SYLLABI

For

M.Sc. (Physics)

(Semester III & IV)

Academic Session: 2026-27, 2027-28

Under

Choice based Credit System (CBCS)

Scheme of NEP 2020

Programme Code: MPHY

Department of Physics

GURU NANAK COLLEGE
BUDHLADA
(An Autonomous College)
Website: www.gncbudhlada.org

Head
Department of Physics
Guru Nanak College Budhlada

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

PROGRAMME NAME: M.Sc. (PHYSICS) PART – II (III & IV Semesters)

SCHEME OF PAPERS

Session: 2026-27 & 2027-28
Semester: III

Core Papers									
Course Code	Name of Paper	Internal Assessment Marks	Practical Examination Marks	Written Examination/Theory Marks	Total Marks	Contact hours per week			Total Credits
						L	T	P	
MPHY2301T	Condensed Matter Physics–I	20	--	60	80	4	0	0	04
MPHY2302T	Nuclear Physics	20	--	60	80	4	0	0	04
MPHY2303T	Advanced Quantum Mechanics	20		60	80	4	0	0	04
MPHY2305P	Laboratory Practice: i) Nuclear Physics & Counter Electronics Laboratory ii) Advanced Electronics Laboratory	30	90	--	120	0	0	6	03
MPHY2306P	Computer Lab	15	45	--	60	0	0	2	01
Elective Papers (Choose One)									
Course Code	Name of Paper	Internal Assessment Marks	Practical Examination Marks	Written Examination/Theory Marks	Total Marks	Contact Hours per week			Total Credits
						L	T	P	
MPHY2304T	Laser Physics	20	--	60	80	4	0	0	04
MPHY2305T	Space Physics	20	--	60	80	4	0	0	04
MPHY2306T	Physics of Semiconductor Nanostructures	20	--	60	80	4	0	0	04
MPHY2307T	Material Science	20	--	60	80	4	0	0	04
MPHY2308T	Computational Simulations in Physics	20	--	60	80	4	0	0	04
					Total Credits =				20

Semester: IV

Core Papers									
Course Code	Name of Paper	Internal Assessment Marks	Practical Examination Marks	Written Examination/Theory Marks	Total Marks	Contact Hours per week			Total Credits
						L	T	P	
MPHY2401T	Condensed Matter Physics–II	20	--	60	80	4	0	0	04
MPHY2402T	Advanced Electronics	20	--	60	80	4	0	0	04
MPHY2405P	Laboratory Practice: i) Nuclear Physics & Counter Electronics Laboratory ii) Advanced Electronics Laboratory	30	90	--	120	0	0	6	03
MPHY2406P	Computer Lab	15	45	--	60	0	0	2	01

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Elective Papers (Any two of the followings elective subjects)									
Course Code	Name of Paper	Internal Assessment Marks	Practical Examination Marks	Written Examination/Theory Marks	Total Marks	Contact Hours per week			Total Credits
						L	T	P	
MPHY2403T	Experimental Techniques in Physics	20	--	60	80	4	0	0	04
MPHY2404T	Radiation Physics	20	--	60	80	4	0	0	04
MPHY2405T	High Energy Physics	20	--	60	80	4	0	0	04
MPHY2406T	Theoretical Nuclear Physics	20	--	60	80	4	0	0	04
MPHY2407T	Plasma Physics	20	--	60	80	4	0	0	04
MPHY2408T	Electronic Communication Systems	20	--	60	80	4	0	0	04
MPHY2409T	Atomic and Molecular Physics	20	--	60	80	4	0	0	04
Open Elective Subject									
MPHY2410T	Open Elective Subject*	20	--	60	80	4	0	0	–
								Total Credits =	20

Note:

1. In Sem – III & IV, one Elective papers for Sem III and two Elective papers for Sem IV will be offered depending on availability of teaching staff.

2. *Open Elective Subject will be optional and qualifying only. The marks obtained will not be added to the Grand total of the course. This paper (Not from subjects of Physics) will be offered by other departments. The students can also opt for one of the MOOC (Massive Open Online Courses; web-site: swayam.gov.in) courses with prior approval of Head, Department of Physics.

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M.Sc. (PHYSICS) PART – II (III & IV Semesters)
Program Code:
Session: 2026-27 & 2027-28

Semester III

(THEORY) PAPER CODE: MPHY2301T,

PAPER NAME: CONDENSED MATTER PHYSICS – I

Course Objectives: *The objectives of this course are to:*

1. *Introduce the fundamental concepts of crystal structure, diffraction methods, and lattice dynamics in solids.*
2. *Provide knowledge of the electronic properties of metals and semiconductors using classical and quantum models.*
3. *Familiarize students with the principles of nanotechnology, nanomaterials, and their applications.*
4. *Develop an understanding of optical processes and energy band theory in crystalline solids.*
5. *Provide a foundation for advanced study of condensed matter physics and modern electronic materials.*

Course Outcomes: *On completion of this course, student will be able to: –*

1. *Have a basic knowledge of binding in crystal systems and elastic properties.*
2. *Understand the concept of various models and theories of condensed matter physics such as Drude model, Free electron theory.*
3. *Know the significance of Brillouin zones and band theory and Kronig-Penney model.*
4. *Know the concept of phonons.*
5. *Understand the concept of Fermi Surfaces, semiconductors and superconductors.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35% **Total Credits: 4**
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours **Max. Marks:** 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION-A

Diffraction methods, Lattice vibrations, Free electrons: Diffraction methods, Reciprocal lattice, Brillouin zones, Lattice vibrations of mono-atomic and diatomic linear lattices, Free electron gas in 1-D and 3-D. Heat capacity of metals, Thermal effective mass, Drude model of electrical conductivity, Wiedman-Franz law,

Nanotechnology: Introduction to nanoparticles, Methods of synthesis: Top down and Bottom up approach, Properties of semi conducting nanoparticles, Quantum well, Quantum wire and Quantum dots (in brief) and their fabrication. Carbon nanostructures and Energy bands in semiconductors: C_{60} (its crystals and superconductivity), Carbon nano tubes, their fabrication and properties, application of carbon nano tubes.

SECTION-B

Syllabus Optical processes: Optical reflectance, Kramers-Kronig relations, Electronic inter-band transitions, Excitons and its type, Raman Effect in crystals, Electron spectroscopy with X-rays, Energy loss of fast particles in solids.

Semiconductor Physics: Nearly free electron model, Bloch functions, Kronig-penny model, Metals and insulators. Equation of motion, properties of holes, Effective mass of electrons (m^*), m^* in semiconductors, Intrinsic carrier concentration, Intrinsic and extrinsic conductivity,

Fermi-surfaces in Metals: Band gap, Thermoelectric Effects, Semimetals, Different zone schemes, Constructions of Fermi surfaces, Experimental methods in Fermi surface studies, Quantization of orbits in a magnetic field, De Haas-Van Alphen effect, Magnetic breakdown.

RECOMMENDED READINGS

1. Introduction to Solid State Physics; C. Kittel (7th Ed.), Wiley Eastern, N. Delhi, 1995
2. Introduction to Nano Technology: Charles P Poople, Jr. and Frank J. Owens, John Wiley & Sons Publications, 2003
3. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Cengage Learning.
4. J. R. Hook and H. E. Hall, *Solid State Physics*, 2nd Edition, Wiley.
5. S. O. Pillai, *Solid State Physics*, 8th Edition, New Age International Publishers.
6. M. A. Omar, *Elementary Solid-State Physics: Principles and Applications*, Addison-Wesley (or Pearson).

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Guru Nanak College, Budhlada

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(THEORY) PAPER CODE: MPHY2302T

PAPER NAME: NUCLEAR PHYSICS

Course Objectives: *The objectives of this course are to:*

1. *Introduce the fundamental properties of atomic nuclei, nuclear forces, and nuclear structure.*
2. *Develop an understanding of nuclear models and the role of nuclear spin, moments, and excited states.*
3. *Provide knowledge of nuclear reactions, reaction mechanisms, and neutron physics.*
4. *Familiarize students with the principles and applications of particle accelerators and nuclear experimental techniques.*
5. *Establish a strong theoretical foundation for advanced studies in nuclear physics and its applications.*

Course Outcomes: *On completion of this course, student will be able to: –*

1. *Analyse the nuclear properties like nuclear radius, mass and abundance of nuclides, binding energy and semi-empirical formula and relation between angular momentum and parity. Also the methods of calculating such properties.*
2. *Learn about the spin and orbital contribution to magnetic moment and methods of measuring these terms.*
3. *Understand properties of nuclear force and use of various models that tells about the interaction between nucleons.*
4. *Study the various models that examine the detailed information about the nuclear structure.*
5. *Learn about various types of nuclear reactions & their properties, the neutron sources and detectors and also the methods of slowing down the neutrons.*
6. *Analyse various methods of accelerating various types of particles to perform scattering experiments.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35% **Total Credits: 4**
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours **Max. Marks:** 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

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SECTION – A

Nuclear Properties: Nuclear Radius, Mass and Abundance of Nuclides, Nuclear Binding Energy, Semi-empirical Mass Formula, Nuclear Angular Momentum and Parity, Nuclear Electromagnetic Moments, Nuclear Excited States

Nuclear Spin and Moments: Nuclear Spin, Nuclear Moments, Measuring Nuclear Moments

Forces between Nucleons: Deuteron problem, Nucleon-Nucleon scattering, Proton-Proton and Neutron-Neutron interactions, Properties of Nuclear Forces, Exchange Force Model

Nuclear Models: Shell Model, Even-Z Even-N Nuclei and Collective Structure, Many-Particle Shell Model, Single Particle States in Deformed Nuclei

SECTION – B

Nuclear Reactions-I: Types of Nuclear Reactions and Conservation Laws, Energetics of Nuclear Reactions, Isospin, Reaction cross-sections.

Neutron Physics: Neutron Sources, Absorption and Moderation of Neutrons, Neutron Detectors

Nuclear Reactions-II: Experimental Techniques, Coulomb Scattering, Nuclear Scattering, Optical Model, Compound-Nucleus Reactions, Direct Reactions, Resonance Reactions, Heavy Ion Reactions, Fission and Fusion.

Accelerators: Cyclotron, Van de Graaff & Pelletron Accelerators, Synchrotrons, Colliding Beam Accelerator.

RECOMMENDED READINGS

Text Books:

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, New York

Reference Books:

1. Nuclear Physics: R. R. Roy and B. P. Nigam, New Age Pub., N. Delhi
2. Nuclear Physics: W.E. Burcham and M. Jobes (Ind. Ed.), Addison Wesley
3. S. N. Ghoshal, *Nuclear Physics*, S. Chand & Company.
4. Kenneth S. Krane, *Introductory Nuclear Physics*, Wiley.
5. Irving Kaplan, *Nuclear Physics*, Narosa Publishing House.
6. John M. Blatt and Victor F. Weisskopf, *Theoretical Nuclear Physics*, Springer.
7. B. L. Cohen, *Concepts of Nuclear Physics*, McGraw-Hill.

Guru Nanak College, Budhlada

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(THEORY) PAPER CODE: MPHY2303T,

PAPER NAME: ADVANCED QUANTUM MECHANICS

Course Objectives: *The objectives of this course are to:*

1. *Develop a comprehensive understanding of advanced quantum mechanics, including identical particles, approximation methods, and perturbation theory.*
2. *Introduce analytical techniques such as the variational method, WKB approximation, and scattering theory for solving quantum mechanical problems.*
3. *Provide knowledge of collision theory and partial wave analysis for understanding quantum scattering phenomena.*
4. *Familiarize students with the principles of relativistic quantum mechanics through the Klein–Gordon and Dirac equations.*
5. *Build a strong theoretical foundation for advanced research in quantum physics, atomic physics, nuclear physics, and condensed matter physics.*

Course Outcomes: *On completion of this course, student will be able to: –*

1. *Calculate the change in energy (wave function) of a quantum system by applying the time-independent (degenerate and non-degenerate) perturbation theory. Moreover, the time-dependent perturbation theory will also be taught to understand probabilities of transitions from lower to higher energy eigenstates.*
2. *Calculate the ground-state energy of a system (H-atom, He-atom, SHO etc.) by using a trial wave function as employed in the variational method.*
3. *Understand about the scattering theory of quantum particles. The concepts of Born approximation and partial wave analysis will be explained in detail to obtain the scattering cross-section in a scattering process.*
4. *Gain knowledge about the relativistic quantum mechanics and will get aware about the pioneer work of Dirac in this field. They will learn about (i) the concept of spin and its inclusion into the total wave function of the electron (ii) the existence of anti-particles.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35% **Total Credits: 4**
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

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INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

ıe Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION-A

Identical Particles: Indistinguishability principle, Symmetry and anti-symmetry of wave functions, Exchange operators, Spin statistic theorem, Slater determinant, Scattering of identical particles. *Problems*: Hydrogen molecule.

Variational Method: Rayleigh Ritz variational method for ground & excited States, *Problems:* Ground state energy of hydrogen, helium and harmonic oscillator,

Time Independent Perturbation Theory: First order and second order perturbation theory for nondegenerate case; *Problems*: Anharmonic oscillator, He-atom; Degenerate perturbation theory, *Problems*: Stark effect, Zeeman effect.

Time Dependent Perturbation Theory: Transition probability for constant and harmonic perturbation, Golden rule, Induced absorption and emission, Einstein coefficients; *Problems*: Radiative transitions.

SECTION-B

Collision Theory: Scattering amplitudes and cross section, Green function method, Integral equation of scattering amplitude, Born approximation. Partial wave analysis: Scattering by central potential, Short range interaction, Phase shifts, Optical theorem, s and p-wave scattering, Scattering length, Effective range, Breit-Wigner formula. *Problems*: Scattering by three-dimensional square well potential,

Relativistic Quantum Mechanics: Klein-Gordon equation: Probability and current densities, Continuity equation, Difficulties of K.G. equation, Plane wave solution. Dirac equation: Dirac algebra, Plane wave solutions, Hole theory, Non-relativistic limit, Spin and magnetic moment, Zitterbewegung, Lamb shift, Spin-orbit coupling,

RECOMMENDED READINGS

Text Books:

1. Quantum Mechanics: P.M. Mathews and K. Venkatesan, Tata McGraw-Hill Publication, N. Delhi
2. Quantum Mechanics: M.P. Khanna, Har-Anand Publication, Delhi

Reference Books :

1.Quantum Mechanics: L.I.Schiff, Tata McGraw-Hill Publication.
2.Quantum Mechanics: V.K.Thankappan, New Age International
3. L. I. Schiff, *Quantum Mechanics*, 3rd Edition, McGraw-Hill.
4. David J. Griffiths and Darrell F. Schroeter, *Introduction to Quantum Mechanics*, 3rd Edition, Cambridge University Press.
5. A. K. Ghatak and S. Lokanathan, *Quantum Mechanics: Theory and Applications*, Macmillan India.
6. Eugen Merzbacher, *Quantum Mechanics*, 3rd Edition, Wiley.

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Elective Papers

(THEORY) PAPER CODE: MPHY2304T

PAPER NAME LASER PHYSICS

Course Objectives: *The objectives of this course are to:*

1. *Introduce the fundamental principles of lasers and the interaction of radiation with matter.*
2. *Develop an understanding of laser systems, pumping mechanisms, optical resonators, and laser dynamics.*
3. *Familiarize students with the operating principles and applications of different types of lasers.*
4. *Provide knowledge of nonlinear optical phenomena and multiphoton processes.*
5. *Build a foundation in laser spectroscopy and its applications in modern science and technology.*

Course Outcomes: *On completion of this course, students will be able to: –*

1. *Understand the fundamentals of LASER.*
2. *Describe the construction and working of different types of lasers.*
3. *Explain the relation between Einstein coefficients and Laser rate equation.*
4. *Understand the nonlinear optics.*
5. *Discuss various laser spectroscopies.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Assessment Criteria:

Total Credits: 4

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION-A

Introductory Concepts: Absorption, Spontaneous and stimulated emission, The laser idea, Properties of laser light.

Interaction of radiation with matter: Summary of black body radiation theory, Rates of absorption and stimulated emission, Allowed and forbidden transitions, Line broadening mechanisms, Transition corss-section, Absorption and gain coefficient, non-radiative decay.

Pumping processes: Optical and electrical pumping, Passive optical resonators: Photon lifetime and cavity Q. Plane parallel resonator; Confocal resonator, Stability diagram.

Laser rate equation: Three level and four level lasers: Optimum output coupling, Laser spiking.

SECTION-B

Transverse and longitudinal mode selection, Q switching, Mode locking.

Types of lasers: Ruby lasers, Nd: YAG laser, He-Ne laser, Co_2 laser, N_2 laser, Excimer laser, Dye lasers, Chemical lasers, Semiconductor lasers, Colour center and free electron lasers.

Nonlinear optics: Harmonic generation, Phase matching, Optical mixing, Parametric generation of light, Self focussing, Multiquantum photoelectric effect. Two photon process theory and experiment. Violation of the square law dependence. Doppler-free two photon spectroscopy.

Laser spectroscopy: Stimulated Raman effect. Hyper Raman effect. Coherent anti-stokes Raman spectroscopy. Spin-flip Raman laser, Photo acoustic Raman spectroscopy.

RECOMMENDED READINGS

Text Books:

1. Principles of Lasers: O. Svelto, (3rd Ed.), Plenum Press
2. Lasers and its applications: A.K. Ghatak and K. Thyagrajan
3. Lasers and Nonlinear Optics: B.B. Laud (2nd Ed.), Wiley Eastern
4. Laser Electronics: J.T. Verdeyen (2nd Ed.), PHI
5. M. N. Avadhanulu and P. G. Kshirsagar, *A Textbook of Lasers*, S. Chand & Company.
6. William T. Silfvast – *Laser Fundamentals*.
7. Anthony E. Siegman – *Lasers*.
8. M. N. Avadhanulu and P. G. Kshirsagar – *A Textbook of Engineering Physics* (laser section).
9. K. R. Nambiar – *Lasers: Principles, Types and Applications*.
10. Milonni and Eberly – *Laser Physics*.
11. Donald C. O'Shea, W. R. Callen and W. T. Rhodes – *Introduction to Lasers and Their Applications*.

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(THEORY) PAPER CODE: MPHY2305T

PAPER NAME SPACE PHYSICS

Course Objectives: The objectives of this course are to:

1. Introduce the structure, composition, and physical processes of the Earth's upper atmosphere and ionosphere.
2. Develop an understanding of ionospheric regions, their formation, variations, and disturbances.
3. Explain the propagation of radio waves through the ionosphere and its applications in communication.
4. Familiarize students with the structure, atmosphere, and activity of the Sun and its influence on near-Earth space.
5. Provide a foundation for the study of space physics, atmospheric science, and solar–terrestrial interactions.

Course Outcomes: On completion of this course, students will be able to: –

1. *Understand the fundamentals of Earth's atmosphere.*
2. *Describe the auroral spectra.*
3. *Explain the ionospheric irregularities and disturbances.*
4. *Learn about the Sun.*
5. *Understand solar cycle and solar flares.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35% **Total Credits: 4**
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours **Max. Marks:** 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Hydrostatics, Heating of the upper atmosphere, Variations in the earth's atmosphere, Model atmosphere, The earth's exosphere.

Emission mechanisms, Airglow, Aurora, Morphology, Excitation mechanism, Auroral spectra.

Ionosphere: Ion-electron pair production, Ion-kinetics, Equilibrium, Ionospheric regions (D,E,F_1), Variations in these regions.

F_2 region: Formation of F_2-layer, Continuity equation, F_2-region anomalies, Thermal properties of the F_2-region.

SECTION – B

Ionospheric Irregularities and disturbances: Spread-F, Travelling ionospheric disturbances, Perturbation by electromagnetic and corpuscular radiation, Ionospheric and magnetic storms.

Propagation of radio waves through ionosphere, Appleton Hartee equation. Faraday rotation.

The Sun: Interior, A model, Outer atmosphere: Photosphere, Chromosphere, Transition region, Corona

Active Regions: Development and structure, Loops, Internal motions, Sunspots: Classification, Structure and evolution of sunspots, Solar cycle, Prominences, Solar flares (descriptive only).

RECOMMENDED READINGS

1. Fundamentals of Aeronomy, R.C. Whitten & I.G. Poppoff, John Wiley & Sons Inc. 1971.
2. Priest, E.R., Solar Magnetohydrodynamics, D. Reidel Pub. Company, 1987
3. Introduction to Space Physics, Kivelson, M.G. and Russell, C.T., Cambridge University Press, 1996

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)
(THEORY) PAPER CODE: MPHY2306T

PAPER NAME: PHYSICS OF SEMICONDUCTOR NANOSTRUCTURES

Course Objectives:

Course Outcomes: On completion of this course, students will be able to: –

1. *Understand the growth and characterization of quantum dots for infrared photodetectors.*
2. *Learn about high speed quantum dot lasers.*
3. *Understand heteroepitaxy and self-assembled growth nanostructures.*
4. *Learn properties and applications of zinc oxide, III-antimony and III-nitride based quantum nanostructures.*
5. *Understand carbon nanotube engineering.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Total Credits: 4
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Quantum Dot Infrared Photodetectors (QDIP); QD and QDIP Structure Growth and Characterization, QDIP Device Characteristics, Prognosis

Quantum Dot Lasers: Theoretical Overview; Introduction: Dimensionality and Laser Performance, Advantages of an Idealized QD Laser, Progress in Fabricating QD Lasers, State-of-the-Art Complications, Novel Designs of QD Lasers with Improved Threshold and Power Characteristics

High-Speed Quantum Dot Lasers; Introduction, MBE Growth of Self-Organized QDs and Their Electronic Properties, Separate Confinement Heterostructure QD Lasers and Their Limitations, Tunnel Injection of Carriers In QDs, Characteristics of High-Speed Tunneling-Injection QD Lasers

Self-Assembled Germanium Nano-Islands on Silicon; Heteroepitaxy Mechanisms, Uniform Ge Islands, Registration and Regimentation of Ge Islands, Novel Device Applications

SECTION – B

Zinc Oxide-Based Nanostructures; Growth, Characterization, Properties, Device applications

Antimony-Based Materials for Electro-Optics; Introduction, III-Sb Binary Compounds: GaSb, AlSb, and InSb. InAsSb/InAsSbP for IR Lasers, GaSb/InAs Type II Superlattice for IR Photodetectors
Growth, Structures, and Optical Properties of III-Nitride Quantum Dots; Growth of III-Nitride QDs, Optical Properties of III-Nitride QDs

Carbon Nanotube Engineering and Physics; Controlled Fabrication of Uniform Nanotubes in a Highly Ordered Array, Interfacing with Biomolecules and Cells, Intrinsic Quantum Electromechanical Couplings, Extrinsic Coupling to Radiation Fields, Heterojunction Nanotubes, Prospects for Future Advances

RECOMMENDED READINGS

Text Books:

1. *Semiconductor Nanostructures for Optoelectronic Applications* Edited by Todd Steiner, Published by ARTECH HOUSE, Inc.
2. *Handbook of Semiconductor Nanostructures & Nanodevices* Edited by A A Balandin and K L Wang, Published by American Scientific Publishers.
3. *Encyclopedia of Nanoscience and Nanotechnology* Edited by H S Nalwa, Published by American Scientific Publishers

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)
(THEORY) PAPER CODE: MPHY2307T

PAPER NAME: MATERIAL SCIENCE

Course Objectives: The objectives of this course are to:

1. Introduce the concepts of crystal imperfections, diffusion mechanisms, and their influence on material properties.
2. Develop an understanding of the mechanical behavior of materials and various mechanical testing techniques.
3. Familiarize students with phase equilibria, phase diagrams, and phase transformations in engineering materials.
4. Explain heat treatment processes and strengthening mechanisms used to tailor material properties.
5. Provide a foundation for the study and selection of materials for engineering and technological applications.

Course Outcomes: On completion of this course, student will be able to learn about: –

1. Crystal imperfections, Classification of imperfections, dislocations.
2. Diffusion processes, Laws of diffusion, Solution to Fick's second law, mechanical properties.
3. Phase diagram, Iron-Carbon phase diagram, Transformation in steel and critical cooling curve.
4. Casting of ingots, plain carbon steels and applications, properties of aluminum alloys.

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Assessment Criteria:

Total Credits: 4

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.

2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Crystal Imperfections:

Classification of imperfections: Point imperfections, Line imperfections; Mixed dislocations. Characteristics of dislocations; Sources of dislocations, their effects and remedies; Phenomena related to behaviour of dislocations, Surface imperfections, Volumes imperfections, Whiskers.

Diffusion in solids: Diffusion controlled applications, Types of diffusion, Diffusion processes, Laws of diffusion, Solution to Fick's second law, Applications based on second law, Experimental determination of diffusivity, Factors affecting diffusivity.

Mechanical Properties:

Basic properties: Strain, Stress, Young's modulus, Elastic constants, Isotropy, Anisotropy, Orthotropy, Homogeneity and heterogeneity; Stress-strain diagrams, Stress-strain diagram of structural steel, Elastic properties; Other mechanical properties: Strength, Stiffness, Elasticity, Plasticity, Resilience, Proof resilience, Toughness, Ductility, Brittleness and malleability, True stress-strain diagrams, Fatigue and Creep.

Mechanical Tests: Destructive tests, Tensile test, Compression tests, Shear and bending (on Flexure) tests, Torsion test, Hardness tests, Impact tests, Fatigue test and Creep test.

SECTION – B

Phases and Phase diagrams

Solid phases in alloys, Solid solution, Inter-metallic compounds and intermediate compounds, Phases, Phase diagrams, Binary phase diagram, Typical phase diagrams, Application of phase diagrams, Ternary phase diagram.

Phase Transformations and Heat Treatment

Rate of cooling and crystallization, strengthening mechanisms; Cold and hot working; Precipitation (or Age) hardening, Dispersion hardening, Solid solution hardening, Recovery and re-crystallization, Grain growth and preferred orientation.

Purpose of heat treatment, Microstructure of steel and iron, Iron-Carbon phase diagram, Transformation in steel and critical cooling curve, Heating temperature range in various heat treatment processes, Hardening, Tempering, Annealing, Normalizing, Case hardening or carburizing, Cyaniding, Nitriding, Flame hardening, Induction hardening and Jaminy End-quenched test.

Engineering Materials (Ferrous)

Production of iron and steel, casting of ingots, Refining, Continuous casting, Steels, Plain carbon steels and applications, Alloy steels, Heat treatment of stainless-steels, Tool-steels and Cast iron.

Engineering Materials (Non-ferrous)

Aluminium, Properties of aluminium alloys, Age-hardening of aluminium alloys, Copper and its production, Copper alloys, Magnesium and its alloys, Titanium alloys, Bearing materials, Alloys for cutting tools, Creep resistant materials.

RECOMMENDED READINGS

Text Books:

1. Material Science and Engineering: K.M. Gupta (Ist Ed.), Umesh Pub., Delhi
2. Material Science: Abdul Mubeen and Farhat Mubeen (2nd Ed.), Khanna Pub., Delhi
3. **William D. Callister Jr. and David G. Rethwisch**, *Materials Science and Engineering: An Introduction*, 10th Edition, Wiley.
4. **V. Raghavan**, *Materials Science and Engineering: A First Course*, 6th Edition, PHI Learning.
5. **Donald R. Askeland and Wendelin J. Wright**, *The Science and Engineering of Materials*, 7th Edition, Cengage Learning.
6. **R. E. Smallman and A. H. W. Ngan**, *Modern Physical Metallurgy*, 8th Edition, Butterworth-Heinemann.

7. **Sidney H. Avner**, *Introduction to Physical Metallurgy*, 2nd Edition, McGraw-Hill.

(THEORY) PAPER CODE: MPHY2308T

PAPER NAME: COMPUTATIONAL SIMULATIONS IN PHYSICS

Course Objectives: The objectives of this course are to:

1. Introduce numerical methods for solving algebraic equations, systems of linear equations, and interpolation problems.
2. Develop an understanding of numerical differentiation, integration, and ordinary differential equation solving techniques.
3. Familiarize students with curve fitting, approximation methods, and error analysis in scientific computations.
4. Provide knowledge of Monte Carlo methods and random number generation for computational applications.
5. Develop computational skills for modeling and simulating physical systems using numerical algorithms.

Course Outcomes: *On completion of this course, student will be able to: –*

1. Understand the evaluation of polynomials and iterative methods for systems of equations to enhance knowledge of physics.
2. Gain knowledge about the application of numerical methods used in computation.
3. Learn about ordinary differential equations.
4. Understand the Random Variables and Monte Carlo Methods

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Total Credits: 4
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours
Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.

2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Evaluation of polynomials and Root finding: Evaluation of truncated series: Fundamental iterative scheme. Solution of nonlinear equations: Newton-Raphson method, Secant method, Newton method for two dimensions.

Iterative methods for systems of equations: Linear system: Jacobi method, Gauss Seidal Iteration.

Interpolation and Approximation: Polynomial interpolation: Lagrange's and Newton methods.

Curve fitting: Linear and nonlinear curve fitting: Least squares approximation, Data linearization, Piecewise and Cubic Spline interpolation.

Differentiation and Integration: Differentiation using forward, backward and central difference operators; Error analysis, Trapezoidal and Simpson rules; Two- and three-dimensional integration.

SECTION – B

Ordinary Differential equation: Taylor method, Runge-Kutta method and Predictor-Corrector method, System of differential equations for initial value problems.

Monte-Carlo method: Pseudo random numbers and their generation, Monte-Carlo integration.

Simulation of Physics Problems: Algorithm development of

1. 1 and 2-Dimensional motion: Viscous effects and projective motion.
2. 1 dim. SHO, damping and anharmonic effects
3. Linear electrical circuits (Kirchoff's laws)
4. Solution of 1-dim. Schrodinger equation
5. Monte-Carlo method for evaluation of Pi and moment of inertia
6. Monte-Carlo modelling of radioactivity

RECOMMENDED READINGS

Text Books:

1. Numerical Methods: J.H. Mathews, Prentice Hall of India
2. Computer Oriented Numerical Methods: V. Rajaraman, Prentice Hall of India
3. Computational Physics: R.C. Verma, P.K. Alhuwalia and K.C. Sharma, New Age Pub., N.Delhi
4. Introduction to Computational Physics: M.L. De Jong, Addison Wesley Pub. Co.

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(PRACTICAL) PAPER CODE: MPHY2305P

PAPER NAME: LABORATORY PRACTICE

Course Objectives: *The objectives of this laboratory course are to:*

1. *Develop practical skills in performing advanced experiments in nuclear physics, condensed matter physics, and electronics.*
2. *Familiarize students with modern scientific instruments, detectors, electronic circuits, and data acquisition techniques.*
3. *Strengthen the ability to analyze experimental data, estimate errors, and interpret physical phenomena.*
4. *Enhance problem-solving and experimental design skills through hands-on laboratory investigations.*
5. *Prepare students for research and industrial applications by integrating theoretical concepts with experimental practices*

Course Outcomes: *Students will thoroughly understand the theoretical concepts of Physics by experimentation.*

Max. Marks: 120
Internal Assessment: 30
Written Examination: 90
Pass Marks: 35%
Assessment Criteria:

Total Credits: 3

Internal Assessment	Marks
	30
Seminar, viva-voce of experimental reports	12
number of experiments performed	12
Attendance	6

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

Out of 120 Marks, internal assessment (based on seminar, viva-voce of experimental reports, number of experiments performed and attendance) carries 30 marks, and the final examination at the end of the semester carries 90 marks.

The laboratories comprise of experiments based on **Nuclear Physics & Counter Electronics** in one group and **Condensed Matter Physics and advanced Electronics** in the other group. Each student will be placed in one of the two groups during the entire semester.

Note: Student must perform any 10 experiments from group 1 or group 2.

GROUP-I: NUCLEAR PHYSICS & COUNTER ELECTRONICS EXPERIMENTS

1. Study of standard deviation using G-M counter
2. Half-life of ^{40}K using G-M Counter
3. Measurement of mass absorption coefficient of beta rays in given materials
4. To find range and energy of β- particles

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5. To find Dead time of a GM Tube
6. Study of energy calibration of NaI(Tl) scintillation detector
7. Study and analysis of spectrum of ^{137}Cs
8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer.
9. Study of Compton scattering law for energy of scattered photons
10. To study Internal Conversion Coefficient for ^{137}Cs (or suitable gamma source)
11. To determine the source strength of a given radioactive gamma source
12. Study and analysis of the spectrum of ^{60}Co
13. Photoelectric cross-section measurement for a given target material at known incident gamma photon energy
14. Compton cross-section measurement for known incident gamma photon energy
15. Measurement of Photo-peak (full energy peak) efficiency of Scintillation detector.
16. To verify the given Boolean identities on the ALU system.
17. To study various Encoders and Decoders, and Random Access Memory (RAM) circuit.
18. To study the various counters.
19. To study the left and right shift registers and ring counters.
20. To study the operation of multiplexer and demultiplexer circuits.

GROUP-II: CONDENSED MATTER PHYSICS AND ADVANCED ELECTRONICS EXPERIMENTS

1. Find the value of the 'g' factor in a DPPH sample by using ESR technique.
2. To determine the Curie temperature of a given PZT sample.
3. Determine the coercivity, retentivity and saturation value of magnetic induction of the given sample by studying the B-H loop.
4. Determine the Hall coefficient of the given sample and hence find the carrier concentration and mobility.
5. Find the band gap energy of the given semi-conductor sample by four probe method.
6. Measurement of susceptibility of paramagnetic solutions by Quinck's Tube Method.
7. Measurement of magneto-resistance of a semi-conducting sample.
8. Study of Dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
9. Study of solar cell and characteristics
10. Measurement of wavelength, frequency, VSWR and Reflection coefficients of microwaves.
11. Determination of velocity of ultrasonic wave in liquids hence to find the compressibility.

12. Frank Hertz experiment for Quantization of Bohr's model of atom.
13. To study Digital to Analog Converter and Analog to Digital Converter.
14. To study multivibrators (astable, monostable and bistable) using discrete components.
15. To study the multivibrators (BMV, AMV and MMV) using IC-555.
16. To study Timer Integrated circuit IC-555.
17. To study the basic operational amplifier (Model 741).
18. To study the applications of operational amplifier (Model 741).
19. To study the voltage controlled oscillator (VCO)
20. To study the voltage regulator using IC 317
21. Programming with Microprocessor training kit (8085 processor)

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(PRACTICAL) PAPER CODE: MPHY2306P

PAPER NAME: COMPUTER LAB

Course Objectives: *The objectives of this laboratory course are to:*

1. *Develop fundamental programming skills for solving basic scientific and mathematical problems.*
2. *Introduce computational techniques for numerical calculations and data analysis in physics.*
3. *Enhance logical thinking and algorithm development through programming exercises.*
4. *Familiarize students with computer-based simulation of simple physical systems.*
5. *Build a foundation for advanced computational methods used in physics and scientific research.*

Course Outcomes: *Students will be able to write programs for solving Physics problems and gain expertise in graph plotting, simplification of calculations etc.*

Max. Marks: 60
Internal Assessment: 15
Written Examination: 45
Pass Marks: 35%
Assessment Criteria:

Total Credits: 1

Internal Assessment	Marks
	15
Seminar, viva-voce of experimental reports	6
Performance of the candidate in the computer lab	6
Attendance	3

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

Out of 60 Marks, internal assessment (based on performance of the candidate in the computer lab and attendance) carries 15 marks, and the final examination at the end of the semester carries 45 marks.

This laboratory comprises of any ten of the following physics problems to be solved using Python.

1. To print even and odd numbers between given limit
2. To generate prime numbers between given limit.
3. To construct Fibonacci series.
4. To find maximum and minimum number among a given data.
5. To find area of a triangle.
6. To find factorial of a number.
7. To find roots of a quadratic equation.
8. To construct AP and GP series.
9. To construct Sine and Cosine series.

10. Conversion of temperature scale.
11. Addition of two matrices.
12. Motion of horizontally thrown projectile.
13. Finding mean and standard deviation of a given data.
14. To find perfect numbers.

Guru Nanak College, Budhlada

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Semester–IV

(THEORY) PAPER CODE: MPHY2401T

PAPER NAME: CONDENSED MATTER PHYSICS–II

Course Objectives: *The objectives of this course are to:*

1. *Introduce the fundamental concepts of magnetic, dielectric, and ferroelectric properties of materials.*
2. *Develop an understanding of superconductivity and its theoretical foundations, properties, and technological applications.*
3. *Familiarize students with collective excitations in solids, including plasmons, polaritons, and polarons.*
4. *Explain the origin and effects of lattice defects, diffusion, and dislocations on material properties.*
5. *Provide a strong foundation for advanced study and research in condensed matter physics and functional materials.*

Course Outcomes: *On completion of this course, student will be able to learn about: –*

1. *Langevin diamagnetism equation, Anti-ferromagnetic magnons, Ferromagnetic domains, Crystal field splitting.*
2. *Cooling by adiabatic demagnetization, Ferromagnetism, Debye equations, Dipole theory of ferroelectricity.*
3. *Superconductivity, London equations, Superconducting Quantum Interference Device and its applications.*
4. *Plasmons, polarons, polaritons and Lattice defects, Mott transition.*
5. *Burger's vector, Low angle and large angle grain boundaries, Dislocation multiplication by Frank-Read source.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Assessment Criteria:

Total Credits: 4

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

dium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

ıe Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION-A

Magnetic properties of Materials: Langevin diamagnetism equation, Quantum theory of diamagnetism of mononuclear system, Paramagnetism, Quantum theory of para-magnetism, magnetism of rare earth and iron group ions, Crystal field splitting, Quenching of orbital angular momentum, Conduction electron magnetization, Cooling by adiabatic demagnetization, Ferromagnetism, Magnetization at absolute zero and its temperature dependence, Spin waves and magnons in ferromagnetics, Neutron magnetic scattering, Ferrimagnetic order and iron garnets, Anti ferromagnetic order and susceptibility, Anti ferromagnetic magnons, Ferromagnetic domains, Bloch wall, Origin of domains, Application of soft and hard magnetic materials.

Ferroelectric Properties of materials: Ferro-electric materials and their classification, Dipole theory of ferroelectricity, Objections against dipole theory, Ferroelectricity in BaTi03, Landau theory of phase transition.

SECTION-B

Superconductivity: Survey of traditional and high Tc superconductors, Meissner effect, Heat capacity, Energy gap, Isotope effect, Stabilization energy density, London equations, Coherence length, Some basic ideas of BCS theory, Flux quantization in superconducting ring, Duration of persistent currents, Type II Superconductors, Estimation of HC_1 and HC_2, Single particle Tunneling, DC and AC Josephson effects. Macroscopic quantum interference, SQUIDS and its applications.

Lattice Defects: Point defects, diffusion, Ionic conductivity, Photoconductivity, Concepts of traps, Colour centers, Shear strength in single crystals, Dislocations and its types, Burger's vector, Stress field of dislocations. Low angle and large angle grain boundaries

RECOMMENDED READINGS

Text Books:

1. Introduction to Solid State Physics; C. Kittel (7th Ed.), Wiley Eastern Ltd.,1995
2. Solid State Physics; A.J. Dekker (2nd Ed.), Mc Millan India Ltd.
3. Charles Kittel, *Introduction to Solid State Physics*, 8th Edition, Wiley.
4. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Cengage Learning.
5. J. S. Blakemore, *Solid State Physics*, 2nd Edition, Cambridge University Press.
6. J. R. Hook and H. E. Hall, *Solid State Physics*, 2nd Edition, Wiley.
7. S. O. Pillai, *Solid State Physics*, 8th Edition, New Age International Publishers.

Guru Nanak College, Budhlada

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(THEORY) PAPER CODE: MPHY2402T

PAPER NAME: ADVANCED ELECTRONICS

Course Objectives: The objectives of this course are to:

1. Introduce the fundamentals of digital-to-analog and analog-to-digital conversion techniques and their applications.
2. Develop an understanding of the architecture, organization, and operation of the 8085 microprocessor.
3. Familiarize students with memory organization, I/O interfacing, and microcomputer systems.
4. Provide practical knowledge of 8085 assembly language programming and programming techniques.
5. Build a foundation for advanced study of microprocessors, microcontrollers, and embedded systems.

Course Outcomes: *On completion of this course, student will be able to learn about: –*

1. Analog to digital and digital to analog converter. Generation of (A to D) and (D to A) signal and evaluate their performance.
2. Use of Micro-Processor in daily life and block diagram of 8085 microprocessors.
3. Various memories in terms of RAM and ROM and compare (Bipolar ROM, MOS ROM, Static RAM, Dynamic RAM).
4. Interfacing concept and demonstrate the interfacing of Input device, output devices and Memory segment with 8085.
5. Various types of instructions (Data transfer, Arithmetic, Logic, Branch, Rotate and compare) and their format in 8085.
6. Looping, counting, and indexing concept and differentiate higher bit addition and data transfer instruction from lower bit instruction.
7. Stack, Subroutine, conditional Call and Return Instructions of 8085.
8. Classification of various higher bits processors.

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Total Credits: 4
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

ne Allowed: 3 hours
Max. Marks: 60

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Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Digital to analog and analog to digital converters: Binary equivalents of analog signals. Weighted register and binary ladder networks. Digital to analog converter, Performance criteria for digital to analog converters. Resolution and accuracy. Analog to digital converters. Performance criteria for analog to digital converters; counter; up down, Successive approximation; Dual slope analog to digital converters.

General Introduction of Microprocessors, assembly and computer languages.

Microprocessor Architecture: Registers, ALU, timing and control section and their arrangement in 8085 microprocessor. Microprocessor operations and its bus organization.

Memory: ROM; Bipolar and MOS ROMs. RAM; Bipolar and Static/Dynamic MOS RAMs, Addressing of a RAM and Applications of RAM. Memory Mapping, addressing and interfacing with microprocessor.
I/O Devices and their Interfacing: Input/output devices, Basic interfacing concepts; Memory-Mapped I/O (8085 based).

SECTION – B

Introduction to 8085 assembly language programming: The 8085 programming model, Instruction classification, Instruction and data format.

Introduction to 8085 instructions: Data transfer (copy) operations. Arithmetic operations. Logic operations. Branch operations. Writing assembly language programs.

Programming techniques with additional instructions: Programming techniques; Looping; Counting; and indexing. Additional data transfer and 16 bit arithmetic instructions. Logic operations: Rotate, Compare.

Stack and Subroutines: Stack, Subroutine, conditional Call and Return Instructions.

RECOMMENDED READINGS

1. An Introduction to Digital Electronics: M.Singh, Kalyani Publishers, N.Delhi
2. Ajit Paul; Microprocessors, Principles and Applications, Tata McGraw-Hill.
3. R. S Gaonkar; Microprocessor Architecture, Programming and Applications Willey Eastern.
4. Millman and Grabel: Microelectronics, 2nd Ed., MHB.
5. Millman: Microelectronics, Digital and Analog Circuits and Systems, MHB.
6. R. L. Tekheim: Microprocessor Fundamentals, MHB.

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Elective Papers

(THEORY) PAPER CODE: MPHY2403T

PAPER NAME: EXPERIMENTAL TECHNIQUES IN PHYSICS

Course Objectives: *The objectives of this course are to:*

1. *Introduce the principles and techniques of thin-film deposition and vacuum technology.*
2. *Develop an understanding of thickness measurement methods, analytical techniques, and transducers used in material characterization.*
3. *Familiarize students with diffraction techniques for structural analysis of materials.*
4. *Provide knowledge of advanced microscopy techniques for surface and microstructural characterization.*
5. *Build a foundation in modern spectroscopic techniques for the analysis of the structural, optical, and electronic properties of materials.*

Course Outcomes: *On completion of this course, student will be able to: –*

1. *Learn about thermal evaporation, cathodic sputtering, glow discharge sputtering.*
2. *Understand the analytical and transducers techniques.*
3. *Understand the theories of Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunnelling Microscope, Atomic Force Microscope.*
4. *Know about the basic concepts and applications of spectroscopic techniques.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Assessment Criteria:

Total Credits: 4

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

ledium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Thin Film Deposition Technology: Thermal evaporation – general considerations and evaporation methods. Cathodic sputtering – sputtering process, glow discharge sputtering, sputtering variants and low pressure sputtering. Chemical methods – electrodeposition and chemical vapour deposition. Vacuum deposition apparatus – vacuum systems and surface deposition technology.

Thickness Measurements, Analytical Techniques and Transducers Techniques: Thickness measurement – electrical methods, microbalance monitors, mechanical method, radiation absorption and radiation emission methods, optical interference methods.

Transducers: Transducers as input elements to instrumentation systems, classification of transducers, selecting a transducer, strain gauges, displacement transducers, temperature measurements, photosensitive devices.

SECTION – B

Diffraction techniques: Principal, Instrumentation, working and applications of X-ray diffraction, Neutron diffraction, Electron diffraction

Electron microscopy: concepts, Instrumentation & working, Applications of Scanning Electron Microscope and Transmission Electron Microscope

Scanning probe microscopy: Scanning Tunneling Microscope: Principal, Construction & working, Applications; Atomic Force Microscope: Principal, Construction & working, Applications

Spectroscopic Techniques *(Basic concepts, Instrumentation & working, Applications)*: UV-Visible absorption spectroscopy, X-ray photoelectron spectroscopy, Raman spectroscopy, Infrared spectroscopy, Luminescence spectroscopy, Atomic absorption spectroscopy, Mass spectroscopy, Mossbauer spectroscopy

RECOMMENDED READINGS

Text Books:

1. Thin Film Phenomena: K.L. Chopra, McGraw Hill Book Company
2. Electronic Instrumentation and Measurement Techniques: W.D. Cooper and A.D. Helfrick (3rd Ed.), Prentice Hall of India Pvt. Ltd.
3. Springer Handbook of Nanotechnology Edited by Bharat Bhushan, Published by Springer.
4. Handbook of Spectroscopy Edited by G Gaugliz an T Vo-Dinh,Published by WILEY VCH Verlag GmbH & Co.
5. Encyclopedia of Spectroscopy and Spectrometry Edited by JC Lindon, G E Tranter and J L Holmes, Published by Academic Press.
6. Concise Encyclopedia of Materials Characterization Edited by R Cahn, Published by Elsevier.
7. Dekker Encyclopedia of Nanoscience and Nanotechnology. Edited by J A Schwarz, C I Contescu and K Putyera, Published by Marcel Dekker Inc.
8. Handbook of Microscopy for Nanotechnology Edited by N Yao and Z L Wang, Published by Kluwer Academic Publishers.

Guru Nanak College, Budhlada

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(THEORY) PAPER CODE: MPHY2404T

PAPER NAME: RADIATION PHYSICS

Objectives: The objectives of this course are to:

Introduce the physics of thermal neutrons, neutron moderation, diffusion, and transport in nuclear systems.
Develop an understanding of nuclear chain reactions, reactor kinetics, and the principles of nuclear reactor operation.
Familiarize students with nuclear spectrometry and techniques for determining nuclear properties.
Provide knowledge of modern nuclear analytical techniques and their instrumentation.
Build a foundation for the applications of nuclear physics in energy production, industry, materials characterization, and nuclear medicine.

Outcomes: *On completion of this course, student will be able to: –*

Understand basics of thermal neutrons like energy distribution of thermal neutrons, effective cross section of thermal neutron.
Understand the concept of nuclear chain reaction.
Learn thermal Neutron diffusion, Neutron diffusion equation, Thermal diffusion length.
Analyze nuclear spectrometric data and able to measure g-factors and hyperfine fields.
Understand the principle, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques.

Marks: 80
Assessment: 20
Examination: 60
Marks: 35%
Total Credits: 4
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

Question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from five sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over entire range of syllabus. In no case, question should be asked from outside the syllabus. The question should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time: 3 hours

Max. Marks: 60
Pass Marks: 35%

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Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(THEORY) PAPER CODE: MPHY2404T

PAPER NAME: RADIATION PHYSICS

Course Objectives: The objectives of this course are to:

1. Introduce the physics of thermal neutrons, neutron moderation, diffusion, and transport in nuclear systems.
2. Develop an understanding of nuclear chain reactions, reactor kinetics, and the principles of nuclear reactor operation.
3. Familiarize students with nuclear spectrometry and techniques for determining nuclear properties.
4. Provide knowledge of modern nuclear analytical techniques and their instrumentation.
5. Build a foundation for the applications of nuclear physics in energy production, industry, materials characterization, and nuclear medicine.

Course Outcomes: *On completion of this course, student will be able to: –*

1. Understand basics of thermal neutrons like energy distribution of thermal neutrons, effective cross section of thermal neutron.
2. Understand the concept of nuclear chain reaction.
3. Learn thermal Neutron diffusion, Neutron diffusion equation, Thermal diffusion length.
4. Analyze nuclear spectrometric data and able to measure g-factors and hyperfine fields.
5. Understand the principle, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques.

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35% **Total Credits: 4**
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours **Max. Marks:** 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Thermal neutrons: Energy distribution of thermal neutrons, Effective cross section of thermal neutron, slowing down of reactor neutrons, Angular and energy distribution, Transport mean free path and scattering cross-section, Average logarithmic energy decrement, slowing down power and moderating ratio, Slowing down density, Slowing down time, Resonance escape probability.

Nuclear chain reaction: Neutron cycle and multiplication factor Neutron leakage and critical size, Nuclear reactors and their classification.

Neutron diffusion: Thermal Neutron diffusion, Neutron diffusion equation, Thermal diffusion length, Exponential pile, Diffusion length of a fuel-moderator mixture, Fast neutron diffusion and Fermi age equation, Correction for neutron capture.

SECTION – B

Nuclear spectrometry and applications: Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g-factors and hyperfine fields.

Analytical Techniques: Principles, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques. Experimental techniques and applications of Mossbauer effect, Rutherford backscattering. Industrial applications of elemental analysis, Diagnostic nuclear medicine, Therapeutic nuclear medicine.

RECOMMENDED READINGS

Text Books:

1. Liverhant, S.E.: Elementary Introduction to Nuclear Reactor Physics
2. Singru, R.M.: Introduction to experimental nuclear physics, Wiley Eastern Pub., N. Delhi
3. Krane, K.S, : Introductory Nuclear Physics, John Wiley & Sons, New York
4. H.R.Verma: Atomic and Nuclear Analytical Methods, Springer Beclin Heidelbug, New York
5. Glasstone and Edlund: The Elements of Nuclear Reactor Theory
6. Murray, Introduction to Nuclear Engineering

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(THEORY) PAPER CODE: MPHY2405T

PAPER NAME: HIGH ENERGY PHYSICS

Course Objectives: *The objectives of this course are to:*

1. *Introduce the classification, properties, and interactions of elementary particles within the framework of modern particle physics.*
2. *Develop an understanding of symmetry principles, conservation laws, quark models, and flavor symmetries.*
3. *Familiarize students with particle decays, resonances, and weak interaction phenomena, including parity and CP violation.*
4. *Provide knowledge of gauge theories, the Standard Model, Quantum Electrodynamics (QED), and Quantum Chromodynamics (QCD).*
5. *Build a foundation for advanced studies in high-energy physics, particle phenomenology, and their connections to cosmology*

Course Outcomes: *On completion of this course, student will be able to: –*

1. *Classify the elementary particles and fundamental interactions.*
2. *Understand the concept of Gell Mann–Nishijima scheme, Quark model, need of color quantum numbers.*
3. *Understand the general features of conservation laws in quantum theory.*
4. *Learn the observation and properties of resonances, C and CP violation, CPT theorem.*
5. *Understand the theory of Higgs Mechanism and its application in gauge theories and strong interaction theory of quarks and gluons.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Assessment Criteria:

Total Credits: 4

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Particle kinematics: Classification of elementary particles and fundamental interactions, *Properties of elementary particles*. Lie algebra, Young diagrams for SU (3) representations, GellMann-Nishijima scheme, Baryon and meson multiplets, Charged and neutral pions; *Strange particles*: Masses and lifetimes, production and decays of strange mesons and baryons. Prediction of omega, Hyperon extension, Quark model: Hadron spectra and quark content, Search for quarks (Hofstadter et al. experiment, qualitative treatment), Need of colour quantum numbers.

Problems and Examples: Decomposition of 3 x 3 and 3 x 3 x 3, Flavour symmetries: SU(3) unitary groups, SU(4) charm scheme. Hadron mass formulae. Quark wave function of Meson and nucleon, Vector meson decays.

Symmetry properties: General features of conservation laws in quantum theory, Parity conservation, Operators and transformation, Isospin, G-parity, Conservation of Isospin, Generalized Pauli principle; Conservation laws: Baryon and lepton and flavour no. conservation.

Problems: Positronium decay, Application of Isospin conservation to NN interaction and strong-decays.

SECTION – B

Resonances: Observation and properties of Resonances; Tau-theta problem, Observation of Tau-lepton and new flavours., Parity violation in weak interaction, K0-K bar mixing, C and CP violation, CPT theorem (statement only),

Problems: Two body decay phase space, decay length and Dalitz plot, Breit-Wigner formula.

Gauge theories of fundamental interactions, Higgs Mechanism and its application in gauge theories Elements of QED, Global and local gauge invariance, Feynman diagrams, Successes of QED; Current-current interaction and V-A theory, Cabibbo modification. Introduction to GSW model and limitations of QED. Strong interaction theory of quarks and gluons (QCD), Recent developments in high energy physics (supersymmetry, extra dimensions, neutrino oscillations) and Link with cosmology (QUALITATIVE TREATMENT ONLY). *Problems*: Classification of weak decays and selection rules.

RECOMMENDED READINGS

Text Books:

1. Introduction to Elementary Particles: D.J. Griffiths
2. Elementary Particle Physics: I.S. Hughes, Cambridge University Press
3. D. H. Perkins, *Introduction to High Energy Physics*, 4th Edition, Cambridge University Press.
4. Donald H. Perkins, *Particle Astrophysics*, 2nd Edition, Oxford University Press.
5. F. Halzen and A. D. Martin, *Quarks and Leptons: An Introductory Course in Modern Particle Physics*, Wiley.
6. B. R. Martin and G. Shaw, *Particle Physics*, 4th Edition, Wiley.
7. T. D. Lee, *Particle Physics and Introduction to Field Theory*, Harwood Academic Publishers.

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(THEORY) PAPER CODE: MPHY2406T

PAPER NAME: THEORETICAL NUCLEAR PHYSICS

Objectives: *The objectives of this course are to:*

1. *Develop a thorough understanding of angular momentum theory and its applications in quantum and nuclear physics.*
2. *Introduce the concepts of nuclear forces and two-nucleon systems, with emphasis on the deuteron and nucleon interactions.*
3. *Familiarize students with nuclear structure through shell, liquid drop, collective, and Nilsson models.*
4. *Provide knowledge of advanced mathematical tools such as spherical tensors, Clebsch–Gordan coefficients, Wigner symbols, and Racah coefficients.*
5. *Build a strong theoretical foundation for advanced studies and research in nuclear structure and nuclear spectroscopy.*

Outcomes: *On completion of this course, student will be able to: –*

1. *Understand the concept of angular momentum operators and their matrix representations, Clebsch–Gordan coefficients and their properties.*
2. *Learn about nucleon–nucleon force, isospin of two nuclear systems, Deuteron problem.*
3. *Explain nuclear models like liquid drop model, single particle shell model, extended single particle shell model, two particle shell model.*
4. *Understand the concept of odd-odd and even-even nuclei, Interacting Boson Model.*
5. *Learn about scattering theory.*

Marks: 80
Assessment: 20
Examination: 60
Marks: 35%

Total Credits: 4

Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Angular momentum theory: Angular momentum operators and their matrix representations. Vector addition of two angular momenta. Clebsch-Gordan coefficients and their properties. Rotation operators, Rotation D-matrices and their properties.

***Problems*:** Matrix representation of angular momentum operators for j =1 case, Evaluation of C-G Coefficient for $j_1=1/2$ and $j_2 = ½$ case. Evaluation of Rotation matrices for simple cases.

Spherical tensors. Wigner-Eckart theorem and its applications, Wigner 3-j symbols. Addition of three angular momenta. Definition of Racah coefficients and their properties.

***Problems*:** Matrix representation of angular momentum operators

Nuclear force and two nucleon systems: Symmetries of nucleon-nucleon force. Isospin of two nuclear systems. Solution of Deuteron problem, Deuteron magnetic dipole moment. Evaluation of Deuteron electric quadrupole moment. Tensor force and Deuteron D-state.

Problems: Evaluation of nuclear magnetic moments in the Schmidt limit. Symmetry properties of two nucleon spin and isospin wave functions.

SECTION – B

Nuclear models: Deformable liquid drop and nuclear fission. Single particle shell model, spin and parity of ground state of nuclei. Extended single particle shell model, seniority scheme and reduced isospin, configuration mixing, Simple description of two particle shell model spectroscopy.

Problems: Calculation of nuclear ground state spin and parity of odd-A nuclei using shell model (with examples), Spin-orbit coupling in shell model. Description of two particle shell model spectroscopy (with examples);

Vibrational model. Rotational model, nuclear rotational wave functions and energy spectra from deformed even-even and odd-A nuclei. Nilsson model. Nilsson diagrams. Statistical model, evaporation spectra and nuclear temperature. Interacting Bosan Model.

Problems: Calculation of nuclear spin and parity for deformed nuclei using Nilsson diagrams.

Scattering Theory: Elastic scattering of spin zero projectile from a spin zero target, total cross section for elastic scattering and optical theorem. Integral equation for the scattering wave function and Born approximation. Low energy scattering parameters. Scattering from a complex potential.

Problems: Discussion of low energy scattering parameters.

RECOMMENDED READINGS

Text Books:

1. Introductory Nuclear Physics by S. S. M. Wong, Prentice Hall of India Pub., New Delhi
2. Nuclear Physics by R. R. Roy and B. P. Nigam, New Age Publication, New. Delhi
3. Nuclear and Particle Physics by W. E. Burcham and M. Jobes, Addison Wesley Pub. (Ind. Ed.)
4. Nuclear reactions by D. F. Jackson
5. Nuclear Structure by M. K. Pal, Affiliated East-West Press

6. Physics of the Nucleus by M.A. Preston

(THEORY) PAPER CODE MPHY2407T
PAPER NAME: PLASMA PHYSICS

Course Objectives: *The objectives of this course are to:*

1. *Introduce the fundamental concepts of plasma physics and the motion of charged particles in electric and magnetic fields.*
2. *Develop an understanding of plasma dynamics using kinetic theory, fluid models, and the Boltzmann equation.*
3. *Familiarize students with magnetohydrodynamics (MHD), plasma equilibrium, and stability criteria.*
4. *Explain the propagation of electromagnetic and electrostatic waves in plasmas and magnetized plasmas.*
5. *Provide a theoretical foundation for advanced studies in plasma physics, controlled fusion, and space plasma applications.*

Course Outcomes: *On completion of this course, student will be able to: –*

1. *Understand the concept of motion of charged particles, adiabatic invariants, Boltzmann equation, Fokker Planck equation.*
2. *Understand the theory of Ohm's law, MHD equation and stability.*
3. *Learn about Plasma oscillations, Electron plasma waves, Ion waves, magneto-plasma, magneto-sonic waves.*
4. *Understand the propagation of electromagnetic waves through a plasma and magneto-plasma.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Total Credits: 4
Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.

2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Motion of charged particles: Motion of charged particles in a constant uniform magnetic field, Constant and uniform electric and magnetic fields, Inhomogeneous magnetic field. Constant non-electromagnetic forces, Time varying magnetic field, constant magnetic and time varying electric field, Adiabatic invariants, Magnetic mirrors.

Boltzman equation: Fluid model of a plasma, Two fluid and one fluid equations, Collisionless less Boltzman equation, Moment equations and conservation laws, Transport phenomena in plasma: Fokker Planck equations.

SECTION – B

Magnetohydrodynamics: Generalized Ohm's law, MHD equations, MHD equilibrium, Force free fields. MHD Stability: Normal mode technique, Sausage and kink instability in a linear pinch, Energy principle, Interchange instabilities, Cusp configuration, Two stream, Ion-acoustic drift, Firehose instabilities.

Waves in Plasma: Plasma oscillations, Electron plasma waves, Ion waves, Electrostatic electron and ion oscillations in a magnetoplasma, Electromagnetic waves propagation through a plasma and magnetoplasma, Alfven waves and magnetosonic waves.

RECOMMENDED READINGS

Text Books:

1. Plasma Dynamics: Boyd, T.J.M. and Sanderson, J.J., Nelson, 1969
2. Introduction to plasma Physics, Chen, F.F., Plenum Press, N.Y. 1977
3. Elements of Plasma Physics: Goswami, S.N., New Central Book Agency, 1995
4. Introduction to Plasma Theory, Nicholson, D.R., John Wiley & Sons, 1983.
5. R. J. Goldston and P. H. Rutherford, *Introduction to Plasma Physics*, CRC Press.
6. Nicholas A. Krall and Alvin W. Trivelpiece, *Principles of Plasma Physics*, San Francisco Press.
7. T. J. M. Boyd and J. J. Sanderson, *The Physics of Plasmas*, Cambridge University Press.
8. Paul M. Bellan, *Fundamentals of Plasma Physics*, Cambridge University Press.

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(THEORY) PAPER CODE: MPHY2408T

PAPER NAME: ELECTRONIC COMMUNICATION SYSTEMS

Course Objectives: *The objectives of this course are to:*

1. *Introduce the fundamental principles of analog, pulse, and broadband communication systems.*
2. *Develop an understanding of modulation and demodulation techniques used in modern communication.*
3. *Familiarize students with AM, FM, SSB, and radar communication systems and their applications.*
4. *Provide knowledge of pulse communication, multiplexing, and microwave communication technologies.*
5. *Build a strong foundation in communication engineering for advanced studies and practical applications.*

Course Outcomes: *On completion of this course, student will be able to:*

1. *Have knowledge about communication systems like transmitter, channel noise, receiver, bandwidth etc.*
2. *Represent AM frequency spectrum, power relations and techniques for generation of AM.*
3. *Explain single side band, balanced modulator, ISB systems, VSB transmission, single and side band receivers.*
4. *Describe mathematical representation, frequency spectrum, phase modulation of FM systems.*
5. *Understand the concept of stereophonic FM multiplex system, FM generation techniques, FM demodulators, FM receivers.*
6. *Understand the basic principle of Radar systems.*
7. *Know about pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PWM transmission system, PCM transmission system.*
8. *Understand about Microwave Radio communications, system gain and optical fibers.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%
Assessment Criteria:

Total Credits: 4

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from pective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.

2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION-A

Introduction to communication systems: Information, transmitter, channel noise, receiver, need for modulation, bandwidth requirements. Noise and its types.

AM: Representation of AM, frequency spectrum, power relations in AM wave, techniques for generation of AM, AM transmitter, AM receiver types, single and multi-superhetrodyne receivers, communication receivers.

SSB: Evolution and description of single side band, suppression of carrier, the balanced modulator, suppression of unwanted side band, pilot carrier systems, ISB systems, VSB transmission, single and independent side band receivers. (Ref. 1)

FM: Description of FM systems, mathematical representation, frequency spectrum, phase modulation,, intersystem comparison, pre-emphasis and de-emphasis, comparison of wide band and narrow band FM, stereophonic FM multiplex system, FM generation techniques, FM demodulators, FM receivers.

Radar systems: Basic principles, pulsed radar systems, moving target indication, radar beacons, CW Doppler radar, frequency modulated CW radar, phased array radars, planar array radars. (Ref. 1)

SECTION-B

Pulse Communication: Information theory, pulse modulation, types of pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PWM transmission system, PCM transmission system, telegraphy and telemetry.

Broadband communication systems: Frequency division multiplex (FDM), Time division multiplex TDM), coaxial cables, fiber optics links, microwave links, tropospheric scatter links, submarine cables, satellite communication systems, elements of long distance telephony. (Ref. 1)

Microwave Radio communications and system gain: Advantages of microwave communication, frequency modulated microwave radio system, microwave radio repeaters, protection switching arrangements, FM microwave radio stations, path characteristics, system gain. (Ref. 2)

Optical fiber communications: History of optical fibers, type of optical fibers, optical fiber communication system (block diagram), propagation of light through an optical fiber, optical fiber configurations, losses in optical fiber cables, light and optical sources, light detectors. (Ref. 1,2,)

RECOMMENDED READINGS

Text Books:

1. G. Kennedy and B. Devis, Electronic communication systems, Tata McGraw Hill Publishing Co., New Delhi.
2. W. Tomasi, Electronic communication systems, Pearson Education Asia, Delhi
3. George Kennedy and Bernard Davis, *Electronic Communication Systems*, 5th Edition, McGraw-Hill.
4. Simon Haykin, *Communication Systems*, 5th Edition, Wiley.
5. Wayne Tomasi, *Electronic Communications Systems: Fundamentals Through Advanced*, 5th Edition, Pearson.
6. B. P. Lathi, *Modern Digital and Analog Communication Systems*, 4th Edition, Oxford University Press.
7. Taub and Schilling, *Principles of Communication Systems*, 3rd Edition, McGraw-Hill.

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)
(THEORY) PAPER CODE: MPHY2409T

PAPER NAME: ATOMIC AND MOLECULAR PHYSICS

Course Objectives: *The objectives of this course are to:*

1. *Introduce the principles of atomic structure and the spectra of hydrogen, alkali, and multi-electron atoms.*
2. *Develop an understanding of atomic coupling schemes, fine structure, Zeeman effect, and shell structure.*
3. *Familiarize students with the fundamentals of molecular spectroscopy, including rotational, vibrational, and Raman spectra.*
4. *Explain the origin and interpretation of electronic spectra and molecular energy transitions.*
5. *Provide a strong theoretical foundation in atomic and molecular spectroscopy for advanced study and research.*

Course Outcomes: *On completion of this course, student will be able to:*

1. *Understand the concept of spectrum of hydrogen, coupling scheme, Lamb shift.*
2. *Understand the concept of Larmor's theorem, Zeeman effect and anomalous g-value.*
3. *Understand the spectroscopy terms like rotational levels, infrared spectroscopy.*
4. *Know about Raman spectra.*
5. *Learn about electronic spectra, Deslandre's table, symmetry properties of electronic eigen-functions.*

Max. Marks: 80
Internal Assessment: 20
Written Examination: 60
Pass Marks: 35%

Total Credits: 4

Assessment Criteria:

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

edium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

Time Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

SECTION – A

Hydrogen and Hydrogen-like ions: Series in hydrogen, circular motion, nuclear mass effect, elliptical orbits, energy levels. Fine structure: basic facts and Sommerfeld theory, electron spin and spin-orbit coupling, relativistic correction and Lamb shift (qualitative).

Alkali-like Spectra: General features, doublet structure, Larmor's theorem and magnetic levels, elementary theory of weak and strong magnetic fields, Zeeman effect in doublet spectra: anomalous Zeeman effect and the anomalous g-value.

Pauli's principle and shell structure: Systems with several electrons and spin functions.

Complex Spectra: LS-Coupling scheme, normal triplets, basic assumptions of the theory, identification of terms, selection rules, jj- coupling (Qualitative).

SECTION – B

Infrared and Raman Spectra: Rigid rotator, energy levels, spectrum (no derivation of selection rules),

Harmonic oscillator: energy levels, eigenfunctions, spectrum, comparison with observed spectrum, Raman effect, Quantum theory of Raman effect, Rotational and Vibrational Raman spectrum. Anharmonic oscillator. energy levels, Infrared and Raman Spectrum, Vibrational frequency and force constants. Non-rigid rotator: energy levels, spectrum, Vibrating-rotator energy levels, Infrared and Raman spectrum (no derivation of Dunham coefficients), Symmetry properties of rotational levels, influence of nuclear spin.

Electronic Spectra: Electronic energy and potential curves, resolution of total energy, Vibrational Structure of Electronic transitions. General formulae, Deslandre's table, absorption sequences (qualitative) and Vibrational analysis, Rotational Structure of Electronic bands: General relations, branches of a band, band-head formation, Intensity distribution in a vibrational band system. Franck-Condon Principle and its wave mechanical formulation. Classification of electronic states: Orbital angular momentum, Spin, total angular momentum of electrons, Symmetry properties of electronic eigen-functions.

RECOMMENDED READINGS

Text Books:

1. Atomic Spectra: H. Kuhn (Longman Green) 1969.
2. Molecular Spectra and Molecular Structure I: G. Herzberg (Van-Nostrand Rein-hold), 1950.
3. Atomic Spectra: H.E. White (McGraw Hill) 1934.
4. Fundamentals of Molecular spectroscopy: Banwell and McCash (Tata McGraw Hill), 1994.
5. Molecular Spectroscopy: S. Chandra (Narosa), 2009.
6. Atomic. Molecular and Photons, Wolfgang Damtrodes (Springer), 2010.

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(PRACTICAL) PAPER CODE: MPHY2405P

PAPER NAME: LABORATORY PRACTICE

Course Objectives:

1. *Develop practical skills in performing advanced experiments in nuclear physics, condensed matter physics, and electronics.*
2. *Familiarize students with modern scientific instruments, detectors, electronic circuits, and data acquisition techniques.*
3. *Strengthen the ability to analyze experimental data, estimate errors, and interpret physical phenomena.*
4. *Enhance problem-solving and experimental design skills through hands-on laboratory investigations.*
5. *Prepare students for research and industrial applications by integrating theoretical concepts with experimental practices.*

Course Outcomes: *Students will thoroughly understand the theoretical concepts of Physics by experimentation.*

Max. Marks: 120
Internal Assessment: 30
Written Examination: 90
Pass Marks: 35% **Total Credits: 3**
Assessment Criteria:

Internal Assessment	Marks
	30
Seminar, viva-voce of experimental reports	12
number of experiments performed	12
Attendance	6

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

Out of 120 Marks, internal assessment (based on seminar, viva-voce of experimental reports, number of experiments performed and attendance) carries 30 marks, and the final examination at the end of the semester carries 90 marks.

The laboratories comprise of experiments based on **Nuclear Physics & Counter Electronics** in one group and **Condensed Matter Physics and advanced Electronics** in the other group. Each student will be placed in one of the two groups during the entire semester.

Note: Student must perform any 10 experiments from group 1 or group 2.

GROUP-I: NUCLEAR PHYSICS & COUNTER ELECTRONICS EXPERIMENTS

1. Study of standard deviation using G-M counter
2. Half-life of ^{40}K using G-M Counter
3. Measurement of mass absorption coefficient of beta rays in given materials

4. To find range and energy of β- particles
5. To find Dead time of a GM Tube
6. Study of energy calibration of NaI(Tl) scintillation detector
7. Study and analysis of spectrum of ^{137}Cs
8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer.
9. Study of Compton scattering law for energy of scattered photons
10. To study Internal Conversion Coefficient for ^{137}Cs (or suitable gamma source)
11. To determine the source strength of a given radioactive gamma source
12. Study and analysis of the spectrum of ^{60}Co
13. Photoelectric cross-section measurement for a given target material at known incident gamma photon energy
14. Compton cross-section measurement for known incident gamma photon energy
15. Measurement of Photo-peak (full energy peak) efficiency of Scintillation detector.
16. To verify the given Boolean identities on the ALU system.
17. To study various Encoders and Decoders, and Random Access Memory (RAM) circuit.
18. To study the various counters.
19. To study the left and right shift registers and ring counters.
20. To study the operation of multiplexer and demultiplexer circuits.

GROUP-II: CONDENSED MATTER PHYSICS AND ADVANCED ELECTRONICS EXPERIMENTS

1. Find the value of the 'g' factor in a DPPH sample by using ESR technique.
2. To determine the Curie temperature of a given PZT sample.
3. Determine the coercivity, retentivity and saturation value of magnetic induction of the given sample by studying the B-H loop.
4. Determine the Hall coefficient of the given sample and hence find the carrier concentration and mobility.
5. Find the band gap energy of the given semi-conductor sample by four probe method.
6. Measurement of susceptibility of paramagnetic solutions by Quinck's Tube Method.
7. Measurement of magneto-resistance of a semi-conducting sample.
8. Study of Dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.

study of solar cell and characteristics

Measurement of wavelength, frequency, VSWR and Reflection coefficients of microwaves.

Determination of velocity of ultrasonic wave in liquids hence to find the compressibility.

Frank Hertz experiment for Quantization of Bohr's model of atom.

To study Digital to Analog Converter and Analog to Digital Converter.

To study multivibrators (astable, monostable and bistable) using discrete components.

To study the multivibrators (BMV, AMV and MMV) using IC-555.

To study Timer Integrated circuit IC-555.

To study the basic operational amplifier (Model 741).

To study the applications of operational amplifier (Model 741).

To study the voltage controlled oscillator (VCO).

To study the voltage regulator using IC 317

Programming with Microprocessor training kit (8085 processor)

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(PRACTICAL) PAPER CODE: MPHY2406P
PAPER NAME: COMPUTER LAB

Objectives: *The objectives of this laboratory course are to:*

- *Develop fundamental programming skills for solving basic scientific and mathematical problems.*
- *Introduce computational techniques for numerical calculations and data analysis in physics.*
- *Enhance logical thinking and algorithm development through programming exercises.*
- *Familiarize students with computer-based simulation of simple physical systems.*
- *Build a foundation for advanced computational methods used in physics and scientific research.*

Outcomes: *Students will be able to write programs for solving Physics problems and gain expertise in cation of calculations etc.*

Marks: 60
Assessment: 15
Examination: 45
Marks: 35%

Total Credits: 1

Assessment Criteria:

Internal Assessment	Marks
	15
Seminar, viva-voce of experimental reports	6
Performance of the candidate in the computer lab	6
Attendance	3

Medium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

Out of 60 Marks, internal assessment (based on performance of the candidate in the computer lab and attendance) carries 15 marks, and the final examination at the end of the semester carries 45 marks.

This laboratory comprises of any ten of the following physics problems to be solved using Python.

1. To generate Frequency Distribution Table.
2. Solution of a differential equation by RK2 method.
3. To find area under a curve by Trapezoidal Rule and Simpson's Rule
4. Gauss elimination method.
5. Multiplication of Two Matrices.
6. Motion of Projectile thrown at an Angle.

7. Numerical Solution of Equation of Motion.

8. Simulation of planetary motion.

9. Root of an equation by Newton- Raphson method.

10. Sorting numbers by selection sort.

11. Solution of a differential equation by RK4 method.

12. Fitting straight line through given data points.

13. Roots of an equation by secant method.

14. Newton interpolation.

Guru Nanak College, Budhlada

(Autonomous College, Punjabi University Patiala)

(THEORY) PAPER CODE: MPHY2410T
PAPER NAME: Open Elective Subject

Course Outcomes: *On the completion of this course student will be able to understand concepts of a subject of his own interest.*

ax. Marks: 80
ernal Assessment: 20
itten Examination: 60
ss Marks: 35%
sessment Criteria:

Total Credits: --

Internal Assessment	Marks
	20
Performance in Mid-Semester Test	8
Assignment/Project/Seminar	8
Attendance	4

dium of Instruction: English

INSTRUCTIONS TO THE PAPER SETTER:

The question paper will consist of 3 sections: A, B and C. Sections A and B will have four questions each from respective sections of the syllabus and carry 10 marks each. Students have to attempt any two questions from Section A and B. Section C will consist of 10 short answer type questions which will cover the entire syllabus uniformly and carry 2 marks each. Questions should be evenly spread over the entire range of syllabus. In no case, question should be asked from outside the syllabus. The question paper should be set strictly according to the instructions mentioned above.

INSTRUCTIONS TO BE GIVEN IN THE QUESTION PAPER

me Allowed: 3 hours

Max. Marks: 60
Pass Marks: 35%

Note:

1. Answer five questions in all, selecting at least two questions from each section. The question in section C is compulsory.
2. Questions in sections A and B carry 10 marks each. The questions in section C carry 2 marks each.

Note: Open Elective Subject shall be optional for all students. The students opting this paper are required to qualify this paper. The marks obtained will not add to the Grand total of the course. This paper will be, of 4 hours per week, from the Open Elective Subjects offered by other departments.

or

One of the on-line Open Elective Subject (Not discarded by Physics Department) offered at web-site: swayam.gov.in