1/3^{rd}$ and $3/8^{th}$ rule and Weddle rules.
Numerical Solutions of Ordinary Differential Equations:
Euler, Picard and Taylor series methods, Runge–Kutta 2^{nd} order and 4^{th} order method, and Predictor Corrector methods.
Unit 2:
Solution of Simultaneous Linear Equations: Matrix inversion method, Cramer's rule with Pivotal and triangle methods for determinants.
Eigen values and Eigenvectors of a Matrix: Characteristic roots method, Jacobi method, Householder method.
Unit 3:
Operating systems, higher level compiler languages, algorithm; flow charting,
FORTRAN Language: Character set, structure of a program, constants and variables, arithmetic expressions, arithmetic statement; assignment statements, input and output statements, control statements: IF-THEN-ELSE, arithmetic IF, logical expressions and assignments, GO TO, basic looping structure,
Unit 4:
FORTRAN Language: Subscripted variables, DIMENSION statements; format specifications; OPEN and CLOSE statements; function statements, function subprograms and subroutines.
Unit 5:
C Language: Introduction to C language, identifiers and keywords, data types, constants and variables, arithmetic expressions; input and output statements, conditional statements: *while*-loop, *for*-loop, *do while*–loop; arrays; logical operators and expressions, structures: *switch*, *break* and *continue* statements;
Unit 6:
C Language: functions; structures; pointer data type; random and sequential files, file handling in C.
FORTRAN and C Programs: Program writing in FORTAN and C for interpolation, integration, roots of equations, matrix diagonalization, solution of differential equations. Good programming practices.
</td></tr>
<tr><td>Reference Books</td><td>
J. B. Scarborough, Numerical Mathematical Analysis, Oxford Books Co., (1962).
S. S. Sastry, Introductory Methods of Numerical Analysis. PHI, (1998).
K. S. Rao. Numerical Methods for Scientists and Engineers, PHI, (2001).
V. Rajaraman, Computer Oriented Numerical Methods, PHI, (1994).
J. H. Mathews, Numerical Methods for Math., Science and Engineering, PHI, (1994).
V. Rajaraman, Computer Programming in FORTRAN 77, PHI, (1994).
P. S. Grover, Programming and computing with FORTRAN 77 and 90.
V. Rajaraman, Computer Programming in C, PHI, (1997).
C. Xavier, C Language and Numerical Methods, (1999).
B.W. Kernigham and D.M. Ritchie, The C Programming language, PHI, (1988).
</td></tr>
</table>

Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course:</td><td>PH-425: Practical’s</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : At the end of the course, the students will be able to understand the fundamentals of working of semiconductor and special devices
CO2 : Applications of electronic devices</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Group-A
1. Numerical Analysis-III
2. Numerical Analysis-IV
3. Computer Experiment –II
4. 'e' by Milliken's Oil drop Method
5. Electron Spin Resonance
6. Measurement of Susceptibility of Liquid by Quinck's Methods
7. Lattice Dynamics
8. X-Ray Diffraction
9. Transducers-II
10. Electrical Conductivity of a Semiconductor using Four Probe Method.
Group-B
Photo Cell
Measurement of 'h' by Solar Cell
Design build and test an Astable multivibrator
Design build and test a phase shift oscillator using operation amplifier
Design build and test regulated power supply.
Design build and test combinational logic circuit using multiplexer.
Design, build and test 4 bit R-2R ladder type DAC
To design, build and test a first order band pass filter using operational amplifier.</td></tr>
<tr><td>Reference Books</td><td></td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study, Seminars and/or Assignment</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination</td></tr>
</table>

Master of Science – PHYSICS, SEM-III

Course:	**PH-531: QUANTUM MECHANICS - II**
Course Outcomes	CO1 : At the end of the course, the students will be able to understand the scattering and Perturbation theory. CO2 : Also understand the relativistic wave equations.
Mapping between COs with PSOs	
Pre-requisite	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

Course Content

Unit-1:
Scattering Theory
Kinematics of the scattering process: Differential and total cross- sections, Wave mechanical picture of scattering: The scattering amplitude, Green’s function; Formal expression for scattering amplitude, The Born approximation, Validity the Born approximation.

Unit-2:
Scattering Theory-Phase shifts
Partial Waves Analysis: Asymptotic behavior of partial waves - phase shifts Optical theorem, Phase shifts- relation to the potential, potentials of finite range, Low energy scattering, scattering by a square well potential, Scattering by a hard sphere, Yukawa and Coulomb potential scattering by a square well potential, Scattering by a hard sphere, Yukawa and Coulomb potential.

Unit-3:
Approximation Methods for Stationary States
Time independent perturbation theory, non-degenerate and degenerate case, applications to fine structure splitting,, Zeeman (normal and anomalous) effect, Stark effect. The Variational method, upper bound on ground state, application to helium atoms and simple cases. The WKB method, Bohr-Sommer field quantization condition, applications of WKB to simple cases.

Unit-4:
Time dependent Perturbation Theory
The Schrodinger Picture, Heisenberg picture, interaction picture, Time dependent perturbation theory, transition probability, first and second order transitions, constant perturbation, Harmonic perturbation, Fermi’s golden rule, adiabatic and sudden approximations.

Unit-5 & 6:
Relativistic wave equations:
Generalization of the Schrödinger equation, The Klein-Gordon equation: Plane wave solutions; Charge and current densities, The Dirac’s Equation: Properties of Dirac matrices, Dirac equation in covariant form, Plane wave solutions of the Dirac equation; Energy spectrum, The spin of the Dirac particles, Significance of the negative energy states.

Reference Books	1. Quantum Mechanics by Nouredine Zettili (Wiley) 2nd Ed. (2004) 2. Quantum Mechanics by Franz Schawbl Springer 4th Ed. (2007) 3. Introductory Quantum Mechanics by Liboff, Pearson Education India, 4th Ed. (2003) 4. Quantum Mechanics by Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe Vol. I & II, Wiley-CH, (1997) 5. Quantum Mechanics, by L. I. Schiff, McGraw-Hill Inc.,US, 3rd Revised Ed. (1968) 6. Introduction to Quantum Mechanics by David Griffiths, Pearson Education; 5th Ed. (2015) 7. Quantum Mechanics, by A. K. Ghatak and S. Lokanathan (Macmillan - India), 5th Ed. 8.Quantum Mechanics by Mathews and Venkatesan, 2nd Ed. (2010)
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH-532: Nuclear and Particle Physics**
Course Outcomes	CO1: Students have better understanding of theoretical aspects of nuclear structure models, nuclear interaction, nuclear decay and nuclear reactions. CO2: They also learn about the structure and interaction of the sub-nuclear particles in quark models and the underlying fundamental symmetry properties.
Mapping between COs with PSOs	(see mapping table below)
Pre-requisite	
Course Content	**Unit-1:** *Brief history*: developments in nuclear and particle physics. Fundamental interactions, classification of particles: fermions, bosons, leptons, hadrons (mesons and baryons), excited states, resonances. *Nuclear properties*: nomenclature, symbols, charge, mass, charge and potential radii, spin, statistics, isospin, magnetic dipole moment, electric quadrapole moment, binding energy. *Nuclear force*: saturation property, charge independence, exchange forces, tensor force, symmetry and nuclear force, low energy n-p and p-p scattering, low energy scattering parameters, nuclear potential, Intermediate bosons. **Unit-2: *Nuclear Models*** *Liquid-drop model*: semi-empirical mass formula, nuclear stability *Single Particle Shell Model*: evidence of shell structure, magic numbers, Spin-orbit coupling, parity, spin and moments of nuclear ground states, Schmidt lines, *Collective Models*: evidence for collective motion, brief introduction to vibrational and rotational states, single particle motion in deformed potential. **Unit-3:** *Gamma Transitions*: Measurement of life-times of excited states,

Mapping between COs with PSOs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■			■		
CO2	■		■			

	theoretical predictions of decay constants, selection rules, angular correlation, internal conversion. *Beta Decay*: Fermi theory of beta decay, Kurie plots, comparative half-lives, selection rules, electron capture decay, parity violation in beta decay, double beta decay. *Alpha Decay*: Barrier penetration, reduced widths of alpha unstable states, energy levels. **Unit-4:** *Nuclear Reactions*: Theories of nuclear reactions, partial wave analysis of reaction cross-section, Compound-nucleus (CN) formation and breakup, resonance scattering and reaction, optical model of particle induced nuclear reactions, direct reactions- theory of stripping reactions, Spontaneous fission, induced fission, fission theories, heavy-ion reactions. **Unit-5:** *Symmetries*: Discrete and Continuous symmetry transformations, symmetry and degeneracy, conservation laws, parity, charge conjugation and time reversal, CPT theorem (statement), Permutation symmetry, Isospin, G-parity, strangeness, charm, beauty quantum numbers; need for color, Gell-Mann Nishijima Scheme; Multiplets of $SU(2) \otimes U(1)_Y$ **Unit-6:** *Standard Model*: quarks and leptons, isospin of antiparticles, isospin of quarks, static quark model of hadrons: mesons; pseudo scalar mesons; vector mesons, Baryon singlet; Baryon octet; magnetic dipole moment of baryon octet, hadrons mass and quark–quark interaction.
Reference Books	1. H.A. Enge, Introduction to nuclear Physics, Addison Wesley, 1982. 2. S.S.M. Wong, Introductory Nuclear Physics, PHI, 2002. 3. M.P. Khanna, Introduction to Particle Physics, PHI, 2004. 4. W.E. Burcham and M. Jacobs, Nuclear and Particle Physics, Addison, Wesley, 1998. 5. D.H. Perkins, Introduction to High Energy Physics, Addison Wesley, 1987. 6. B. L. Cohen, Concepts of Nuclear Physics, TMGH, 1984 7. Y. R. Waghmare, Introductory Nuclear Physics, Oxford-IBH, 1981 8. A. Das and T. Ferbel, Introduction to Nuclear and Particle Physics, 2nd ed. World Scientific, 2003. 9. H.S. Hans, Nuclear Physics, Experimental and Theoretical, New Age International (P) Ltd, 2001. 10. Kenneth S. Krane, Introductory Nuclear Physics, John Wiley & sons. Inc. Reprint Edition, 2014.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(E)-533: Physics of Semiconductor Devices**
Course Outcomes	CO1 : The syllabus provide an introduction to theory of Semiconductor Device. CO2 : The emphasis on vital understanding of both the operation of

<table>
<tr><td></td><td>present day devices will be benefited of present day device will be benefited to further development of new Semiconductor device in the field.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
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<tr><td>CO2</td><td bgcolor="gray"></td><td></td><td></td><td bgcolor="gray"></td><td bgcolor="gray"></td><td></td></tr>
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</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>
Unit-1:
Introduction: Carrier transport phenomena: Mobility, Resistivity and Hall Effect, Recombination process, Phonon spectra, optical thermal and high field properties of semiconductor, basic equation for semiconductor device operation.
Unit-2:
P-N Junction Diode Depletion region and depletion capacitance, Abrupt and linearly graded junctions, Current-Voltage characteristics, Ideal case- Shockley equation, Generation and recombination, High injection condition, Diffusion capacitance, Junction breakdown, Thermal instability, Tunnelling effect, Avalanche multiplication, Terminal function, Heterojunction .
Unit-3:
Bipolar transistor: Bipolar transistors, Static characteristic, Microwave transistors, Cut-off frequency, Microwave characterization, Device geometry and performance, Power transistors, switching transistor.
Unit-4:
Thyristor: Basic characteristic, Shockley diode and three terminal Thyristor: Static I-V Characteristic, Turn-On and Turn-Off time, Cathode short and dV/dt Effect, Maximum operation frequency. Related power thyristor: Reverse conducting Thyristors, Light activated Thyristor, DIAC and TRIAC, Uni- Junction Transistor and trigger Thyristor.
Unit-5:
M-S Contact: Energy band relation, Schottky effect, Characterization of barrier height, General expression of barrier height, Measurement of barrier height, Barrier height adjustment, Ohmic contact.
Unit-6:
Optical Devices: Optical absorption: Photon absorption coefficient, Electron –Hall pair generation, Solar cell: PN Junction solar cell, Conversion efficiency and solar concentration, Heterojunction solar cell, Amorphous silicon solar cell, Photo-detectors, PIN photodiode, Phototransistor, Light emitting diode, Laser diode.
</td></tr>
<tr><td>Reference Books</td><td>
1. D.A. Neamen, Semiconductor Physics and devices, Tata McGraw-Hill Publishing Company Limited. (2002).
2. S.M. Sze, Physics, of semiconductor devices, Wiley-Interscience, (1981).
3. B.G. Streetman, Solid State Electronic Devices, Prentice-Hall of India Private Linlited 3rd Ed.(1994).
4. R.M. Warner and B.Z. Grang, Transistors, John Wiley, (1983).
</td></tr>
</table>

Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(E)-534: Microcontroller and its applications**
Course Outcomes	CO1 : Being Advance subject, Microcontroller and its application is introduced in the curriculum. CO2 : In the field of electronics & Instrumentation the microcontroller base circuits play important roll. CO3: Therefore the employability of the student's in the Industry increases.
Mapping between COs with PSOs	(see table below)
Pre-requisite	
Course Content	(see below)

Mapping between COs with PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■			■	■	
CO2		■		■		
CO3				■		■

Course Content

Unit-1:

Numbering systems and Binary Arithmetic, Binary Arithmetic circuit design, Binary Codes, Character code, Numeric code, Packed and unpacked BCD numbers, Gray codes, Error correction and detection codes, Specialized codes, memory elements, primary and secondary storage, Memory organization in computer, microprocessor and microcomputers.

Unit-2:

8051 Architecture: 8051 Hardware, 8051 Block diagram, 8051 Programming model, 8051 Oscillators and clock, Internal memory, Stack and stack pointer, Special Function Registers, Input / Output pins ports and circuits, External memory, Counters and Timers, TCON-SFR, TMOD-SFR, Timer Counter Interrupts, Timing, Timer Mode of Operation, Counting, Serial data Input / Output, SCON-SFR, PCON-SFR, Serial Data interrupts, Data transmission and reception, Serial data transmission Modes, Interrupts, IE-SFR, IP- SFR, Timer flag Interrupt, Serial Port Interrupt, External Interrupt, Reset, Interrupt control, Interrupt Priority, Interrupt Destinations, Software-Generated Interrupts,

Unit-3:

Moving data: Addressing modes, Immediate addressing mode, Register addressing mode, Direct addressing mode, Indirect addressing mode, External data moves, Code memory Read-Only data moves, Push and Pop codes, Data exchanges, Example Programs.

Unit-4:

Logical operation: Byte level logical operation, Bit level logical operation, Internal RAM bit addresses, SFR bit addresses, Bit level Boolean operation, Rotate and Swap operation, Example Programs.

Unit-5:

Arithmetic operation: Flags, Instruction affecting flags,

	Incrementing and Decrementing, Unsigned addition, Signed addition, Unsigned subtraction, Signed subtraction, Multiplication, Division, Decimal arithmetic, Example Programs. **Unit-6:** **Jump and Call instructions:** Jump and Call program range: Relative range, Short absolute range, Long absolute range, Jumps: Bit jumps, Byte, jumps, Unconditional jumps, Calls and Subroutine: Subroutine, Calls and stack, Calls and returns, Example Programs.
Reference Books	1. Kenneth J. Ayala, The 8051 microcontroller, Architecture, programming and application, West publishing company (1996). 2.M.A.Mazidi, J.G. Mazidi, Rolin D. McKinlay The 8051 Microcontroller and Embedded Systems. Pearson Prentice Hall (2000). 3. Satish Shah, Embedded system design using The 8051 Microcontroller, OUP India (2010).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><th>Course:</th><th>PH(E)-535 Practical’s</th></tr>
<tr><td>Course Outcomes</td><td>CO1 : Some of the ‘Design, Build, and Test” type Electronic experiments are included in this lab to realise the theory of Electronics.
CO2: Programming part of the theory course PH(E)-534 (Microcontroller) learnt in the class room is practiced in this lab course.
CO3 : A good hand on experience in “Electronic circuit design, Build and Test” is gained.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
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<tr><td>CO3</td><td></td><td></td><td></td><td style="background:gray"></td><td></td><td style="background:gray"></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>To design, build and test a Mono-stable multivibrator.
To design, build and test a Bistable multivibrator.
To design, build and test a Voltage to Frequency converter
To design, build and test Schmitt Trigger circuit.
To design, build and test Saw tooth Generator with adjustable slop.
To design, build and test Adjustable Voltage Regulator.
To design, build and test a Window Detector.
To design, build and test a BCD to 7-Segnment ROM.
To design, build and test 4-bit binary Counter with Up/Down control.
To design, build and test 4-bit Mod-N Counter.
To design, build and test Digital to Analog converter.
Experiments on Microwave Bench.
Workshop practice. (Fitting and Turning)
Study of designing and preparing PCB.
Microcontroller Programming.</td></tr>
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Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(M)– 533: Crystal Growth & Characterizations**
Course Outcomes	CO1 : At the end of the course, the students will be able to get familiarized with various techniques involved in Crystal Growth. CO2 : At the end of the course, the students will be able to get familiarized to determine various theoretical parameters.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							

Pre-requisite	
Course Content	**Unit-1:** The Historical Development of Crystal Growth, Significance of Single Crystals, Reasons for growing crystals, Crystal Growth Techniques. Melt Growth Techniques, Solution Growth Techniques, Vapor Growth Techniques, The Chemical Physics of Crystal Growth. **Unit-2:** Nucleation, Classical theory of Nucleation, Homogeneous Nucleation, Heterogeneous Nucleation, Kinetics of Crystal Growth, Theories of Crystal Growth. **Unit-3:** Need for Crystal Growth, Target of Crystal Growth, Furnaces, design and fabrication of a crystal puller. **Unit-4:** Applications of Synthetic Crystals, Crystals in atmosphere, Ice Nucleation, Cloud seeding experiments, Food Seeding experiments. **Unit-5:** Qualitative and chemical Analysis : Introduction, stages of Analysis, selection of Analysis Method, Searching of Literature, Chemical Analysis, Thermal Analysis (TGA, DTA, DSC, etc.),x-ray Analysis (XRD, EDAX, etc.) **Unit-6:** Spectroscopic Methods: Introduction, Infrared spectroscopy (IR, FTIR) Ultraviolet spectroscopy, Raman Spectroscopy, Optical microscopy and morphology studies, SEM, TEM and AFM.
Reference Books	1. P. Ramaswamy & Santhan Raghavan Crystal Growth, KRU Publications, Chennai (2000). 2. Henisch H. K.Crystal Growth in Gel, The Pennsylvania state University Press , London (1973). 3. Vogel A. I., Elementary Practical Organic Chemistry part-2, Qualitative Organic Analysis, Longmans Green and Co. Ltd. (1966). 4. Crystal Growth Method – A. R. Patel
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment

Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course:</td><td>PH(M)-534 : Advanced Materials Science</td></tr>
<tr><td>Course Outcomes</td><td>CO1 :The Course consist of civilization of materials to advanced materials like, smart materials, Quantum Dots, Spintronics, Ceramics, composites and macro molecules.
CO2 : Nonmaterial , Synthesis of nonmaterial and advanced applications of materials are briefly explain.</td></tr>
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<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Unit-1:
Material and Civilization, Material Science and Engineering, Classification of Engineering Materials, Levels of Structure, Structure-Property Relationship in Materials, Materials Science in India.
Unit-2:
States of Matter, -Theory of Liquids, Structures of Solids, Colloidal state of Matter, Gel, Emulsion, Emulsifier, Liquid Crystals, Applications of liquid crystals, The Plasma State of Matter, Criterions for plasma state, applications of plasma.
Unit-3:
Advanced Materials, -Smart Materials Quantum Dots, Spintronics, Polymer, Ceramics, Biomaterials, Composites, Macromolecules-Protein, Lipid, Nucleoid.
Unit-4:
Polymers, Classification of Polymers, Structure of long chain Polymer, Crystallinity of long chain Polymers, Ceramics, Classification of Ceramics, Properties of Ceramics, Applications of Ceramics.
Unit-5:
Composite, Particulate Reinforced Composites, Fibre Reinforced Composites, Laminuted Composite, Polymer Matrix Composites, Metal Matrix Composite, Ceramic Matrix Composites, Applications of Composite.
Unit-6:
Nano-materials, Fullerenes, History of Nano Materials, How is the nanoworld is different from the world around us? Begining of Nano-science, Nano-materials, Properties of Nano-materials, seeing nano-objects, Preparation of Nano-materials, Nano-biotechnology, Molecular Motors, Nano-cosmetics, Nano in Textiles. Drug Delivery, Cancer Therapy, Tissue Engineering, Lab-on-chip (LOC), Nano- lithography, Future Lighting, MRI With magnetic Nano-particles.</td></tr>
<tr><td>Reference Books</td><td>1. Materials Science and Metallurgy U.C. Jindal, Atish Mozumder Pearson-Dorling Kindersley (India) Pvt. Ltd. Third Edition (2013).
2. Material Science and Metallurgy Parashivamurthy K.I. Pearson-Dorling Kindersley (India) Pvt. Ltd. First Edition (2012).
3. Materials Science - An Intermediate Text Willam F. Hosford, Cambridge University Press, First Edition (2007).</td></tr>
</table>

	4. V. Raghvan, Materials Science and Engineering - A First Course (Fifth Edition), Prentice - Hall of India Publishers, New Delhi (2005)
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course:</td><td>PH(M)-535 Practical’s</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : At the end of Performing material Practical’s students have ability to measurement conductivity crystal growth characterization like hardness etching etc.
CO2 : Magnetic Proportion at material and aware of the non destructive technique of liquid Penetration method.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
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<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>
<u>Group A: List of Experiment</u> (3 hours/ week + 1 hour/week tutorial)

<u>Numerical Analysis Exercises:</u>
1. Interpolation and inverse interpolation using Lagrange's formula.
2. Numerical integration using Simpson's $1/3^{rd}$ rule.
3. Solving ordinary differential equations using Runge-Kutta method.
<u>FORTRAN Programming Exercises:</u>
4. Writing and testing FORTRAN programs for Interpolation and inverse interpolation using Lagrange's formula.
5. Writing and testing FORTRAN programs for Numerical integration using Simpson's $1/3^{rd}$ rule.
6. Writing and testing FORTRAN programs for solving ordinary differential equations.
<u>Group B: List of Experiments</u> (6 hours/ week) Specialization: M<u>aterials Science</u>
1. Stereographic Projection of Crystal Modes
2. Laue Experiment
3. Curie temperature of Novel Metal
4. Measurement of dielectric constant of ferroelectric materials
5. Measurement of magnetic susceptibility of materials
6. Non Destructive Test
7. Magnetostriction set up
8. Speed of a vacuum motor
9. Holography
10. Thermal and Electrical Conductivity of Metal
11. Specific heat of solids
</td></tr>
</table>

	12. Dielectric Constant 13. Study of divergence of a Laser beam 14. Study of Light pipes and Fiber optics 15. Growing the single crystal from solution 16. Micro hardness study 17. Morphological Studies and Use of Research Microscope 18. Etching of crystals.
Reference Books	
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(T)-533: Non-linear Dynamics and High-Performance-Computing**
Course Outcomes	CO1 : Most advanced packages and languages are learnt for simulation of Physics problem with theoretical aspects. This course also contains the parallel programming. CO2 : It is essential for all students of computing to understand the architecture and programming of parallel computing.
Mapping between COs with PSOs	(see mapping table below)
Pre-requisite	
Course Content	<u>**Unit 1 & 2:**</u> **Mathematica for Theoretical Physics** • Introduction: interfaces, numerical and algebraic calculations. • Symbolic mathematics: differentiation, integration, sums and products, solving equations, differential equations, power series, and limits, integral transforms, recurrence equations. • Numerical mathematics: numerical sums, products and integrals numerical equation solving, numerical differential equations, optimization • Functions and programs • Lists • Graphics and sound • Input/output • File operations **Unit-3:** **Nonlinear Oscillations:** Phase space trajectories of Harmonic oscillator, damped harmonic oscillators, Singular Points of trajectories; Nonlinear Oscillations using *Mathematica*; Linstedt-Poincaré method for a mathematical pendulum, Volterra’s Problem; Limit Cycles. **Unit-4:** **Chaos:** Introduction to Chaos; Discrete mapping and Hamiltonian, Logistic

Mapping between COs with PSOs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■	■	■	■		
CO2	■				■	

	Maps; Poincaré Sections; Strange Attractors; Intermittency, Crisis and Quasi-periodicity, Lyapunov exponent. **Non-linear Dynamics:** Introduction to Non-linear dynamics, the Korteweg-deVries equation and its numerical solution, the inverse scattering transform using *Mathematica*. **Unit-5:** Essentials of parallel computation, need for high speed computing and parallel computers, temporal and data parallelism, pipelined parallel computers, array processors, generalized structure of a parallel computer, shared memory multiprocessors, message passing multiprocessors, multilink multidimensional multi-computers. Programming parallel computers for High-Performance Computing (HPC). **Unit-6:** • Software issues in Parallel Computing. • **FORTRAN 90**: additional features different from FORTRAN 77 such as named constants, conditional operators, loops, CASE statement, arrays, variable dimensions, pointers, given functions, masking, sub-arrays, MODULES, INTERFACE, WHERE. **FORTRAN 95:** features for parallel computers, FORALL etc.
Reference Books	1. S. Wolfram, Mathematica book, 5th ed. 2003. 2. Patrick T. Tam, A Physicist's Guide to Mathematica, 2nd ed., Elsevier, 2008. 3. Andrey Grozin, Introduction to Mathematica for Physicists, Springer, 2014. 4. V. B. Bhatia, Classical Mechanics, Narosa Pub. House, 1997. 5. Lui Lam (editor), Introduction to Nonlinear Dynamics, Springer 1997. 6. Gerd Baumann, Mathematica for Theoretical Physics-Classical Mechanics and Non-linear Dynamics, 2nd ed., Springer, 2005. 7. Stephen Lynch, Dynamical Systems with Applications using Mathematica, Birkhaüser Boston, 2007. 8. V.Rajaraman, Elements of Parallel Computing, PHI, 2006. 9. V.Rajaraman and C. Siva Ram Murthy, Parallel Computers: Architecture and Programming, 2004. 10. V.Rajaraman, Computer Programming in Fortran 90 and 95, PHI, 1999. 11. P.S. Grover, programming and computing with FORTAN 77-90, Allied publishers, 1990. 12. A. Grama, A. Gupta, G. Kryapis, Vipin Kumar, Introduction to Parallel Computing, 2nd ed, Addison Wesley, 2003.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(T)-534: Computational and Simulation methods in Physics**
Course Outcomes	CO1 : More advanced numerical techniques for solving physics problems are learnt and applied in computer simulation of physics problems to learn theoretical aspects and predictabilities.

	CO2 : students to handle larger simulation problems in physics.

Mapping between COs with PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■	■			■	
CO2		■			■	

Pre-requisite	

Course Content

Unit 1:

- *LU decomposition methods for solution of linear algebraic equations*: Lu decomposition, Gauss elimination and LU decomposition, Crout decomposition with substitution step, Matrix inverse using LU decomposition, tridiagonal systems, Cholesky decomposition.
- *Spline Interpolation*: Linear, Quadratic, and Cubic Spline fitting.
- *Least squares fitting techniques* : Least square techniques for fitting linear, quadratic, exponential and power law curves.

Unit 2:

- *Eigen value problem*: power method, location of bound, largest and smallest eigen values.
- Richardson's extrapolation, Romberg integration.
  Gauss Quadrature, improper integrals.

Unit 3:

Partial Differential Equations:

Finite-difference method for Elliptic equations: Laplace equation, Laplacian difference equation, the Liebmann method, secondary variables, derivative boundary conditions, irregular boundaries; example a heated plate.

Finite-difference method for Parabolic equations: the heat conduction equation, explicit methods, derivative boundary conditions, implicit method, Crank-Nicolson method, example-heat conduction over a long thin rod. parabolic equation in two spatial dimensions: the alternating-direction- implicit (A.D.I.) scheme, example: a heated plate.

Unit 4:

- *Simulation of one-dimensional motion*:
  Falling object, oscillatory motion (with and without damping), Model of an accelerating car.
- *Simulation in two-dimensions*: Projectile motion.
- Simulation of RC, LR, and LRC circuits.

Unit 5:

- *Basics of simulative Classical Molecular Dynamics*:
  Intermolecular potential, the numerical algorithm, boundary condition, molecular dynamics program, microscopic quantities, transport quantities Rutherford scattering.

Unit 6:

Simulation of Quantum systems: *Time-independent Schrödinger equation*: infinite square well, perturbation on the ground-state of infinite square well, finite square well, harmonic oscillator, enharmonic oscillator.

Time-dependent Schrödinger equation: motion of a free wave-

	packet, motion of a wave-packet incident on a potential step, motion of a wave-packet inside an infinite well. *Variational quantum Monte Carlo methods:* Ground-state of the harmonic and anharmonic oscillators, Monte Carlo calculation of square well potentials Monte Carlo simulations: Modeling of Radioactive decay.
Reference Books	1. S.C. Chapra, R.P. Canale, Numerical methods for Engineers, 5th ed., McGraw Hill, (2006). 2. K. Sankara Rao, Numerical Methods for Scientists and Engineers, PHI, (2001). 3. M. L. Dejong, Introduction to computational physics, Addison Wesley, (1977). 4. T. Pang, An introduction to computational physics, Cambridge Uni. Press, (1971). 5. H. Gould and Tobochnik, An Introduction to computer simulation methods, vols. 1-2, Addison Wesley, (1988). 6. S.E. Koonin, Computational Physics, Addison Wesley, (1986). 7. R. C. Verma, Computer Simulation in Physics, Anamaya Publishers, (2004). 8. G.I. Duchi, spreadsheet Applications for Scientists & Engineers, Addison- Wesley, (1988).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course:</td><td>PH(T)-535 Practical's</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : Some of the numerical techniques and simulation techniques learnt in the theory course PH(T)-534 are practiced in this lab course.
CO2 : A good hand on experience in FORTRAN and C programming is gained.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td><table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td style="background:grey"></td><td></td><td style="background:grey"></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td style="background:grey"></td><td></td><td></td><td></td><td></td><td style="background:grey"></td></tr>
</table></td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>1. To determine the efficiency of a G. M. counter using gamma source and also verify the Inverse Square Law using gamma & β -sources.
2. To study the pulse height spectra and the resolution of a NaI (T l) Scintillator Detector (Cs137, Co60, Mn54, Co57, Ba133).
3. To determine the β-ray spectrum of Cs137 source and to calculate the energy of K-shell electron of Cs-137.
4. To determine the Linear Absorption co-efficient of gamma rays using NaI(T l) Scintillator Detector and establish the relation between energy and linear absorption coefficient.
5. To study the Compton scattering using NaI (T l)detector.
6. Study of Feather's analysis using GM counter.
7. Range of alpha particles (Am-241) in air and polymer using alpha</td></tr>
</table>

	detector. 8. Determination of activity of a gamma source using NaI (T l) detector. 9. Study of backscattering of beta particle using GM counter with different materials. 10. Analysis of efficiency spectrum of Ge detector using ^{152}Eu Standard source. 11. To design built and test high pass filter (2nd order) using Op-Amp. 12. To study the transistor coincident circuit. 13. Identification of the particles by visual range in nuclear emulsion. 14. Alpha-Spectroscopy with surface barrier detector-Energy analysis of an unknown gamma source. 15. Determination of the range and energy of Alpha-particles using spark counter. 16. To study the various modes in multi-channel analyser and to calculate the energy resolution, energy of gamma ray.
Reference Books	
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Master of Science – PHYSICS, SEM-IV

<table>
<tr><td>Course:</td><td>PH- 541: Physics of Lasers and Lasers Applications</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : At the end of the course work, the student has to knowledge of the basic theory behind Laser Operation and Its properties throughout.
CO2 :the treatment has been kept as simple as positive with some familiarity of electromagnetic theory and non-linear optics.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td><table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td>■</td><td></td><td>■</td><td></td><td></td><td>■</td></tr>
<tr><td>CO2</td><td></td><td>■</td><td></td><td>■</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td><u>Unit 1</u> LASER: Introduction, Einstein coefficients, Population inversion, Methods of population inversion, Threshold conditions, Laser rate equations: Two, three & four level systems, Variation of Laser power around threshold, Optimum output coupling.
<u>Unit 2</u> Optical Resonators: Modes of a rectangular cavity and open planar resonator, Quality factor, Ultimate line width of the laser, Transverse & longitudinal mode selection, Q- switching, Techniques and for Q-switching, Mode locking in lasers, Techniques for mode locking.</td></tr>
</table>

	<u>Unit 3</u> Properties of laser beams and types of lasers: Coherence properties of laser light, Temporal Coherence, Spatial Coherence, Directionality, Ruby laser, Neodymium lasers (Nd: YAG & Nd: Glass) He-Ne laser, CO_2 laser, Argon ion laser, Dye laser, Semiconductor lasers. **<u>Unit 4</u>** Non-linear optics: Introduction, Second harmonic generation, Phase matching, Third harmonic generation, Optical mixing, Parametric generation light, self focusing of light, Multiphoton process: Multi-quantum Photoelectric effect, Two photon processes, Theory of two photon processes, Experiments in two photon processes, Three photon processes, SHG & parametric generation of light in three photon process, Parametric light oscillator, Frequency up conversion, Phase conjugate optics. **<u>Unit 5</u>** Laser Spectroscopy: Rayleigh and Raman scattering, Stimulated Raman effect, Hyper- Raman effect Classical and Quantum mechanical treatment, Coherent anti stokes Raman Scattering, Spin Flip Raman laser, Free- electron laser, photo- acoustic Raman spectroscopy, Brillion Scattering, Saturation Absorption spectroscopy, Doppler free two Photon spectroscopy. **<u>Unit 6</u>** Applications of LASER: Modulation Methods, Communications, Applications Using Focused Laser Radiation, Medical applications, Coherent Light Image And Data Processing, Holography, Photorefractive Holographic Recording, Laser For Fusion, Laser Cooling, Integrated Optics, Quantum Interference and Lasing Without Inversion.
Reference Books	Optical Electronics: A. K. Ghatak and K. Thyagarajan, Cambridge university press, (1990). Lasers and Non – linear optics : B. B. Laud, Wiley Eastern Limited, (1992). Introduction to Fiber Optics : Ajay Ghatak & K. Thyagarajan, Cambridge university press, (1999). Principles of Lasers : Orazio svelto & David C. Hanna, Plenum Press- New York and London (1982). Lasers and non linear optics: G. D. Baruha, Pragati Prakadhan, (2009).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course:</td><td>PH-542 : Atomic and Molecular Physics</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : The course presents unifies account of physics of atoms and molecules from a modern viewpoint.
CO2 : At the end of the course, the students deal with of material on basic atomic physics, including atomic structure, the optical and X-ray spectra of atoms, the interaction of atom with electric and magnetic fields.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
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<tr><td>CO2</td><td bgcolor="gray"></td><td></td><td></td><td bgcolor="gray"></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>
<u>Unit 1</u> One electron Atoms:
One-electron atoms, The Schrödinger equation and its solution, energy-levels and Eigen- -Functions, special hydrogenic systems, interaction of one- electron atoms with electromagnetic radiation, the dipole selection rules. Einstein coefficients, selection rules, Fine structure of hydrogenic atoms The Lamb shift and its determination, Hyperfine structure and isotopic shifts, The Stark effect, The Zeeman effect in strong and weak fields.
<u>Unit 2</u> Two-electron atoms
Schrödinger equation for Two-electron atoms - the role of Pauli exclusion principle, Energy levels of He atom. Level Scheme of two-electron atom, independent particle model, ground and excited states.
<u>Unit 3</u> Many electron atoms
The central field Approximation, The Thomas-Fermi model, The Hatree- fock method, Correction to the central field approximation, correlation effects , L-S coupling and j-j coupling. Many electron atom in an electromagnetic field, Selection rules for electric dipole transition, Retardation effects, magnetic dipole, electric quadrupole transitions.
<u>Unit 4</u> Molecular Structure
Born-Oppenheimer approximation - rotational, vibrational and electronics energy levels of dyatomic molecules, The electronic spin and Hund's cases, the structure of polyatomic molecules.
<u>Unit 5</u> Molecular Spectra
Molecular spectra, Rotational spectra, vibrational-rotational and electronic spectra of diatomic molecules, Spin –dependent interaction and electric dipole transition, The Nuclear spin, The inverse spectrum of Ammonia.
<u>Unit 6</u> Applications
Magnetic resonance, Atom optics, Atoms in cavities and ions in traps, atomic clocks.
</td></tr>
<tr><td>Reference Books</td><td>Physics of Atoms and Molecules by Bransden and Joachain, Pearson Education, 2nd Ed. (2004).
Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles by Eisberg and Resnick, John Wiley and Sons, 2nd Ed. (1985).
Fundamentals of molecular spectroscopy, C.N. Banwell, Tata McGraw-Hill,</td></tr>
</table>

	3rd ed. (1983). Molecular structure and spectroscopy, G. Aruldhas, Prentice Hall of India 2nd ed. (2002).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(E)-543: MICRO ELECTRONICS**
Course Outcomes	CO1 : The course contains the advance topics of Microelectronics like, NMOS, CMOS, BIFET-BIMOS-BICMOS, ECL and CCD technology. CO2 : Syllabus also giving emphasis on architecture of memory devices likes PROM, EPROM, EEPROM. CO3 : Current sources multi loop feedback Amplifier, and Theory of High Frequency response of Amplifiers are briefly discuss.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						

Pre-requisite	
Course Content	**Unit-1** Classification of Semiconductor Devices, The enhancement MOSFET, The enhancement MOSFET Volt-Ampere characteristics, Early effect, MOSFET Circuit Symbols, The MOSFET as a Resistance, MOSFET as an Analog Switch, NMOS amplifier, Small Signal analysis of MOSFET. **Unit-2** Complementary MOS devices, BIFET, BIMOS and BICMOS Circuits, Three Stage operational Amplifiers, other types of operational Amplifiers, MOS operational Amplifiers. Current Source, The Widlar Current Source, Three Transistors Current Sources. **Unit-3** The NMOS Inverter, Propagation Delay of on NMOS Inverter, NMOS Logic Gates, The CMOS Inverter, CMOS Logic Gates, Emitter-coupled Logic (ECL) Circuit, Architecture of Complete ECL Circuit, Advantages and Limitations of ECL Circuit, Comparison of Logic families. **Unit-4** Classification of Solid State Memory devices, Limitations of Read Only Memory (ROM), Programmable ROMS(PROMS), Erasable PROMS, FAMOS, Programmable Array Logic (PAL), Programmable Logic Arrays (PLA). **Unit-5** Very Large Scale Integrated Systems (VLSI), Dynamic MOS Shift registers, Ratioless shift Register stages. CMOS Domino Logic,

	Charge Coupled Devices (CCD), CCD structures, Integrated Injection Logic (I^2L), Microprocessor and Microcomputers. **Unit-6** High Frequency Response of Common-Emitter stage, The Common-Source Stage at High Frequency, The time-constant Method of obtaining the Response, General Analysis of Multistage Feedback Amplifiers, Multiloop Feedback Amplifiers, Effect of Feedback on Bandwidth, Stability, Test of Stability.
Reference Books	Microelectronics, J. Millman and A. Grable, McGraw Hill, (1987). Microelectronics Circuits, A. S. Sedra & K. C. Smith, Holt-Saunders, Japan,(1991). Microelectronics- An Integrated Approach, Roger T. Howe, Charls G. Sodini. Pearson Education, Prentice Hall, First Edition, (2006). Microelectronics Devices, Dipnakar Nagchoudhuri, Pearson Education, Prentice Hall, Second Edition, (2002). Electronics Devices and Circuit Theory, Robert Boylestad and Louis Nashelesky PHI - Prentice Hall of India Pvt. Ltd., Fifth Edition, (1994).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(E)- 544: Electronic Communication**
Course Outcomes	CO1 : The course provides excitement of the electronic communication field as well as background essential for advanced study in communication systems. CO2 : The practicing students will find it of service to update their knowledge in the field.
Mapping between COs with PSOs	(see mapping table below)
Pre-requisite	
Course Content	**<u>Unit 1</u> Review of General communication system** Spectral analysis: Fourier series, Exponential form of Fourier series, Examples of Fourier series, Sampling function, Response of a linear system, Normalized power in a Fourier expansion, Power spectral density, Effect of transfer function on power spectral density, Fourier transform, Example of Fourier transform, Convolution, Convolution, Power & energy transfer through a network, Correlation between waveforms, Power & cross correlation, Autocorrelation, Autocorrelation of a periodic waveform, Autocorrelation of non-periodic waveform of finite energy.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■			■		
CO2			■	■	■	■

	<u>Unit 2</u> Amplitude Modulation Frequency Translation, Frequency multiplexing, Practicality of antenna, Narrow banding, Method of frequency translation, Amplitude modulation-DSB: Demodulation, Multiplier modulator, Non linear modulator, Switching modulator, Demodulation of DSB-SC signal, Amplitude modulation, Sideband & carrier power, Generation of AM signal, Demodulation of AM signal, Amplitude modulation-SSB: Time domain representation of SSB signals, Generation of SSB signal, Demodulation of SSB-SC signals. **<u>Unit 3</u> Angle modulation** Concept of instantaneous frequency, generalized concept of angle modulation, Narrow-band Angle modulation, Wideband FM (WBFM), Generation of FM waves: Indirect method of Armstrong, Direct generation, Demodulation of FM signals, Phase locked loop, Analysis of phase locked loop. Stereophonic FM broadcasting, Comparisons: Frequency & phase modulation, Frequency & Amplitude modulation, **<u>Unit 4</u> Noise and Noise in AM systems** External & internal noise, Noise calculations, Noise figure, Noise temperature, Noise in Amplitude modulation system: Advantage of super-heterodyne principle: Single channel, SSB-SC, DSB-SC, Envelope demodulator. **<u>Unit 5</u> Noise in FM systems** Calculation of output signal & noise powers, Pre-emphasis & de-emphasis: Single Channel, Pre-emphasis & de-emphasis in commercial FM broadcasting. Sampling theorem: low pass signals, Pulse amplitude modulation, Other forms of pulse modulation, Time division multiplexing, Bandwidth required for transmission of PAM signals, Comparison of FDM & TDM systems. **<u>Unit 6</u> Quantization of signals** Quantization error, Pulse code modulation, PCM system, Companding & Differential PCM Delta modulation & Adaptive Delta modulation. Digital Carrier schemes : FSK, PSK & DPSK.
Reference Books	H. Taub and D. L. Schilling Principles of communication systems, McGraw-Hill. (1986). G. K. Mithal, Radio Engineering : Applied Electronics Vol. II (1987). B. P. Lathi, Modern Digital & Analog communication systems, Prism Books Pvt. Ltd. (2011). G. Kennedy, Electronic communication systems, McGraw-Hill, (2011). J. G. Proakis and M. Salehi,, Fundamentals of communication systems: Pearson Education (2014). D. Roddy and J. Coolem, Electronic communications, PHI (1995). K. Samshanmugum, Digital and Analog communication systems, Johan Wiley & Sons (1979).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><td>Course:</td><td>PH(E) - 545 Practical</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : As part of this lab course, a full semester project is carried out on some Electronics related problem which is am electronic circuit.
CO2: The project in this lab. Includes system designing, PCB designing, using, construction and testing of the circuit.
CO3: Good training in planning and executing an Electronic project and technical skill development is the outcome.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td><table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td>■</td><td></td><td></td><td>■</td><td>■</td><td></td></tr>
<tr><td>CO2</td><td></td><td>■</td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td>■</td><td>■</td></tr>
</table></td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Group A: List of Experiment (3 hours/ week + 1 hour/week tutorial)
C-Programming Exercises:
1. Writing and testing C-programs for Interpolation and inverse interpolation using Lagrange's formula.
2. Writing and testing C-programs for Numerical integration using Simpson's 1/3rd rule.
3. Writing and testing C-programs for solving ordinary differential equations.
Nuclear Physics Experiments:
4. Determination of plateau for Geiger-Muller tube and radiation absorption coefficient of a material.
5 Gamma ray spectrometer: calibration and finding gamma ray energy of a source.
6 Rutherford Scattering experiment.
Group B: Project work in specialization field based on syllabus.</td></tr>
<tr><td>Reference Books</td><td></td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study, Seminars and/or Assignment</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination</td></tr>
</table>

<table>
<tr><td>Course:</td><td>PH(M)-543: Properties of Materials</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : At the end of the course, the students will be able to understand the various methods involved in material characterization
CO2 : At the end of the course, the students will be able to understand the importance of use of different instruments for material study.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td><table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td>■</td><td></td><td></td><td>■</td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td>■</td><td></td><td>■</td></tr>
</table></td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Unit 1
Optical Properties of Materials, Electromagnetic wave propagation in solids, Reflection and Refraction at the interface Absorption and scattering.
Unit 2
Transparency, Translucency, Color, Florescence, Phosphorescence and</td></tr>
</table>

	Luminescence, NLO Properties, Ellipsometry. **Unit 3** Mechanical Properties of Materials Elastic, Inelastic and visco elastic behaviour, Plastic Deformation. The Tensile Stress-Strain curve. The Stress to move a Dislocation, Tension Test, Hardness, Fracture, Fracture Mechanics, Fatigue, Creep, Review of Strengthening Methods. **Unit 4** Electrical Conductivity, Band gap and Resistivity of material, Dielectrical Properties of material. Electrical Classification of Thermo couples, Piezoelectric material. **Unit 5** Insulating Properties of Materials High Resistivity Materials, Electron Mobility. Commercial Alloys, Insulation. Properties of Insulating. **Unit 6** Engineering Design Parameters for Selection of Materials, Environmental aspects of Material design, Industrial aspects of Materials design, Applications of advanced materials in Industries.
Reference Books	W. D. Caliseter, Materials Science & Engineering, John Wiley (1997). A. G. Gay, Essentials of Materials Science, McGraw Hill (1976). Manas Ghanda, Science of Engineering Materials, Vol. 1-3, MacMillan (1980).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(M)-544: Techniques of Material Science**
Course Outcomes	CO1 : After the study of this paper students have capable to fundamental understanding of vacuum Technology and perspective of current vacuum application. CO2 : Also syllabus focused operation and selection of equipment for process Used in semiconductor devices, optical and related thin film technologies.
Mapping between COs with PSOs	(see table below)
Pre-requisite	
Course Content	**Unit 1** Vacuum Science and Technology Introduction Vacuum, Brief History of Vacuum technology, Units of Vacuum, characteristics of vacuum, classification of vacuum ranges, applications of vacuum, vacuum system, **Unit 2** Production and Measurement of Vacuum Classification of vacuum pumps, Rotary pumps, Roots pumps, Diffusion pumps. Molecular drag and turbo molecular pumps, Sorption pumps, cryogenic pump, Measurement of pumping speed, Constant pressure methods. Classification of vacuum gauges, Mechanical gauges, Bourdon gauge, Pirani Gauge, Pennay Gauge Bayard-Alpart gauge, modified Ionization gauges. **Unit 3**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

	Preparation of Thin Film Physical methods: Vacuum evaporation, Laser ablation. Epitaxial deposition, Molecular beam epitaxy, Sputtering methods: Glow discharge, DC and RF Sputtering, Reactive Sputtering, Magnetron Sputtering, Ion plating, Ion beam deposition Chemical methods: Electroplating, Thermal spray and detonation technology, plasma chemical vapor deposition (PCVD), Metal organic Chemical vapor deposition (MOCVD). **Unit 4** Non-Destructive Testing: Non-destructive testing: Basic test methods, leakage testing, penetrate method, magnetic methods, ultrasonic testing, radiography and applications, eddy current methods, recent developments in non-destructive testing holography, Non invasive diagnostic instrumentation, ultrasonic measurement, ultrasonic diagnosis. **Unit 5** Phase Diagrams : Phase diagrams, Solidification of O Metal in a Ingot Mould, Types of Phase diagrams, Development of Microstructures in Amorphous Alloy, No equilibrium cooling, Binary Eutectic Systems. Paratactic Reactions, Gibb's Phase rule. **Unit 6** Phase Transformation: Phase Transformation, Types of Phase transformation, Multiphase transformation Peritectic transformation, Bainite Transformation. Continuous Cooling transformation Curve.
Reference Books	Material Science and Metallurgy –U.C. Jindal, Atish Mozumder Pearson - Dorling Kinderstey (India) Pvt. Ltd. 4th Edition (2012). Material Science and Metallurgy Parashiva murthy K.I. Pearson - Dorling Kindersely Pvt. Ltd. First Edition (2012). Materials Science and Engineering – A First Course V. Raghavan. Prentce Hall of India – Pvt. Ltd., New Delhi 5th Edition (2005). Vacuum Science and Technology V. V. Rao, T. B. Ghosh and K. L. Chopra Allied Publishers Limited (India) (1998). Vacuum Technology, A. Roth, North-Holland, (1986). "Handbook of Thin film technology" L. I. Maissel and R. I. Glang, Mc Graw Hill book Co. New york, (1970). R. Hamshaw, Non-destructing Testing, Edward Arnokd, (1987). Practical Non-destructive Testing Baldev Raj etc. Narosa Publishing House, (2009).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(M) - 545 Practical**
Course Outcomes	CO1 : After Competition of Project Work student have knowledge scientific technique to work on advance and now growth. CO2: Crystallization material and how to synthesis crystalline material and learn to skill about report writing.
Mapping between COs with PSOs	(see table below)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■	■			■	
CO2	■	■				■

Pre-requisite	
Course Content	**Group A: List of Experiment** (3 hours/ week + 1 hour/week tutorial) C-Programming Exercises: 1. Writing and testing C-programs for Interpolation and inverse interpolation using Lagrange's formula. 2. Writing and testing C-programs for Numerical integration using Simpson's $1/3^{rd}$ rule. 3. Writing and testing C-programs for solving ordinary differential equations. **Group B: Project work in specialization field based on syllabus.**
Reference Books	
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course:	**PH(T)-543: ADVANCED QUANTUM MECHANICS**
Course Outcomes	CO1 : At the end of the course the students will be able to understand the negativistic equations in central potential, symmentuios and application to many body systems.
Mapping between COs with PSOs	(see mapping table below)
Pre-requisite	
Course Content	**Unit 1&2** **Relativistic equations in central potential:** Coupling of Klein-Gordon equation in electromagnetic field and its coupling to electromagnetic field, Klein-Gordon equation in a Coulomb field, Dirac particle in Electromagnetic fields, Dirac equation in a Coulomb field. Application of the Dirac equation to hydrogen-like atoms. **Unit 3** **Symmetries:** Active and passive transformations, invariance and conservation laws, charge conjugation, time reversal invariance of the Dirac equation, helicity, chirality, vacuum polarization. **Unit 4 & 5:** **Relativistic Scattering Theory:** The non-relativistic propagator, propagator in positron theory, Scattering of spin ½ particle, Coulomb scattering of electrons, Coulomb scattering of positrons, Bremsstrahlung, Compton scattering, electron-electron scattering, electron- positron scattering, electron-positron pair annihilation into gamma rays. **Unit 6** **Applications to Many-body Systems:** Angular Momentum of a System of Identical Particles, Angular Momentum and Spin One-Half Boson Operators, First-Order Perturbation Theory in Many-Body Systems, The Hartree-Fock Method, Quantum Statistics and Thermodynamics.
Reference Books	Advanced Quantum Mechanics by Franz Schawbl Springer, 2nd Ed (2009). Relativistic Quantum Mechanics and Field Theory by Franz Gross, Wiley VCH, (1993).

Mapping between COs with PSOs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■		■	■	■	

<table>
<tr><td></td><td>Relativistic Quantum Mechanics by Armin Wachter, Springer, (2011).
Relativistic Quantum Mechanics by J. D. Bjorken and S. D. Drell (1964).
Advanced Quantum Mechanics by J. J. Sakurai, Pearson, (1967).</td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study, Seminars and/or Assignment</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination</td></tr>
<tr><td>Course:</td><td>PH (T)-544: Group Theory and Quantum Field Theory</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : Discrete and continuous Symmetries in physics are learnt through group theoretical aspects and their applications in solving physics problems.
CO2 : Fundamental aspects of quantum field theory and its application in understanding of fundamental interactions are also learnt in this course.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td><table>
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<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Unit 1
Group axioms (postulates), examples of groups, conjugate elements and classes, subgroups, direct product of groups, isomorphism and homomorphism, permutation groups. Representations of a group, reducible and irreducible representations, Schur's lemmas (statement), Orthogonality theorem, characters of a representation, direct product of representation, representation of a direct product group.
Unit 2
Continuous groups: Topological groups and Lie groups, the axial rotation group SO(2), 3-dimentional rotation group SO(3), Lorentz group, special unitary group SU(2), generators of U(n), SU(n), Lie algebra and representation of a Lie group, special unitary group SU(3), physical applications of SU(2) and SU(3).
Unit 3
Review of Schrödinger equation, Klein-Gordon equation and Dirac equations. Introduction to Quantum theory of Fields, transition from discrete to continuous systems, Classical Field theory, choosing Lagrangian. Field quantization, a real scalar (KG) field, Yukawa potential, quantization of a real scalar field, vacuum state, the pion-nucleus interaction. Complex scalar field, charge scalar field. Free Dirac Field, quantization of a free Dirac field, Vector Mesons.
Unit 4
Radiation field and photons, gauge transformations, quantization of electromagnetic field. Electron-photon interaction. Covariant perturbation theory, S-matrix, U-matrix, scattering of electrons by an external field, normal product, time ordered products, propagators, contraction, covariant commutation relation, Feynman graphs: configuration-space rules, momentum-space rules, scattering of photons by an electron (Compton Scattering), electron-electron scattering, electron-muon scattering, electron-proton scattering. Higher order corrections, renormalization in quantum electrodynamics.
Unit 5
Gauge field theories, Abelian transformations U(1) gauge symmetry, local gauge transformation. Electrodynamics of a Dirac field, local and global</td></tr>
</table>

	gauge transformations, spontaneous breaking of global and local symmetry, Goldstone model, Higgs' mechanism, Non-Abelian transformations. **Unit 6** The Standard Model: Electroweak interaction, electroweak theory of leptons, neutral current, W and Z widths, weak quark mixing, neutral currents, Quantum Chromo dynamics (QCD) and confinement, Quark-Gluon Plasma.
Reference Books	A. W. Joshi, Group theory for physicists, New Age Publication (2005). M. Hamermesh, Group theory and its application to physical problems, Addison- Wesley Pub Co., Inc (1962). M. P. Khanna, Introduction to particle physics, PHI, (1990). C. Itzykson and J.B. Zuber, Quantum Field Theory, McGraw Hill, (1980). B.K. Agarwal, Quantum Mechanics and Field Theory, Asia, (1976). I. J. R. Aitchison and A. J. R.Hey, Guage theories in Particle Physics, Adam Hilger (U.K.) (1992). J. J. Sakurai, Advanced Quantum Mechanics, John Wiley (1967).
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

<table>
<tr><th>Course:</th><th>PH(T)-545 Practical</th></tr>
<tr><td>Course Outcomes</td><td>CO1 : As part of this lab course, a full semester project is carried out on some Electronics related problem which is am electronic circuit.
CO2: The project in this lab. Includes system designing, PCB designing, using, construction and testing of the circuit.
CO3: Good training in planning and executing an Electronic project and technical skill development is the outcome.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>Pre-requisite</td><td></td></tr>
<tr><td>Course Content</td><td>Group A: List of Experiment (3 hours/ week + 1 hour/week tutorial)
C-Programming Exercises:
1. Writing and testing C-programs for Interpolation and inverse interpolation using Lagrange's formula.
2. Writing and testing C-programs for Numerical integration using Simpson's 1/3rd rule.
3. Writing and testing C-programs for solving ordinary differential equations.
Nuclear Physics Experiments:
4. Determination of plateau for Geiger-Müller tube and radiation absorption coefficient of a material.
5 Gamma ray spectrometer: calibration and finding gamma ray energy of a source.
6 Rutherford Scattering experiment.
Group B List of Experiments (6 hours/ week)</td></tr>
</table>

	Project Work involving complete study of a physics problem by simulation by writing FORTRAN / C / Mathematica program.
Reference Books	
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination