DEPARTMENT OF BASIC AND APPLIED SCIENCES

SYLLABUS

SCHEME OF STUDIES AND EXAMINATIONS

Programme Code - 27

MASTER OF SCIENCE IN PHYSICS

(Four-Semester Course)

(Effective from Academic Session 2021-2022)

BHAGAT PHOOL SINGH MAHILAVISHWAVIDYALAYA KHANPUR KALAN-131305 (SONEPAT) HARYANA

Chairperson
Department of Basic & Applied Sciences
BPS Mahila Vishwavidyalaya
Khanpur Kalan (Sonipat)

Course Structure

S. no.	Course	Theory		Lab		Total Credit
		Number	Credit	Number	Credit	
1	Core Courses	12	12x4	04	4*4	64
2	Elective Courses					
a)	Open Elective	2	2x4			08
b)	Discipline Specific Elective	4	4x4	4	4*4	32
3	Ability Enhancement Courses			4	1*4	04
4	Skill Enhancement Course*			2	4+4	8
				Course Credit		108

*** Skill enhancement courses are part of Discipline specific electives and will be part of the programme if the specific option is chosen.**

Note: Total Credit of M.Sc. (Physics) program: 108

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B.P.S. Mahila Vishwavidyalaya, Khanpur Kalan, Sonepat (Haryana)

M.Sc. Physics (Two year Course) with
Choice Based Credit System (CBCS)
Scheme of Examination
(For university teaching department and affiliated colleges/ Institute)
Effective from Session 2021-22
Semester - I

Course opted	Code	Nomenclature	Contact hours (L+T+P)	Credit	Duration of Exam	Examination Scheme		
						Internal Marks	External Marks	Total
Core paper	PHL-501	Mathematical Physics	4+0+0=04	04	3 hours	20	80	100
Core paper	PHL-503	Classical Mechanics	4+0+0=04	04	3 hours	20	80	100
Core paper	PHL-505	Quantum Mechanics–I	4+0+0=04	04	3 hours	20	80	100
Core paper	PHL-507	Physics of Electronic Devices	4+0+0=04	04	3 hours	20	80	100
Core Lab	PHP-509	Practical I: General Physics	0+0+8=8	04	3 hours	20	80	100
Core Lab	PHP-511	Practical II: Electronics	0+0+8=8	04	3 hours	20	80	100
Ability Enhancement	PHP-513	Seminar-I	0+0+2=2	01	----------	20	------	20
		Total	16+0+18=34	25		140	480	620

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Semester - II

Course opted	Code	Nomenclature	Contact hours (L+T+P)	Credits	Duration of Exam	Examination Scheme		
						Internal Marks	External Marks	Total Marks
Core Paper	PHL-502	Statistical Mechanics	4+0+0=04	04	3 hours	20	80	100
Core Paper	PHL-504	Quantum Mechanics -II	4+0+0=04	04	3 hours	20	80	100
Core Paper	PHL-506	Atomic & Molecular Physics -I	4+0+0=04	04	3 hours	20	80	100
Core Paper	PHL-508	Electrodynamics and Wave Propagation	4+0+0=04	04	3 hours	20	80	100
Core Lab	PHP-510	Practical I : General Physics-I	0+0+8=8	04	3 hours	20	80	100
Core Lab	PHP-512	Practical I : General Physics-II	0+0+8=8	04	3 hours	20	80	100
Ability Enhancement	PHP-514	Seminar-II	0+0+2=2	01	----------	20	------	20
			16+0+18 =34	25		140	480	620

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Semester - III

Course opted	Code	Nomenclature	Contact hours (L+T+P)	Credits	Duration of Exam	Examination Scheme		
						Internal Marks	External Marks	Total Marks
Core paper	PHL-601	Atomic & Molecular Physics –II	4+0+0=04	04	3 hours	20	80	100
Core paper	PHL-603	Solid State Physics	4+0+0=04	04	3 hours	20	80	100
Any one of the following two options								
Special paper-I	PHL-605	Condensed Matter Physics – I	4+0+0=04	04	3 hours	20	80	100
Special paper-I	PHL-607	Electronics - I	4+0+0=04	04	3 hours	20	80	100
Any one of the following two options								
Special paper-II	PHL-609	Computational Physics –I	4+0+0=04	04	3 hours	20	80	100
Special paper-II	PHL-611	Radiation Physics - I	4+0+0=04	04	3 hours	20	80	100
Any one of the following practical paper corresponding to the theory paper will be assigned								
Special Lab-I	PHP-613	Practical-II Condensed Matter Physics	0+0+8=8	04	3 hours	20	80	100
Special Lab-I	PHP-615	Practical-II : Electronics	0+0+8=8	04	3 hours	20	80	100
Any one of the following practical paper corresponding to the theory paper will be assigned								

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Skill Enhancement Special Lab	PHP-617	Practical II : Computational Physics	0+0+8=08	04	3 hours	20	80	100
Special Lab-II	PHP-619	Radiation Physics Lab	0+0+8=08	04	3 hours	20	80	100
Special Lab-II	PHP-621	Project	0+0+8=08	04	3 hours	20	80	100
Ability Enhancement	PHP-623	Seminar-III	0+0+2=2	01	----------	20	------	20
Open Elective	------------	Open Elective - I	4+0+0=04	04	3 hours	20	80	100
	Total		20+0+18 =38	29		160	560	720

Note1: Open elective/CBCS provided by the university.

Note2: The student will opt any one option which will be continued in IV Semester as well depending upon the availability of resources in the department.

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Course opted	Code	Nomenclature	Contact hours (L+T+P)	Credits	Duration of Exam 3 hours	Examination Scheme		
						Internal Marks	External Marks	Total Marks
Core paper	PHL-602	Nuclear & Particle Physics	4+0+0=04	04	3 hours	20	80	100
Core paper	PHL-604	Material Science and Nano-materials	4+0+0=04	04	3 hours	20	80	100
Any one of the following two options								
Special paper-I	PHL-606	Condensed Matter Physics – II	4+0+0=04	04	3 hours	20	80	100
Special paper-I	PHL-608	Electronics - II	4+0+0=04	04	3 hours	20	80	100
Any one of the following two options								
Special paper-II	PHL-610	Computational Physics –II	4+0+0=04	04	3 hours	20	80	100
Special paper-II	PHL-612	Radiation Physics - II	4+0+0=04	04	3 hours	20	80	100
Any one of the following practical paper corresponding to the theory paper will be assigned								
Special Lab-I	PHP-614	Practical I: Condensed Matter Physics	0+0+8=8	04	3 hours	20	80	100
Special Lab-I	PHP-616	Electronics	0+0+8=8	04	3 hours	20	80	100
Any one of the following practical paper corresponding to the theory paper will be assigned								
Skill Enhancement Special Lab	PHP-618	Practical II: Computational Physics	0+0+8=08	04	3 hours	20	80	100
Special Lab-II	PHP-620	Radiation Physics	0+0+8=08	04	3 hours	20	80	100

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Ability Enhancement	PHP-622	Seminar-IV	0+0+2=2	01	----------	20	------	20
Open Elective	------------	Open Elective Part - II	4+0+0=04	04	3 hours	20	80	100
Total			20+0+18= 38	29		160	560	720

Semester - IV

Note 1: Open elective/CBCS provided by the university

Note2: The student will opt any one option same as opted in IIIrd semester as well depending upon the availability of resources in the department.

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Program: **The Program Specific Outcomes of the Two Year (Four semesters) M.Sc. Physics**

Learning Outcomes

1 The students would be able to realize various applications with proper understanding of linear vector space and matrices, differential equations, special functions, series expansion and integral transforms. The students are enabled to understand the motion of a mechanical system using Lagrange and Hamilton formalisms, concept of central force motion and moving co-ordinate systems and theory of small oscillations.

2 The students would be able to understand the concepts of Quantum mechanics and capable to solve problems such as hydrogen atom, determination of the energies and wave functions of first and second order. The students would be able to explain ground state of hydrogen and helium molecules and analyse various transitions and their selection rules.

3 The students would be able to explain basic physics and application of different types of electronic devices, familiarization with integrated circuit fabrication technology, design of switching circuits and to seek career in advance research.

4 The students would be able to apply ensemble theory to complex problems, analyze the peculiar gas behaviour and explore the applications of Ising Model and different approximations.

5 Analysis of effect of doping in semiconductor materials, carrier concentration and mobility, fabrication of various active & passive circuit components and metal semiconductor junctions, devices in the microwave region and related applications. In addition, the student will be able to differentiate between different lattice types, explain motion of electron in periodic lattice, understand lattice vibrations in solids and explain various types of magnetic phenomena and possible applications.

6 The student will be able to explain Raman effect and different types of Raman spectra, Electronic spectra and electronic bands using Born Oppenheimer approximation and Frank Condon principle and origin of x-rays and different types of x-rays alongwith emission and absorption spectra. The students would be able to appreciate NMR, ESR and Mossbauer spectroscopy and related applications in the field of spectroscopy/material science/ lasers.

7 Understanding the nature of a specific numerical problem, designing programs in different languages, new necessary basic knowledge of various web enabling languages like HTML and JAVA to acquire a vision for use of computer in research prospective.

8 The students will be able to implement Boolean expressions, design basic building blocks of ICs for different operations and develop building blockes for ICs using MOSFET. The students

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will be able to understand the fabrication process of solar cells, photodiodes, PMT's etc. and realize operational amplifier and related applications such as comparator, A/D & D/A convertor, oscillators etc.

Learning Specific Outcomes:-

- Understanding the fundamental of Physics and capability of developing ideas based on them.
- Inculcate reasoning.
- Prepare and motivate students for research studies in Physics and related fields.
- Provide knowledge of a wide range of experimental techniques .
- Provide advanced knowledge on various topics in Physics, empowering the students to pursue higher degrees at reputed academic institutions.
- Strong foundation on electronics basics which have strong links and application in real world.
- Good Understanding of computational methods which can be used in modern programming of different problems.
- Nurture problem solving skills, thinking, creativity through assignments, project work and seminar . Assist students in preparing (personal guidance, books) for competitive exams e. g. NET, Gate, etc.

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M.Sc. Physics Semester-I

Mathematical Physics: PHL-501

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks: 100
Time: 3 Hours

COURSE OUTCOMES

1 The students would get sufficient exposure /understanding of the complex variables and applications of matrices to physical problems
2 The students would be able to solve problems based on differential equations
3 The analysis of special functions would equip a student for effective tackling of specific problems.
4 The students would be able to realize various applications with proper understanding of series expansion and integral transforms

Unit -I

Complex variables: Analyticity and Cauchy-Riemann Conditions, Cauchy's integral theorem and formula, Taylor's series and Laurent's series expansion, Cauchy's residue theorem, Singular points and evaluation of residues, Jordan's Lemma, Evaluation of infinite integrals using Cauchy's residue theorem and Jordan's Lemma; Linear operators.
Matrices: Cayley-Hamiltion Theorem, Inverse of matrix, Orthogonal, Unitary and Hermitian matrices, Eigenvalues and eigenvectors of matrices, Similarity transformation, Matrix diagonalization, Simultaneous diagonalization and commutativity

Unit –II

Linear ordinary differential equation equations of first and second order, Second order linear differential equation with variable coefficients, ordinary point, singular point, series solution around an ordinary point, series solution around a regular singular point; the method of Frobenius, Wronskian and getting a second solution, Solution of Legendre's equation, Solution of Bessel's equation, Solutions of Laguarre and Hermite's equations.

Unit –III

Special functions, Generating functions for Bessel function of integral order Jn(x), Recurrence relations, Integral representation; Legendre polynomials Pn(x), Generating functions for Pn(x), Recurrence relations, orthogonality, Rodrigue's Relation; Hermite Polynomials; Generating functions, Rodrigue's relation &orthogonality for Hermite polynomials; Laguerre polynomials;

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Generating function and Recurrence relations, Orthogonality, Rodrigue's Relation, The Gamma Function, The Dirac – Delta Function

Unit -IV

Integral transform, Laplace transform, Properties of Laplace transforms such as first and second shifting property, Laplace Transform of Periodic Functions, Laplace transform of derivatives, Laplace Transform of integrals, Inverse Laplace Transform by partial fractions method, Fourier series, Evaluation of coefficients of Fourier series Cosine and Sine series, Applications of Fourier Series, Fourier Transforms, Fourier sine and cosine Transforms, Fourier transform of derivatives, Applications of Fourier Transforms

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books:

[1] Mathematical Physics by B. S. Rajput
[2] Matrices and Tensors for Physicists by A. W Joshi
[3] Mathematical Physics by Mathews and Walkers
[4] Mathematics for Physicists by Mary L Boas
[5] Mathematical Methods for Physicists (6th edition) by Arfken and Weber
[6] Mathematical Physics by H K Dass
[7] Mathematical Physics by P.K. Chattopadhyay (T)

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M.Sc. Physics Semester-I

Classical Mechanics: PHL-503

Theory Marks: 80

Internal Assessment Marks: 20

Time: 3 Hours

COURSE OUTCOMES

1 Student would be able to describe and understand the motion of a mechanical system using Lagrange and Hamilton formalisms.

2 Students would become able to understand the concepts of central force motion and moving co-ordinate systems.

3 Students would become able to understand Variational principle and Hamilton-Jacobi theory.

4.Student would get basic ideas about the theory of small oscillations and use of poisson's bracket which will lead to understand the concepts of quantum mechanics.

Unit-I

Newton's law of motion, Mechanics of a system of particles, Degrees of freedom, Constraints, Generalized coordinates, Principle of virtual work, D'Alembert's principle and Lagrange's equations of motion, some applications of Lagragian formulation, Velocity dependent potentials and dissipation function, motion of a charged particle in electromagnetic field, Hamilton's principle, derivation of Lagrange's equations from the Hamilton's principle, Generalized momentum and cyclic coordinates, Conservation theorems.

Unit II

Hamilton's equations, two body problem, Central force; definition and characteristics; general analysis of orbits; closure and stability of circular orbits; Kepler's laws and equations; artificial satellites; Rutherford scattering.

Unit III

Variational Principle, Hamilton's and Lagrange's Equation of motion from Variational principle; Principle of least action; variation and end points; Hamilton-Jacobi theory: Hamilton's characteristic functions; Hamilton-Jacobi equation, use of H-J method for the solution of harmonic oscillator problem.

Unit-IV

Small Oscillations and Canonical Transformations: Canonical transformation; generating functions, properties of Poisson bracket, angular momentum, Poisson brackets; Theory of small oscillations: Eigen value equation and its solution, Small oscillations in normal modes, Examples of coupled oscillators: Two coupled pendulums and double pendulum.

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Text and Reference Books

[1] Classical Mechanics by N C Rana and P S Joag (Tata McGraw Hill, 1991)

[2] Classical Mechanics by H Goldstein (Addison Wesley, 1980)

[3] Mechanics by A. Sommerfeld (Academic Press, 1952)

[4] Introduction to Dynamics by I Perceival and D Richards (Cambridge Univ. Press, 1982)

[5] Classical Mechanics by J.C. Upadhayaya

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M.Sc Physics Semester I
Quantum Mechanics-I – PHL-505

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

COURSE OUTCOMES

1 Student would be able to understand the concepts of operators in Quantum mechanics.

2 Students would be able to apply Pauli spin matrices to explain angular momentum.

3 Students would be capable to solve problems such as hydrogen atom.

4 Students can determine energies and wave functions of first and second order using Perturbation Theory

Unit I

General formalism of Quantum Mechanics: States and operators; Representation of States and dynamical variables; Linear vector space; Bra Ket notation, Linear operators; Orthonormal set of vectors, Completeness relation; Hermitian operators, their eigenvalues and eigenvectors, The fundamental commutation relation; Commutation rule and the uncertainty relation; Simultaneous eigenstates of commuting operators; The unitary transformation; Dirac delta function; Relation between kets and wave functions; Matrix representation of operators; Solution of linear harmonic oscillator problem by operator methods.

Unit II

Angular momentum operator: Angular momentum operators and their representation in spherical polar co-ordinates; Eigenvalues and eigenvectors of L2 , spherical harmonics; Commutation relations among Lx Ly Lz ; Rotational symmetry and conservation of angular momentum; Eigenvalues of J2 and Jz and their matrix representation; Pauli spin matrices; Addition of angular momentum.

Unit III

Solution of Schrodinger equation for three dimensional problems: The three dimensional harmonic oscillator in both cartesian and spherical polar coordinates, eigenvalues, eigenfunctions and the degeneracy of the states; Solution of the hydrogen atom problem, the eigenvalues, eigenfunctions and the degeneracy

Unit IV

Perturbation Theory : Time independent perturbation theory; Non degenerate case, the energies and wave functions in first order the energy in second order; Anharmonic perturbations of the form $x\lambda$ $x\lambda3$ and $x4$; Degenerate perturbation theory; Stark effect of the first excited state of hydrogen.

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Text and Reference Books:

[1] Quantum Mechanics by Ghatak and Loknathan

[2] Quantum Mechanics by Powell and Craseman

[3] Quantum Mechanics by S. Gasiorowicz

[4] Quantum Mechanics by A.P.Messiah

[5] Modern Quantum Mechanics by J.J.Sakurai

[6] Quantum Mechanics by L.I.Schiff

[7] Quantum Mechanics by Mathews and Venkatesan

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M.Sc. Physics Semester-I `

Physics of Electronic Devices-PHL-507

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to explain the basic physics and application of different transistor types.

2 Students would be able to appreciate the functioning and applications of various optoelectronic and memory devices.

3 Students having familiarization with negative resistance devices and will be in a position to design switching circuits involving these device.

Unit I

Charge Carriers in Semiconductors :Energy Bands: Metals, Semiconductors and Insulators, Direct and Indirect Band Gap Semiconductors, Variation of Energy Bands with Alloy Composition, Electrons and Holes, Effective mass, Intrinsic and Extrinsic Semiconductors, Concept of Fermi Level, Electron and Hole Concentration at Equilibrium, Temperature Dependence of Carrier Concentrations, Compensation and Space Charge Neutrality, Conductivity and Mobility, Effect of Temperature and Doping on Mobility, Hall Effect, Invariance of Fermi level

Unit II

P-N Junction Diode, Transistors: Bipolar junction Transistor (BJT) Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, The Ebers-Moll model, Field Effect Transistors: Junction Field Effect Transistor(JFET), Metal Oxide Semi-Conductor Field Effect Transistor(MOSFET), FET Parameter.

Unit III

Optoelectronic Devices: Vacuum Photodiode, Photo-Multipliers, Micro-channels, Zener Diode, Power Diode, P-N Junction Photodiode, PIN Photodiode, Avalanche Photodiode, Phototransistor, Solar Cell, Varactor Diode, Light Emitting Diode (LED), Diode Laser: Condition for Laser Action and Optical Gain

Unit IV

Negative Resistance devices: Tunnel Diode, Backward Diode, Uni-junction Transistor, p-n-p-n devices, p-n-p-n characteristics Thyristor, Silicon Controlled Switch, SCS. AC/DC converters: Half

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wave & full wave rectifier, clamping circuits, clipping circuit, Characteristics.Switching circuit: Monostable, Bistable and Astable.

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Text & Reference Books

1. Semiconductor Devices - Physics and Technology by S.M. Sze (Wiley).
2. Solid State Electronic Devices by Ben G.Streetman (PHI).
3. Semiconductor Physics and Devices by Donald A Neamen (Tata-McGraw Hill).
4. Integrated Electronics by J. Millman and C.C. Halkias (Tata-McGraw Hill).
5. Semiconductor Devices by Kanaan Kano (PHI).
6. Semiconductor Optoelectronic Devices by Pallab Bhattacharya (Pearson)
7. Semiconductor Device Fundamentals by Robert F Pierret (Addison-Wesley).
8. Electronic Devices and Circuit Theory by Robert L. Boylestad (Pearson).

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M.Sc. Physics Semester-I

Practical I: General Physics- PHP-509

External Practical Marks: 80

Internal Assessment Marks: 20

Total Marks: 100

Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to determine specific charge of an electron and understand helical path of electron in electromagnetic field.

2 Students would be able calibrate the prism spectrometer.

3 Students would be able to calculate band gap energy of semiconductors and will understand its dependence on temperature

4 Students would be able to understand the plateau characteristics of G.M. counter and its applications.

[1] Measurement of resistivity of a semiconductor by four probe method at different temperatures

[2] Measurement of Hall coefficient of given semiconductor: Identification of type of semiconductor and estimation of charge carrier concentration.

[3] To study Faraday effect using He-Ne Laser.

[4] Ultrasonic Interferometer for liquids

[5] Experiment with microwaves (microwave training kit, basic version)

[6] To calibrate the prism spectrometer with mercury vapor lamp and hence to find out the Cauchy's constant.

[7] To determine the capacitance of a parallel plate Capacitor using Capacitance and permittivity kit

[8] To determine the curie temperature of Ferrites

[9] Measurement of Magneto-resistance of Semiconductors

[10] To study the characteristics (illumination, I-V, Power-load, Areal and Spectral characteristics) of a Photovoltaic cell

[11] To determine the band gap of Ge Crystal.

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[12] To measure the numerical aperture (NA) of optical fiber

[13] To study the plateau characteristics of G.M counter and to find the absorption co-efficient of Al- foil.

[14] To determine the value of e/m i.e. specific charge for an electron by Helical Method.

[15] To find Flashing and Quenching voltage of Neon gas and determine the capacitance of a unknown capacitor.

Note: Out of the list as above, a student has to perform at least 08 (eight) practical's in the semester

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M.Sc. Physics Semester-I
Practical II: Electronics PHP-511

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks: 100
Time: 3 Hours

COURSE OUTCOMES

1 The students would get hands on experience on experiments and relation to theory
2 Theoretical results for different networks matched with experiments would enable students for complex circuits
3 The students would get equipped for applications based on solid state devices
4 The students would be able to differentiate between analog and digital electronics

[1] Design/study of a Regulated Power Supply.
[2] Design of a Common Emitter Transistor Amplifier.
[3] Transistor Biasing and Stability.
[4] To study the frequency response of a single state negative feedback amplification for various feedback circuit. Negative Feedback (voltage series/shunt and current series/shunt)
[5] To study rectifier and filter circuits and draw wave shapes.
[6] Astable, Monostable and Bistable Multivibrater.
[7] Characteristics and applications of Silicon Controller Rectifier.
[8] To study the characteristics of a junction transition and determination of FET parameters.
[9] FET and MOSFET characterization and application as an amplifier.
[10] Uni-junction Transistor and its application.
[11] Bridge Rectifier using SCR with DC and AC Gate.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester.

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M.Sc. Physics Semester-II
Statistical Mechanics: PHL-502

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 The students are able to appreciate cellular nature of phase space and interface of Statistical Mechanics with Thermodynamics

2 Knowledge of ensemble theory would result in greater insight into solutions of various complex problems

3 The students would be able to analyse the peculiar gas behavior and are in a position to extend the treatment to complex problems

4 The students would be equipped to explore the applications of Ising Model and to understand different approximations

UNIT- I

The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution; Elements of Ensemble Theory: Phase space and Liouville's Theorem, The micro canonical ensemble theory and its application to ideal gas of monatomic particles, Equipartition and virial theorems, canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations

UNIT- II

The grand canonical ensemble: Equilibrium between a system and a particle-energy reservoir and significance of statistical quantities, Classical ideal gas in grand canonical ensemble theory. Density and energy fluctuations; Elements of Quantum Statistics: Quantum states and phase space, quantum statistics of various ensembles, An ideal gas in quantum mechanical ensembles, statistics of occupation numbers

UNIT- III

Ideal Bose Systems: Basic concepts and thermodynamic behavior of an ideal Bose gas, Bose Einstein condensation, Laser cooling of atom as an example of Bose Condensate, Discussion of gas of photons (the radiation fields) and phonons (The Debye field), Planck's Radiation formula (Black body radiation); Ideal Fermi Systems: Thermodynamic behavior of an ideal Fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism

UNIT- IV

Elements of Phase Transitions: First- and second-order phase transitions (Introduction), Diamagnetism, paramagnetism, and ferromagnetism. a dynamical model of phase transitions, Ising Model, Fluctuations: Thermodynamic Fluctuations, random walk and Brownian motion, introduction to non-equilibrium processes, diffusion equation

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Text and Reference Books:

1. Statistical Mechanics by R.K. Pathria (Butterworth-Heinemann, Oxford)
2. Statistical Mechanics by K. Huang (Wiley Eastern, New Delhi)
3. Statistical Mechanics by B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi)
4. Elementary Statistical Physics by C. Kittel (Wiley, New York)
5. Statistical Mechanics by S.K. Sinha (Tata McGraw Hill, New Delhi)
6. Statistical Mechanics by Gupta and Kumar
7. Statistical and Thermal Physics by F. Reif.

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M.Sc.Physics Semester II
Quantum Mechanics–II – PHL-504

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to explain ground state of hydrogen and helium molecules.
2 Students get enabled to analyze various transitions and their selection rules.
3 Students would be capable to understand 3D collisions.
4 Students would be capable to calculate spin states of identical particles.

UNIT- I

Variational methods: Ground state of Helium by both variational and perturbation methods; The hydrogen molecule; WKB approximation; Time dependent perturbation theory; Constant perturbation; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximation.

UNIT- II

Semi-classical theory of radiation: Transition probability for absorption and induced emission; Electric dipole transition and selection rules; Magnetic dipole transitions; Forbidden transitions; Higher order transitions; Einstein's coefficients.

UNIT- III

Collision in 3D and scattering: Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; Complex potential and absorption; The Born approximation.

UNIT- IV

Identical particles: The principle of indistinguishibility; Symmetric and antisymmetric wave 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.

Note : The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books:

[1] Quantum Mechanics by Ghatak and Loknathan
[2] Quantum Mechanics by Powell and Crassman
[3] Quantum Mechanics by S.Gasiorowicz
[4] Quantum Mechanics by A.P.Messiah
[5] Modern Quantum Mechanics by J.J. Sakurai
[6] Quantum Mechanics by L.I..Schiff
[7] Quantum Mechanics by Mathews and Venkatensan.

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M.Sc Physics Semester II
Atomic and Molecular Physics-I PHL-506

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

The student will be expected to be able to explain:

1 Atomic spectra of one and two electron atoms.

2 The change in behavior of atoms in external applied electric and magnetic field.

3 Diatomic molecules and their rotational vibrational and rotational vibrational spectra.

UNIT- I

One Electron systems and Pauli principle: Quantum states of one electron atoms, atomic orbitals, Hydrogen spectrum, Pauli principle, spectra of alkali elements, spin orbit interaction and fine structure in alkali spectra, Spectra of two electron systems, equivalent and non-equivalent electrons

UNIT- II

The influence of external fields, Two electron system Hyperfine structure and Line broadening: Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems , interaction energy in LS and jj coupling, Hyperfine structure (magnetic and electric, only qualitative)

UNIT- III

Diatomic molecules and their rotational spectra: Types of molecules, Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator, energy levels and spectra of non-rigid rotor, intensity of rotational lines.

UNIT- IV

Vibrational and Rotational Vibration spectra of Diatomic molecules: Vibrational energy of diatomic molecule, Diatomic molecules as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR Branches

Note : The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

1. Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
2. Introduction to Atomic spectra by H.E. White
3. Fundamentals of molecular spectroscopy by C.B. Banwell
4. Spectroscopy Vol I and II by Walker and Straughen
5. Introduction to Molecular spectroscopy by G. M. Barrow
6. Spectra of diatomic molecules by Herzberg
7. Molecular spectroscopy by Jeanne. L. McHale
8. Molecular spectroscopy by J.M. Brown
9. Spectra of atoms and molecules by P. F. Bemath

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10. Modern spectroscopy by J.M. Holias
11. Atomic and Molecular Spectra by Raj Kumar

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M.Sc Physics Semester II
Electrodynamics and Wave propagation PHL-508

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Student would be able to formulate and solve electrodynamic problems in relativistic covariant form in four dimensional space.

2 Student would gain the knowledge about electrostatic and magnetic fields produced by static and moving charges in a variety of simple configurations.

3 Student would be able to analyze the basics of theory of transmission lines and waveguides.

4 Student would be able to find angular distribution of power radiated

UNIT- I

Review of four-vector and Lorentz transformation in four dimensional space; Conservation of charge and four current density; Electromagnetic field tensor in four dimensions and Maxwell's equations; Lorentz invariants of electromagnetic fields; Dual field tensor; Transformation of electric and magnetic field vectors; Covariance of force equation.

UNIT- II

Radiating systems: Field and radiation of a localized source; Oscillating electric dipole; Centre fed linear antenna; Lienard-Wiechert potential ; Electric and magnetic fields due to a uniformly moving charge and accelerated charge; Linear and circular acceleration and angular distribution of power radiated.

UNIT- III

Radiative reaction force; Scattering and absorption of radiation; Thompson scattering and Rayleigh scattering; Normal and anomalous dispersion; Ionoshere; Propagation of electromagnetic wave through ionosphere; Reflection of electromagnetic waves by ionosphere; Motion of charged particles in uniform E and B fields; Time varying fields.

UNIT- IV

Wave guides; Modes in a rectangular wave guide; Attenuation in wave guides; Dielectric wave guides; Circuit representation of parallel plate transmission lines; Transmission line equations and their solutions; Characteristic impedance and propagation coefficient; Low loss radio frequency and UHF transmission lines.

Note : The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

1. Classical Electrodynamics by J.D. Jackson
2. Introduction to Electrodynamics by D.J. Griffiths
3. Electromagnetic by B.B. Laud
4. Classical Electricity and Magnetism by Panofsky and Phillips
5. Fundamentals of Electromagnetics by M.A. WazedMiah

M.Sc. Physics Semester II
Practical I: General Physics-I PHP-510

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3Hours

COURSE OUTCOMES

At the end of this laboratory course in General Physics, students would be able to:

1 Characterize the semiconductor materials by determining resistivity, band gap, mobility, and carrier type.

2 Understand phase transitions in ferroelectric materials and find the ferroelectric curie temperature .

3 Analyze the experimental data of powder diffraction in terms of indexing of peaks coming from different crystal planes and lattice parameters.

4 Find the magnetic susceptibility and energy loss/volume/cycle in ferromagnetic materials.

[1] To determine the Dielectric constant of polar and non-polar liquids

[2] Determination of Ionization Potential of mercury

[3] To determine the Magnetic susceptibility of a solid sample.

[4] To study B-H curve of a given ferrite sample and find energy loss in case of ferrite Core.

[5] Determination of e/m of electron by Normal Zeeman Effects using Febry Perot Etalon.

[6] Stefan's constant by the black copper radiation plates (Electrical Method).

[7] To determine the heat capacity of solids

[8] To verify the existence of different harmonics and measure their relative amplitudes using Fourier Analysis kit

[9] To study of dielectric constant as a function of temperature and determine the Curie temperature

[10] To determine the Dielectric Constant of different solid samples

[11] Study of lead tin phase diagram

[12] To determine Boltzmann Constant (k) make use of the black body Radiation and using Wien's displacement law and Stefan' s law

[13] To determine Planck's Constant (h) by measuring the voltage drop across light-emitting diodes (LEDs) of different colors

[14] To determine the value of energy levels using Frank-Hertz experiment

[15] Dissociation Energy of I2 molecule Note: Out of the list as above, a student has to perform at least 08 (eight) practical's in the semester

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M.Sc. Physics Semester-II
Practical I: General Physics-II PHP-512

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to draw diode characteristics
2 Students would be able to understand ESR spectrometer
3 Students get familiarized with hysteresis loop.
4 Students would be able to understand different components in Low pass and high pass filter.

[1] To study the low pass, High Pass and Band Pass filters using active and passive elements.
[2] Study of the Dispersion relation for the "Monoatomic Lattice" and Comparison with theory using Lattice dynamic kit
[3] Study of Hybrid parameters of a Transistor
[4] Study of the Dispersion relation for the Di-atomic Lattice, Acoustical mode and Energy gap and Comparison with theory using Lattice dynamic kit
[5] To determine the Lande- g factor of DPPH using ESR spectrometer.
[6] To determine the wavelength of He-Ne laser light using an engraved scale as a diffraction grating.
[7] Characteristics of Phototransistor
[8] Setting up a Fiber Optic Analog Link, Study of losses in Optical Fiber, Measurement of Propagation Loss and Measurement of Bending Loss.
[9] Study of characteristics of Fiber Optic LED & Detector, Measurement of Numerical Aperture and Study of Frequency Modulation & Demodulation using Fiber Optic Link.
[10] Study of Diode Characteristics
[11] To determine magneto resistance of a Bismuth crystal as a function of magnetic field.
[12] To study hysteresis in the electrical polarization of a TGS crystal and measure the Curie temperature.
[13] Measurement of thickness of thin wire with laser
[14] Measurement and analysis of fluorescence spectrum of I2vapour
[15] To Study the Thermo-luminescence of F-Centers in Alkali Halides Crystals

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

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<u>M.Sc Physics Semester III</u>
<u>Atomic and Molecular Physics-II PHL-601</u>

Theory Marks:80
Internal Assessment Marks:20
Total Marks:100
Time : 3 Hours

COURSE OUTCOMES

1 The student will be expected to be able to explain NMR spectroscopy , ESR spectroscopy ,Mossbauer spectroscopy.
2 The student will be expected to be able to understand the laser idea.
3 The student will be expected to be able to explain different types of Laser.

UNIT- I

NMR, The principle of NMR, NMR Spectrometer, Type of NMR, Type of Nuclei viewed from the standard point of NMR, high resolution and broad line NMR, relaxation mechanism, chemical shift, spin-spin coupling, Application of NMR Spectroscopy, Mossbauer spectroscopy, Mossbauer spectrometer, isomer nuclear transition, Resonance, fluorescence, Mossbauer effect, Mossbauer nuclei, Isomer shift, quadrupole splitting, Magnetic hyperfine structure, Application of Mossbauer spectroscopy

UNIT- II

ESR spectrometer, substances which can be studied by ESR, Resonance conditions, Description of ESR by precision ,relaxation mechanism, features of ESR spectra(a) the g factor (b) fine structure (c) hyperfine structure(d) the ligand hyperfine structure, applications of ESR

UNIT- III

Spontaneous and stimulated emission, Absorption, Einstein coefficients, The LASER idea, Properties of LASER beams, Rate equations ,methods of obtaining population inversion, LASER resonator.

UNIT- IV

Nd: YAG Laser,2 Laser, Nitrogen Laser ,Dye Laser, Laser application: holography materials processing fusion reactions, Laser isotope separation.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books :

1. Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
2. Introduction to Atomic spectra by H.E. White
3. Fundamentals of molecular spectroscopy by C.B. Banwell
4. Spectroscopy Vol I and II by Walker and Straughen
5. Introduction to Molecular spectroscopy by G. M. Barrow
6. Spectra of diatomic molecules by Herzberg
7 .Molecular spectroscopy by Jeanne . L. McHale
8 .Molecular spectroscopy by J.M. Brown
9. Spectra of atoms and molecules by P. F. Bemath
10. Modern spectroscopy by J.M. Holias

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<u>**M.Sc. Physics Semester-III**</u>

<u>**Solid State Physics PHL-603**</u>

Theory Marks:80
Internal Assessment Marks:20
Total Marks :100
Time: 3 Hours

COURSE OUTCOMES

The student will be expected to be able to:

1 Differentiate between different lattice types and explain the concept of reciprocal lattice and crystal diffraction using X-rays

2 Explain motion of electron in periodic lattice of solids under different binding conditions, concept of energy band and effect of same on electrical properties

3 Lattice vibrations in solids and identity different types of defects in crystals .

4 Explain various types of magnetic phenomenon , physics behind them and their possible applications.

UNIT- I

Crystalline solids, lattice, the basis, lattice translation, vectors, direct lattice, two and three dimensional Bravais lattice, conventional units cells of FCC, BCC, NaCl, CsCl, Diamond and cubic ZnS, primitive lattice cell of FCC, BCC and HCP; closed packed structures: packing fraction of simple cubic, bcc, fcc, hcp and diamond structures.Interaction of x-rays with matter, absorption of x-rays, elastic scattering from a perfect lattice, the reciprocal lattice and its application to diffraction techniques Ewald's construction, Brillouin zones, the Laue, powder and rotating crystal methods, atomic form factor, crystal structure factor and intensity of diffraction maxima. Crystal structure factors of bcc, fcc, monatomic diamond lattice, polyatomic CuZn.

UNIT- II

Vibration of one dimensional mono and diatomic chains, phonon momentum, density of normal modes in one and three dimensions, quantization of lattice vibrations, measurement of phonon dispersion using inelastic neutron scattering, Point defects, line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, observation of imperfection in crystals, x-rays and electron microscopic techniques.

UNIT- III

The Drude model: Assumptions, dc and ac conductivity of metals, thermal conductivity of metal; Lorentz modification of Drude model; the Fermi Dirac distribution function; The Sommerfeld model; the density of states, Free electron gas at 0K, Energy of electron gas at 0K, Electron heat capacity; Thermionic and Field enhanced emission from metals, Change of work function, The contact potential between two metals; Sommerfeld theory of electronic conduction in metals, Static magneto-conductivity, The Hall coefficient, Matthiessen’ rule, Basics of thermoelectric power, the Thomson effect and the Pelletier effect

UNIT- IV

Electron in periodic lattice, block theorem Kronig-Penny model and band theory, classification of solids, effective mass, weak-binding method and its application to linear lattice, tight-binding method and its

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application to cubic bcc and fcc crystals, concepts of holes, Fermi surface : construction of Fermi surface in two- dimension, de Hass van alfen effect, cyclotron resonance, magneto-resistance.

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Text and Reference Books:

1. Verma and Srivastava : Crystallography for Solid State Physics
2. Azaroff : Introduction to Solids
3. Omar : Elementary Solid State Physics
4. Aschroft&Mermin : Solid State Physics
5. Kittel : Solid State Physics
6. Chaikin and Lubensky : Principles of Condensed Matter Physics

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M.Sc. Physics Semester - III

Condensed Matter Physics-I – PHL-605

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 The students would be able to understand the bonding in metals, ionic and covalent crystals and also their thermal expansion , thermal and electrical conductivity.
2 Proper understanding of various theoretical concepts of optical properties of solids.
3 The students would understand different phenomena, and theoretical analysis of superconducting materials along with their applications in SQUIDs magnetometer.
4. The students would be able to understand concepts of Ferromagnetism.

UNIT- I

Difficulties of the classical theory, Free Electron Model, The Fermi Dirac Distribution, Electronic Specific Heats, Para-magnetism of Free Electrons, Thermionic and Field Enhanced Emission From Metals, Change of Work Function, The Contact Potential Between Two Metals, Photo-electric Effect, Electrical Conductivity of Metals: Features, Drift Velocity and Relaxation Time, Boltzmann Transport Equation, Somerfield Theory of Electrical Conductivity, Electron Phonon Collisions, Electrical Conductivity at Low Temperature, Thermal Conductivity of Metals and Insulators.

UNIT- II

Static Dielectric Constant, Electronic and Ionic Polarizabilities, Orientation Polarization, Static Dielectric Constant of Gases and Solids, Complex Dielectric Constant and Loses, Dielectric Relaxation, Classical Theory of Electronic Polarization, Debye Equations, Cole-Cole Plots and Equivalent Circuits, Ferroelectrics: Ferroelectric Materials, Dipole Theory of Ferroelectrics, Ionic Displacement in BaTiO3 above Curie Temperature, Ferroelectric Domains

UNIT- III

The Optical Constants: Index of Refraction, Damping Constant(k), Characteristic Penetration Depth (W), Absorbance (A), Reflectivity (R), Transmittance (T) Hagen–Rubens Relation, Atomistic Theory of the Optical Properties: Free Electrons With & Without Damping, Reflectivity, Bound Electrons, Discussion of the Lorentz Equations, Contributions of Free Electrons and Harmonic Oscillators to the Optical Constants, Quantum Mechanical Treatment of the Optical Properties: Absorption of Light by Inter-band and Intra-band Transitions, Optical Spectra of Materials, Dispersion, Brief idea of Spectroscopic Ellipsometry.

UNIT- IV

Ferromagnetism: Classical Theory of Ferromagnetism, Curie Weis Law, Quantum Theory Ferromagnetism, Exchange Energy, Origin of Domains and Domain Wall, Magnons: Dispersion Relations, Thermal Excitation and Heat Capacity, Anti-ferromagnetism: Neel Two Sub Lattice Model, Anti-Ferromagnetic Ordering, Ferri-magnetism: Spin Arrangement and Two Sub Lattice Model, Soft and Hard Magnetic Materials and Their Uses, Colossal and Giant Magnetoresistance.

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Text & Reference Books

1. Solid State Physics by A. J. Dekker (Macmillan)
2. Introduction to Condensed Matter Physics By K.C. Barua (Narosa)
3. Principle of Electronic Materials and Devices by S. O. Kasap (Tab ta McGraw Hill)
4. Electronic Properties of Materials by Rolf E. Hummel (Springer)
5. Solid State Physics by Ashcroft &Mermin (Cengage Learning).
6. Introduction to Solid State Physics by Charles Kittel (Wiley).

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M.Sc. Physics Semester -III
Electronics – I PHL-607

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

Course Outcomes

1 Student would be able to understand various properties,types and application of op-amp.
2. Students would get familiar with various integrated circuits and fabrication techniques.
3. Students would be able to understand the basic principle and various types of oscillators.
4. Student would be able to understand frequency response of RC coupled, phase shift oscillator..

UNIT- I

Integrated Circuits and their Fabrication: Types of Integrated Circuits, Analog and Digital Integrated Circuits, Semiconductor Device Fabrication: Crystal Growth, Epitaxial Growth, Thermal Oxidation, Photolithography, Dry and Wet Etching, Impurity Doping: Thermal Diffusion and Ion Implantation, Metallization: Thermal Evaporation, e-Beam Evaporation and DC Sputtering, Packaging and Testing, Process Flow for the Fabrication of Monolithic Transistor, Monolithic Diodes, Integrated Resistors, and Integrated Capacitors.

UNIT- II

AC load line, Transistor models and parameters, Equivalent circuits, Two-Port devices and Hybrid model, Transistor Hybrid model, Transistor h-parameters, Conversion for h-parameter for three Transistor Configurations, Analysis of a Transistor Amplifier Circuit for CE, CB, CC, Comparison of Transistor Amplifier Configurations, Linear Analysis of a Transistor Circuit, Miller's Theorem and its Dual, Cascading Transistor Amplifiers, classification of amplifiers, frequency response, RC coupled amplifier and its low frequency response

UNIT- III

Differential amplifier, CMRR, circuit configuration, emitter coupled supplied with constant current, transfer characteristics, block diagram of Op. Amp. Off-set currents and voltages, PSRR, Slew rate, universal balancing techniques, Inverting and non-inverting amplifier, Basic Applications- summing, scaling, current to voltage and voltage to current signal conversion, differential dc amplifier, voltage follower, bridge amplifier, AC-coupled amplifier.

UNIT- IV

Op Amp- Integration, differentiation, analog computation, Butterworth active filters circuits, Comparators, Logarithmic amplifier, antilogarithmic amplifier, sample and hold circuits Digital to analog conversion –ladder and weighted resistor types, analog to digital conversion- counter type, regenerative comparator (Schemitt trigger), Basic principle of oscillators,: Feedback, Square wave generator, pulse

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generator, triangle wave generator. Sinusoidal oscillators using op-amp: Phase shift, Colpitts, Hartley and Wein Bridge oscillator

Note : The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference books:

1. Integrated Electronics by J. Millman and C.C.Halkias(Tata-McGraw Hill)
2. Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication).
3. Electronics communication Systems by George Kennedy and Bernard George (McGraw Hill)
4. Linear Integrated Circuits by D.RoyChoudhury and Shail Jain (Wiley Eastern Ltd)
5. Solid State Electronic Devices by Ben G. Streetman ((Prentice Hall of India)
6. Electronic Devices and Circuit Theory by Robert L. Boylestad (Pearson).
7. Electronic Devices and Circuits, by David A. Bell (Oxford)

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M.Sc Physics Semester - III
Computational Physics – I PHL-609

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would acquire a vision for use of computer in research prospective .
2 Students would be able to understand different numerical methods.
3 Students would be able to design Fortran programs to solve numerical computationally.

UNIT- I

Interpolation: Finite differences; Interpolation with equally spaced points; Gregory - Newton's Interpolation formula for forward and backward interpolation; Interpolation with unequally spaced points: Lagrangian interpolation; Numerical Integration: Newton-cotes formulae : Trapezoidal rule, Simpson's 1/3 rule, error estimates in Trapezoidal rule and Simpson 1/3 rule using Richardson deferred limit approach ; Simpson's 3/8 rule, Gauss quadrature method; Numerical Differentiation: Derivatives of function using newton forward and backward interpolation.

UNIT- II

Roots of Linear, Non-linear Algebraic and Transcendental equations: Bisection Method; Iterative method; Regula Falsi method; Newton-Raphson method and modified Newton Raphson method, Curve Fitting: Principle of least square, Solution of Simultaneous Linear Equations: Gaussian elimination method; Gauss- Jordan elimination method; Matrix inversion. Eigen values and Eigen vectors: Jacobi's method for symmetric matrix.

UNIT- III

Numerical Solution of First Order Differential Equations: First order Taylor Series method; Euler's method; Runge-Kutta methods; Predictor corrector method; Elementary ideas of solutions of partial differential equations, Numerical Solutions of Second Order Differential Equation: Initial and boundary value problems: shooting methods

UNIT- IV

Introduction to FORTRAN 77:Data types: Integer and Floating point arithmetic; Fortran variables; Real and Integer variables; Input and Output statements; Formats; Expressions; Built in functions; Executable and non-executable statements; Control statements; Go To statement; Arithmetic IF and logical IF statements; Flow charts; Truncation errors, Round off errors; Propagation of errors, Block IF statement; Do statement; Character DATA management; Arrays and subscripted variables; Subprograms: Function and SUBROUTINE; New features of FORTRAN 90.

Note : The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books

1. Sastry : Introductory methods of Numerical Analysis.
2. Rajaraman: Numerical Analysis.

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3. C. Haribaskaran: Numerical Methods.
4. Ram Kumar : Programming with FORTRAN 77.
5. Press, Teukolsky, Vellering and Flannery: numerical Recipes in FORTRAN.
6. Desai: FORTRAN programming and Numerical methods.
7. Dorn and McCracken: Numerical Methods with FORTRAN IV case studies.
8. Mathew: Numerical methods for Mathematics, Science and Engineering.
9. Jain, Iyngar and Jain: Numerical methods for Scientific and Engineering Computation"

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M.Sc. Physics Semester- III

Radiation Physics– I PHL-611

Theory Marks: 80
Internal Assessment: 20
Total Marks:100
Time: 3 Hrs.

COURSE OUTCOMES

After taking the course, students should be able to solve problems related to radiations and can explain
1 Radioactivity and uses of radio-isotopes.
2 Radiation quantities and units.
3 Interaction of radiation with matter and neutrons.

UNIT- I

The Nucleus and Radioactivity: Atomic structure, Nuclear mass, Binding energy, binding energy curve and its interpretation, Isotopes, Isotones, Isobars, Nuclear size, Radioactivity, Modes of radioactive disintegration, Nature and properties of radioactive radiations, Radioactive decay, Half life time, Radioactive growth and decay, Radioactive equilibrium, Radioactive series, Radioactive branching, Radioactive dating, Artificial radioactivity, and Uses of radio-isotopes

UNIT- II

Other Sources of Radiations: X-rays: Characteristic X-rays, Bremsstrahlung (continuous) X-rays, X ray targets, and Clinical X ray beams; Cosmic rays: Discovery, Nature of a cosmic rays, soft and hard component, and Geometric effects on cosmic rays; Terrestrial radiations: Radon gas and Radioactive isotopes of lighter elements, Radiation quantities and units: Activity, KERMA, Exposure, Dose, Equivalent Dose, Effective Dose, Annual Limit on Intake (ALI), and Derived Air Concentration (DAC)

UNIT- III

Interaction of Radiation with Matter: Modes of interaction: ionization, excitation, elastic and inelastic scattering, Bremsstrahlung, Cerenkov radiation, concepts of specific ionization, mean free path; Interaction of Light Charged Particles with matter; Interaction of Heavy Charged Particles with matter; Interaction of Electromagnetic Radiations with matter: Photoelectric effect, Compton Scattering, and Pair production; Attenuation of Gamma Radiation: Linear and mass attenuation coefficient

UNIT- IV

Neutron Physics: Discovery of neutrons, Neutron sources, Neutron collimators, Properties of neutrons, Classification of neutrons according to energy, Neutron detectors: Slow neutron detectors (Boron trifluride proportional counter, Boron coated proportional counter, Helium-3 proportional counter, Fission counter, and Scintillation counters), Intermediate neutrons detectors, and Fast neutrons detectors, Neutron detection through slowing down of fast neutrons. Neutron monochromators, and nuclear fission

Note : The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text & Reference Books:

1. Nulcear and Particle Physics by S. L. Kakani and ShubhraKakani

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2. Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005
3. Practical knowledge for Handling Radioactive Sources by Dr. Claus Grupen
4. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx

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M.Sc. Physics Semester III
Practical II: Condensed Matter Physics PHP-613

External Practical Marks: 80
Internal Assessment Marks:20
Total Marks:100
Time:3Hours

COURSE OUTCOMES

1 Students would be able to measure Magneto-resistance of Semiconductors.
2 Students would be able to understand X-ray diffraction technique.
3 Students get familiarized with hysteresis loop.
4 Students would be able to understand set up of hall effect experiment..

1. To determine magneto resistance of a Bismuth crystal as a function of magnetic field.
2. To study hysteresis in the electrical polarization of a TGS crystal and measure the Curie temperature.
3. To determine the band gap of Si material
4. To study dielectric properties of liquids & Solids
5. To study Hall Effect and to determine Hall coefficient.
6. To study of dielectric constant as a function of temperature and determine the Curie temperature
7. To determine the Dielectric Constant of different solid samples
8. Study of lead tin phase diagram
9. To determine the capacitance of a parallel plate Capacitor using Capacitance and permittivity kit
10. To determine the curie temperature of Ferrites
11. Measurement of Magneto-resistance of Semiconductors
12. X-ray diffraction Simulation Experiment
13. To study hysteresis in the electrical polarization of a TGS crystal and measure the Curie temperature.
14. Study of the Dispersion relation for the Di-atomic Lattice, Acoustical mode and Energy gap and Comparison with theory using Lattice dynamic kit
15. To determine the Magnetic susceptibility of a solid sample.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

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<u>M.Sc. Physics Semester-III</u>
<u>Practical II -Electronics PHP-615</u>

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks: 100
Time: 3Hours

Course Outcomes

1 Student would be able to understand various application of op-amp.
2. Students will get hand on experience on various rectifier and filter circuits.
3. Student would be able to understand Wein Bridge and Phase shift oscillator.

[1] To study various applications of op-amp
[2] Frequency response of RC coupled Amplifier.
[3] Study of Emitter follower/Darlington Pair Amplifier
[4] To study the characteristics and frequency response of a Chopper Amplifier
[5] Wein Bridge and Phase shift oscillator.
[6] To study the frequency response of a two stages (a) Transformer coupled amplifier (b) Choke coupled amplifier.
[7] Addition, subtraction, multiplication & division using 8085/8086
[8] Transfer characteristics of TTL inverter and TTL trigger inverter with two digital volt meter
[9] To study network theorems.
[10] To study rectifier and filter circuit.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

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<u>**M.Sc. Physics Semester III**</u>

<u>**Practical II- Computational Physics PHP-617**</u>

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would develop understanding for programming concepts

2 Students would learn the practical implementation of programming languages for carrying numerical calculations.

3 Students would be benefited from their enhanced computational skills in context of higher studiesin physics or business purposes as well.

List of programs using FORTRAN

[1] Numerical Integration
[2] Least square fitting
[3] Numerical solutions of equations (single variable)
[4] Solution of H-atom problem
[5] Solution of RL circuits
[6] Numerical solution of simultaneous linear algebraic equations
[7] Numerical solution of ordinary differential equation
[8] Numerical Solution of second order ordinary differential equations
[9] Motion of Projectile thrown at an angle
[10] Simulation of Planetary Motion
[11] Charging and discharging of Capacitor
[12] Solution of LCR circuit

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

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M.Sc. Physics Semester-III
Practical II-Radiation Physics PHP-619

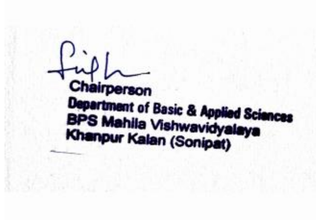
External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students will get hand on experience on GM counter, Spark Counter, Scintillation counter
2 Student will be able measure range of alpha, beta particles, attenuation coefficient
3 Students will be aquatinted with different techniques of detection of nuclear radiations
4 Students will be appreciate the interaction of nuclear radiation with mater

[1] To determine the specific charge of the electron.
[2] To study diffraction of electrons at a polycrystalline lattice (Debye-Scherer diffraction).
[3] To determine the electric unit charge after Millikan and verifying the charge Quantication - measuring the rising and falling speed.
[4] To study Optical Analogy to electron diffraction at a Polycrystalline Lattice.
[5] To determine Planck's constant-selection of wavelengths using interference filters on the optical bench.
[6] To determine Planck's constant-Recording the current-voltage characteristics-selection of wavelengths using interference filters on the optical bench.
[7] To study the fine structure of the characteristics X-Ray radiation on iron anode.
[8] To study absorption of gamma radiation.
[9] To observe the Balmer Series of hydrogen using a compact spectrometer.
[10] To investigate the spectrum of a high pressure mercury lamp.
[11] To study the energy spectrum of a copper anode.
[12] To study an implant model.
[13] To investigate the relationship between the attenuation coefficient and the atomic number Z.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester



M.Sc. Physics Semester-III
Project PHP-621

Internal Assessment: 20
Dissertation: 40
Presentation and Viva – Voce: 40

Course Outcome: At the end of this course, the students should be able to:

1. understand some basic concepts of research and its methodologies
2. identify appropriate research topics
3. select and define appropriate research problem and parameters
4. prepare a project proposal (to undertake a project)
5. organize and conduct research (advanced project) in a more appropriate manner

The aim of the dissertation work in M.Sc. (Physics) is to expose the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc. The work can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department. The students must submit their Dissertation in the department before the last date given by the department. Internal assessment of the dissertation work will be carried out by a committee constituted by Chairperson of the Department through power presentation given by candidate during the semester. External assessment of the dissertation work will be carried out by an external examiner through presentation given by candidate.

Guidelines for dissertation

1. Dissertation will be evaluated internally by a committee constituted by Chairperson of the department during the semester and externally at the end of semester by the external examiner.
2. Panels will be submitted consisting four external examiners from each specialization. The competent authorities will appoint four external examiners from each discipline. One external examiner for each discipline shall be called in an order of preference from a panel of examiners submitted by the department.
3. The candidate shall be required to submit two soft bound copies of dissertation along with a CD in the department
4. The student will defend her/his dissertation/ through presentation before the examiner and will be awarded marks in percentage. A student who could not score pass marks in the dissertation exam shall have to resubmit her/his Dissertation after making all corrections/improvements & this dissertation shall be evaluated as above. The candidate is required to submit the corrected copy of the Dissertation in hard bound within two weeks after the viva -voce.
5. In case a candidate's Dissertation is rejected or he/she is unable to complete it within the prescribed period for her/his category, s/he may be allowed extension by the chairperson on recommendation of the supervisor, up to the limits prescribed for completion of degree by a candidate.
6. Lay out of dissertation will contains cover page, certificate signed by student and supervisor table contents, introduction, methodology, result and discussion conclusion chapter and references. - The typing shall be done on both sides of the paper (instead of single side printing) - The font size should be

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12 with Times Roman Format - The text of the dissertation may be typed in 1.5 (one and a half) space. - The paper to be used should be A-4 size. - The total no. of writing pages should be between 30 to 50 for dissertation.

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M.Sc. Physics Semester-IV
Nuclear and Particle Physics: PHL-602

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to realize the nature of nuclear force.
2 Students would be able to understand the structure of nucleus and would be able to find out spin, parity, magnetic moments etc. of different nuclei.
3 Students would be able to understand different nuclear decays and reactions.
4 Students would gain a basic knowledge about Elementary Particles and their interactions.

UNIT- I

Basic characteristics of nucleus: Size, Density, Nuclear mass, Packing fraction, Binding energy, spin, parity, Angular momentum, Magnetic dipole moment, Electric quadrupole moment, Isospin, and Statistical properties of nucleus; Two nucleon problem: Common potentials used for calculation of nuclear forces viz. Wigner, Majorana, Bartlett and Heisenberg potentials, The ground state of deuteron, Qualitative features of Nucleon – nucleon scattering, Neutron – proton (n-p) scattering at low energies, Scattering length, Significance of sign of scattering length, Coherent and incoherent, Spin dependence of n – p scattering, Singlet state in n – p scattering, and Effective range theory in n – p scattering; Meson theory of nuclear force (Qualitative discussion)

UNIT- II

Types of nuclear reactions: compound and direct nuclear reactions, Reaction cross – section, Reaction cross - section in terms of partial wave treatment, Balance of mass and energy in nuclear reactions, Q-equation and its solution; Liquid drop model: Similarities between liquid drop and nucleus, semi-empirical mass formula, Bohr-Wheeler theory of fission, Merits and limitations of Liquid drop model; Shell model: Experiment evidences for shell effect, Magic numbers, Main assumptions of single particle shell model, Spin-orbit coupling in single particle shell model, Estimation of spin, parities and magnetic moments of nuclei by single particle shell model

UNIT- III

Nuclear Decays: Alpha (α) decay, α- disintegration energy, Range of α-particles, Range – energy relationship for α-particles and Geiger – Nuttall law; Beta decay, Pauli's neutrino hypothesis, Fermi theory of beta decay, Kurie plot, selection rules for beta decay, Fermi and Gamow-Teller Transitions, Parity non-conservation in beta decay, Detection and properties of neutrino; Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules; Internal conversion, Nuclear isomerism

UNIT- IV

Elementary Particle Physics: Classifications of elementary particles: fermions and bosons, particles and antiparticles; Fundamental interactions in nature; Type of interaction between elementary particle: Symmetry and conservation laws; Classification of hadrons: Strangeness, Hypercharge, Gelleman - Nishijima formula, Elementary ideas of CP and CPT invariance; Quark model, Baryon Octet, Meson

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Octet, Baryon Decuplet, Gell-Mann-Okubo formula for octet and decuplet, necessity of introducing colour quantum number, SU (2) and SU (3) multiples (qualitative only)

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus.

Text and Reference Books:

1. Nuclear Physics Theory and Experiment by R.R. Roy and B.P. Nigam (New Age International (P) Limited, Publishers)
2. Nuclear Physics- An introduction by S B Patel (New Age International (P) Limited, Publishers)
3. Concepts of Modern Physics by Arthur Beiser, S Mahajan, and S Rai Choudhury (Mc Graw Hill Education)
4. Introductory Nuclear Physics by Kenneth S. Krane (Wiley, New York)
5. Introductory Nuclear Physics by Y.R. Waghmare (Oxford – IBH, Bombay)
6. Nuclear Physics, 2nd addition by Kapaln (Narosa, Madras)
7. Introduction to Nuclear Physics by F.A. Enge (Addison-Wesley)
8. Nucleon Interaction by G.E. Brown and A.D. Jackson (North-Holland, Amsterdam)
9. Nuclear and Particle Physics by S L Kakani and Shubhra Kakani (Viva Books)
10. Introduction to high Energy Physics by P.H. Perkins (Addison-Wesley, London, 1982)
11. Introduction to Elementary Particles by D. Griffiths (Harper and Row, New York, 1987)

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M.Sc. Physics Semester IV

Material Science and Nano-materials PHL-604

Theory Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to explain the properties of Nanomaterials/nanostructures.
2 Students get enabled to understand the superconductivity and various properties of superconductor.
3 Students get acquainted with important techniques for preparation of Nanomaterials/nanostructures.
4 Understanding quantitatively photoluminescence spectroscopy of Nanomaterials opens up avenues of future research.

UNIT- I

Crystals of inert gases: Van der Waals-London Interaction, Repulsive Interaction, Equilibrium Lattice Constants; Cohesive Energy; Ionic crystals: Electrostatic or Madelung energy, Evaluation of the Madelung constant; Covalent crystals; Metals; Hydrogen bonds, Atomic radii, Ionic crystal radii, Lattice vacancies; Diffusion; Color centers: F centers, Other centers in alkali halides; Frenkel defects; Schottky vacancies

UNIT- II

Occurrence of superconductivity, Destruction of superconductivity by magnetic fields; Meissner effect; Heat capacity; Energy gap; Microwave and infrared properties; Isotope effect; Thermodynamics of the superconducting transition; London equation; Coherence length BCS theory of superconductivity; BCS ground state; Flux quantization in a superconducting ring Duration of persistent currents; Type-II superconductors; Vortex state; Estimation of HC1 and HC2; Single particle tunneling; Josephson superconductor tunneling; Dc and Ac Josephson effect; Macroscopic quantum interference

UNIT- III

Nanomaterials, Synthesis/Fabrication of Nanomaterials/Nanostructures: Bottom up and Top down Approaches for Synthesis of Nano Materials, Synthesis of Zero-Dimensional Nanostructures (Nanoparticles): Sol-Gel Process, Synthesis inside Micelles or Using Micro-Emulsions and Growth Termination, Epitaxial Core-Shell Nanoparticles, Ball Milling, One-Dimensional Nanostructures (Nanowires, Nanorods Nanotubes): Vapor (or solution)-liquid-solid (VLS or SLS) growth and Size Control, Electrochemical deposition, Lithography,

UNIT- IV

Two-Dimensional Nanostructures (Thin Films & Quantum Wells): Molecular Beam Epitaxy (MBE), MOCVD, Cluster Beam Evaporation, Ion Beam Deposition, Chemical Bath Deposition Technique Characterization of Nanomaterials/Nanostructures: Effect of Particle Size and Strain on Width of XRD Peaks of Nanomaterials, Determination of Crystallite/Particle Size and Strain in Nanomaterials Using Debye Scherrer's Formula and Williamson–Hall's Plot, Photoluminescence (PL) Spectroscopy: Basic Principle and idea of Instrumentation, Shift in PL Peaks with Particle Size, Determination of Alloy Composition in Thin Films of Compound Semiconductors, Estimation For Width of Quantum Wells.

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Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference Books:

1. Physics of Low Dimensional Semiconductors by John H. Davies (Cambridge Univ. Press).
2. Introduction to Nano-technology by Charles P. Poole & Jr. Frank J. Owens (Wiley Inter-science).
3. Quantum Mechanics for Nanostructures by Vladimir V. Mitin, Dmitry I. Sementsov&Nizami Z. Vagidov (Cambridge University Press).
4. Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao (Imperial College Press).
5. Introduction to Nano: Basics to Nanoscience and Nanotechnology by AmretashisSengupta&Chandan Kumar Sarkar (Editor) [Springer].
6. Solid State Physics by A. J. Dekker (Macmillan).

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M.Sc. Physics Semester IV
Condensed Matter Physics –II PHL-606

Theory Marks:80
Internal Assessment Marks:20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

At the end of this theory course in Solid State Physics, students would be able to

1.Understand various types of bonding in solids.

2. Understand the various techniques to determine crystal structure.

3.Have understanding of plasma optics and polarons.

4..Appreciate the synthesis of few carbon allotropes.

UNIT- I

Interaction of atoms in a solid, Ionic Bonding, Born- Haber Cycle, Ionic Conductivity, Covalent Bonding: Properties, Metallic Bonding: Properties, Comparisons Between Ionic, Covalent and Metallic Bonding, Hydrogen Bonding, Classification, Electrostatic Nature: Properties, Van der Waals Bonding

UNIT- II

Principle of Powder Diffraction Methods, Interpretation of Powder Photographs, Indexing of X-ray Diffraction Peaks of Poly Crystalline Materials, Determination of Lattice Parameters – Least Square Method, Oscillation and Burger Method, Calculating the Intensity of Diffraction Using the Structure Factor Equation, Determination of Relative Structure Amplitudes: Multiplicity, Polarization Factor, Lorentz Factor, and Temperature Effects

UNIT- III

Definitions of the dielectric function Plasma optics Dispersion relation for electromagnetic waves Transverse optical modes in a plasma Transparency of metals in the ultraviolet Longitudinal plasma oscillations plasmons, Screened coulomb potential Pseudopotential component U(0), Mott metal-insulator transition, Screening and phonons in metals polaritons, Electron-electron interaction: Fermi liquid, Electron-electron collisions, Electron-phonon interaction: polarons

UNIT- IV

Synthetic Carbon Allotropes, Fullerene: Formation, Characterization and Applications, Carbon Nanotubes (CNTs): Classification, Physical Structure, Synthesis Methods, Electronic Properties, Optical, Mechanical Properties and CNTs Based FETs, Graphene: Electronic Structure of Graphene, Properties, Synthesis & Applications

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text & References Books

1. Elements of X-ray Diffraction by B.D. Cullity (Pearson)
2. Solid State Physics by A. J. Dekker (Macmillan)
3. Solid State Physics by Ashcroft &Mermin (Cengage Learning).
4. Introduction to Solid State Physics by Charles Kittel(Wiley)

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. 5. Applied Solid State Physics by Rajnikant (Wiley)
. 6. Solid State Physics: Structure and Properties of Materials by M.A. Wahab(Wiley).

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M.Sc Physics Semester IV
Electronics – II PHL-608

Theory Marks:80
Internal Assessment Marks:20
Total Marks:100
Time : 3 Hours

COURSE OUTCOMES

After successful completion of the course, the students will be able to

1 Understand various types of gates and their applications.
2 understand various combinational and sequential digital circuits.
3 understand digital MOSFETs.
4 Understand modulation and its various types.

UNIT- I

Positive and negative logic designations, OR gate, AND gate, NOT gate, NAND gate, NOR gate, XOR gate, Circuits and Boolean identities associated with gates, Boolean algebra- DeMorgans Laws, Sum of products and product of sums expressions, Minterm, Maxterm, K-maps, don't care condition, deriving SOP and POS expressions from truth tables.

UNIT- II

Combinational Digital circuits: Binary adders: half adders & full adders,Decoders, Multiplexer, Demultiplexer, Encoders, ROM and its application (binary, BCD, Excess-3 Code, Gray Code & BCD to seven segment), Digital comparator, Parity checker and generator Sequential Digital Circuits: 1-bit memory, Flip-Flops- RS, JK, master slave JK, T-type and D-type flip flops, Shift-register and applications, Asynchronous counters and Synchronous counters

UNIT- III

Metal oxide semiconductor field effect transistors, enhancement mode transistor, depletion mode transistor, p-channel and n-channel devices, MOS invertors- static inverter, dynamic inverter, two phase inverter, MOS NAND gates, NOR gates, complementary MOSFET technology, CMOS inverter, CMOS NOR gates and NAND gates, MOS shift register and RAM

UNIT- IV

Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector, Pulse modulation, Network Theorems

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text and Reference books:

1. Integrated Electronics by J. Millman and C.C. Halkias (Tata McGraw Hill).
2. Digital Electronics by William Gothmann (Parentice Hall of India)
3. Digital logic by J. M.Yarbrough (Thomson Publication).
4. Electronic Fundamentals And Applications by John D. Ryder (Prentice-Hall)
5. Foundation for Microwave Engineering by Robert E. Collin (Wiley)

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M.Sc. Physics Semester IV
Computational Physics – II PHL-610

Theory Marks:80
Internal Assessment Marks:20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to understand framework of computer languages
2 Students would be able to solve numerically various physical problems
3 Students would gain the necessary basic knowledge of application of MATLAB for problem solving

UNIT- I

Random numbers: Random number generators, Mid-square methods, Multiplicative & Mixed multiplicative congruential methods, modeling of radioactive decay. Hit and Miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals, chaotic dynamics: Some definitions, the simple pendulum, Potential energy of a dynamical system, Un-damped motion, Damped motion, Driven and damped oscillator.

UNIT- II

Numerical solution of Radial Schrodinger equation for Hydrogen atom using Forth-order RungeKutta method(when Eigen value is given), Numerical Solutions of Partial Differential Equations using Finite Difference Method, Algorithms to simulate interference and diffraction of light, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Computer model of Rutherford scattering experiment, Simulation of electron orbit in H2 ion.

UNIT- III

MATLAB –I: Introduction; windows; arithmetic operation on scalars and their precedence; variables; elementary math built in function; useful commands for managing variables: clear ,clc, who ,whose; creating and working with one and two dimensional arrays, vector & matrices operations, solving linear system; element by element operation on arrays, script files ;input/output commands

UNIT- IV

MATLAB –II: Equations conditional statements and loops, relational and logical operators, break & continue statements; two dimensional plots; plotting multiple graphs in the same plot using hold on ,hold off; line commands, user defined function and function files ;polynomials; curve fitting and interpolation; find minimum and maximum value of function.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text & Reference Books:

1. Introduction to Numerical Analysis by F B Hildebrand (Tata McGraw Hill)
2. Fortran Programming and Numerical methods by R C Desai (Tata McGraw Hill).
3. Computer Applications in Physics by Suresh Chandra (Narosa Publishing House)

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4. Numerical Recipes in Fortran 77 By William H. Press, Saul A Teukolsky, William T Vellerling and Brain P. Flannery (Cambridge University Press)

5. An introduction to MATLAB by Amos Gilat

6. Computational Physics an Introduction by R C Verma, P K Ahluwalia and K C Sharma (New Age International).

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M.Sc. Physics Semester IV
Computational Physics – II PHL-610

Theory Marks:80
Internal Assessment Marks:20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would be able to understand framework of computer languages
2 Students would be able to solve numerically various physical problems
3 Students would gain the necessary basic knowledge of application of MATLAB for problem solving

UNIT- I

Principles of radiation detection; Gas filled radiation detectors: ionization chambers, proportion counters, GM counters, and Spark counter. Scintillation (organic/inorganic) counter; Solid State Detector: Crystal detector, Semiconductor Detectors (Junction type detector, Lithium drift Germanium detector, and HPGe), Thermo – Luminescent Dosimeters (TLD), Chemical detectors (Photographic Emulsions Films), Radiation Monitoring Instruments and Calibration check of radiation monitoring equipment.

UNIT- II

Biological Effects of Ionizing Radiation: Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes- DNA, RNA and Proteins; Effect of Radiation on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiation on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect).

UNIT- III

Principles of Radiological Protection: Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students . Production of Radioisotopes and Labeled Compounds: Introduction, Separation of Isotopes, Production of labeled compounds, Specific Activity of labeled compounds, Storage, Quality, and Purity of Radio-labeled compounds.

UNIT- IV

Radiation Hazard: Internal Hazards and External Hazards; Evaluation and Control of Radiation Hazard, Radiation Shield, Monitoring of External Radiation, Control of Internal Hazard: (i) Containment of Source (ii) Control of Environment (iii) Contamination (iv) Air Contamination Monitoring (v) Personal Contamination Monitoring (vi) Decontamination Procedures; Radiation Emergency and Preparedness.

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four to eight parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Text & Reference Books:

1. Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005
2. Practical knowledge for Handling Radioactive Sources by Claus Grupen

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3. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx
4. Radiation Biology: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2010

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M.Sc. Physics Semester IV
Practical I: Condensed Matter Physics PHP-614

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

At the end of this laboratory course in Solid State Physics, students would beable to:

1 Characterize the semiconductor materialsby determining resistivity, band gap, mobility, and carrier type.

2 Understand phase transitions in ferroelectric materials and find the ferroelectric curie temperature (Tc)

3 Analyze the experimental data of powder diffraction in terms of indexing of peaks coming from different crystal planes and lattice parameters.

4 Find the magnetic susceptibility and energy loss/volume/cycle in ferromagnetic materials.

[1] Determination of the Cut-off frequency of the Monoatomic Lattice using Lattice dynamic kit
[2] To study dielectric properties of liquids & Solids
[3] Measurement of lattice parameter and indexing of powder photograph.
[4] Identification of unknown sample using powder diffraction method.
[5] To study the modulus of rigidity and internal friction in a metal as a functioning temperature.
[6] To measure the cleavage step height of a crystal by multiple Fizaeu Fringes.
[7] To study the ferroelectric transitions in BaTiO3 crystal and measurement of Curie temperature.
[8] To determine magneto resistance of a Ge/ Si crystal as a function of magnetic field.
[9] To find the 'g' factor of DPPH using electron spin resonance.
[10] To study electric properties of oxide materials / thin films of metals/ semiconducting oxides.
[11] Band gap measurement of oxide materials using UV spectroscopy.
[12] To study NMR spectra of 1H and 11F nuclei or other similar nuclei using NMR spectrometer.
[13] To Measurement of Susceptibility of Paramagnetic liquids by Q-tube Method.
[14] To study the dielectric properties of ferromagnetic materials.
[15] To Study the Thermo-luminescence of F-Centers in Alkali Halides Crystals

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

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M.Sc. Physics Semester IV
Practical I: Electronics PHP-616

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3Hours

COURSE OUTCOMES

After successful completion of the course, the students will be able to

1 understand the fabrication process of solar cells, photodiodes, PMT's etc.

2 analyse the functioning of various communication devices such as TV, Radio, mobile phone etc.

3 realize the performance of operational amplifier for various mathematical operations such as addition, subtraction, differentiation, integration etc.

4 understand circuit analysis and implementation of operational amplifier for various applications like comparator, A/D & D/A convertor, oscillators etc.

[1] Pulse position/Pulse width Modulation/Demodulation
[2] FSK Modulation Demodulation using Timer/PLL
[3] PLL circuits and applications
[4] BCD to Seven Segment display
[5] To study the digital comparator, 3 to 8 line Decoder and tri-state digital O/P circuits
[6] To study the binary module-6 and 8 decade counter and shift register.
[7] Study of frequency Multiplication using PLL
[8] Study of Frequency Modulation and Demodulation
[9] Study of Pulse Amplitude Modulations & Demodulation
[10] Study of Module-N Counter using Programmable Counter IC 74190 with input Logics with LED display
[11] Digital I : Basic Logic Gates, NAND and NOR and Flip flops
[12] To study the digital comparator, 3 to 8 line Decoder and tri-state digital O/P circuits
[13] Working of Half & Full Adders
[14] Working of Half & Full substracter

Note: Out of the list as above, a student has to perform atleast 08 (eight) practical's in the semester

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M.Sc. Physics Semester IV
Practical II- Computational Physics PHP-618

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3 Hours

COURSE OUTCOMES

1 Students would develop understanding for programming concepts.

2 Students would learn the practical implementation of programming languages for carrying numerical calculations

. 3 Students would be benefited from their enhanced computational skills in context of higher studiesin physics or business purposes as well.

List of programs using MATLAB

[1] As a calculator
[2] Roots of quadratic equation using command window
[3] Numerical solutions of equations (single variable)
[4] Resonant frequency of LCR circuit
[5] Coefficient of friction in each test and find average of it
[6] Numerical solution of simultaneous linear algebraic equations
[7] Numerical solution of ordinary differential equation
[8] Numerical Solution of second order ordinary differential equations
[9] Create a matrix and find its transpose, inverse and determinant
[10] To find eigen value and eigen vector of given matrix
[11] Create a matrix using zeroes, ones, eye and linespace commands and an another vector, then replace a particular row or column by the 5th root corresponding to that vector.
[12] Charging and discharging of Capacitor
[13] Using input and disp command
[14] Showing vectorized role of fprintf command
[15] Calculate the voltage across each resistor in a circuit when the resistors are connected in series
[16] Plotting a function and its first three derivatives on same plot/ figure
[17] Hold on and hold off command
[18] Plot light intensity vs. distance using label, title, axis text, legand etc. commands.
[19] Find the sum of the first n terms of the series using loop. Execute the script file for given n.
[20] Using nesting loop and conditional statement.
[21] AC to DC converter
[22] Write a function file for given function then use it.
[23] To find subtraction; multiplication & division operation for given two polynomials.
[24] To find roots & derivatives of given polynomial.
[25] Program on curve fitting
[26] Find minimum & maximum value for given function.

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Note: Out of the list as above, a student has to perform at least 12 (twelve) practicals in the semester. Five more practicals can be done of their own choice.

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M.Sc. Physics Semester IV

Practical II- Radiation Physics PHP-620

External Practical Marks: 80
Internal Assessment Marks: 20
Total Marks:100
Time: 3Hours

COURSE OUTCOMES

1 Students will get hand on experience on GM counter, Spark Counter, Scintillation counter
2 Student will be able measure range of alpha, beta particles, attenuation coefficient
3 Students will be aquatinted with different techniques of detection of nuclear radiations
4 Students will be appreciate the interaction of nuclear radiation with mater

[1] Investigation of statistical nature of counting rate
[2] To determine the resolving time of a GM counter
[3] To investigate the relationship between absorber materials (atomic number), absorption thickness and backscattering.
[4] To verify the inverse square relationship between the distance and intensity of radiation.
[5] To investigate the attenuation of radiation via the absorption of beta particles.
[6] To determine the maximum energy of decay of a beta particle. particle range in air using a spark counterα
[7] Measurement of range of rays for Al, Fe and Pb using NaI scintillationγ
[8] Study of the attenuation coefficients of the counter ray energy of Cs-137 source using a NaI Scintillation detectorγ
[9] Measurement of ray energy of Cs-137 source using a NaI Scintillation detector

Note: Out of the list as above, a student has to perform at least 08 (eight) practicals in the semeste

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