# Gujarat University

## M. Sc. (Physics) Semester - I
## (Effective from: 2016-2017)

| Course | Name of the Course | Lect. Hrs. / Week | Internal Marks | External Marks | Total Marks | Course Credits |
|---|---|---|---|---|---|---|
| PHY-401 | Quantum Mechanics-I & Mathematical Physics-I | 4 | 30 | 70 | 100 | 4 |
| PHY-402 | Classical Mechanics-I & Statistical Mechanics | 4 | 30 | 70 | 100 | 4 |
| PHY-403 | Electrodynamics-I & Programming in C | 4 | 30 | 70 | 100 | 4 |
| PHY-404 | Solid State Physics & Electronics-I | 4 | 30 | 70 | 100 | 4 |
| PHY-405PR<br>PHY-406PR | Practicals<br>Practicals | 12 | 60 | 140 | 200 | 8 |
| **TOTAL** | | **28** | **180** | **420** | **600** | **24** |

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## PHY – 401: Quantum Mechanics-I & Mathematical Physics-I

The study of Quantum mechanics and mathematical physics help to understand almost all the modern branches of physics. Both are consider to be language of physics. The syllabus is tuned with the topics of SET / CSIR-NET model syllabus.

**UNIT – I: Approximation Methods for Stationary States & The variation method**

Approximation Methods for Stationary States: Perturbation theory for discrete levels, Equations in various orders of perturbation theory, Non - degenerate case, Degenerate case - removal of degeneracy, Effect of an electric field on the energy levels of an atom (Stark effect), Two - electron atoms. Illustrative examples

The variation method: Upper bound on ground state energy, Applications to excited states, Trial function linear in variational parameters, The Hydrogen molecule, Exchange interaction. Illustrative examples

**UNIT- II: WKB Approximation & Evolution with time**

WKB Approximation: One - dimensional Schrodinger equation, Bohr -Sommerfeld quantum condition, WKB solution of the radial wave equation.

Evolution with time: Exact formal solutions: Propagators, Schrodinger equation: general solution, Propagators, Alteration of Hamiltonian, transitions and sudden approximation. Illustrative examples

**UNIT-III: Integral transform**

Introduction, Laplace transforms, Solution of differential equations by Laplace transform, Convolution, Inverse Laplace transforms, Applications of Laplace Transform for different physical problems.

**UNIT-IV: Group theory & Tensor**

Group theory: Group, subgroups and classes, Invariant sub groups, factor groups, Homomorphism and Isomorphism, Group representation, Reducible and irreducible representation, Schur's Lemmas, orthogonality theorem, Character of a representation, Character tables, Decomposing a reducible representations into irreducible ones, Construction of representation, Representations of groups and quantum mechanics.

Tensor**:** Introduction, n - dimensional space, superscripts and subscripts, Coordinate transformations, Indicial summation conventions, Dummy and Real indices, Kronekar delta symbol, Scalars, Contravariant vectors and covariant vectors, Tensors of higher ranks, Algebraic operations, Symmetric and Antisymmetric tensors, Invariant tensors, Conjugate and reciprocal tensors, Relative and absolute tensors, Line element and matrix tensor, Fundamental tensors.

**Reference books:**


1. P.M. Mathews and K Venkatesan, A text book of Quantum Mechanic, Tata MC Graw - Hill publishing company Limited.
2. Schiff. L. I, Quantum mechanics, Tata MC Graw - Hill publishing company Limited.
3. G. Aruldhas, Quantum mechanics, Prentice - Hall of India
4. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and applications, Macmillan India Limited.
5. Boas M.L., Mathematical methods in the physical sciences, JW, 1966
6. Chattopadhyaya P.K., Mathematical Physics, Wiley Eastern Ltd.
7. Arfken G., Mathematical methods for Physicists, Academic Press, 1970

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## PHY – 402: Classical Mechanics-I & Statistical Mechanics

Classical mechanics: The study of classical mechanics gives insight to understand some fundamental laws of physics in the classical domain. This gives basic understanding to develop such laws of physics in quantum physics.
Statistical mechanics is a core course at the post graduate physics syllabus. The present syllabus is in continuation with undergraduate course and carries some of the advanced topics of the subject. The syllabus covers all the advanced topics of CSIR-NET model syllabus.

**UNIT – I: Canonical Transformation**
Canonical transformation and Hamilton Jacobi theory: Gauge transformation, Canonical transformation, condition for transformations to be Canonical.

Poission bracket, canonical equations in terms of Poisson bracket notation, Relation between infinitesimal transformation and Poisson brackets, The Hamilton Jacobi equations, Separation of variables, Action angle variables, Properties of action angle.

**UNIT – II: Theory of small oscillations**
General case of coupled oscillations, Eigen vectors and eigen frequencies, orthogonality of eigen vectors, normal coordinates, small oscillations of particles on string

**UNIT – III: Fluctuations**
Brownian motion, Langevin theory of random motion, Time dependence of fluctuations, Power spectrum of fluctuation, Persistence and correlation of fluctuation, Wiener - Khinching theorem, Johnson noise - Nyquist theorem, Shot noise

**UNIT-IV: Critical phenomena and phase transitions**
Phase transitions, Condition for phase equilibrium, First order phase transition, Clusius - Clayperon equation, Second order phase transition, The Critical exponent, Co - operative processes, Curie - Weiss theory of Magnetic transition, Ising Model, Ising Model in zeroth approximation, Exact solution of one dimensional Ising Model, Order parameters

**Reference books:**

1. Takwale R.G. and P. S. Puranik, Introduction to Classical Mechanics, TMH, 1979
2. Goldstein H., Classical Mechanics, Addision Wesley
3. Bhatia A. B., Classical Mechanics, Narosa Pub. Co.
4. Statistical Mechanics - Theory and Applications by S.K. Sinha, Narosa Publishing House, New Delhi.
5. Statistical Mechanics and Properties of Matter by E.S. Raja Gopal, Mc Millan Company of India Limited.
6. Statistical Mechanics - An Introduction by Evelyn Guha, Narosa Publishing House
7. Statistical Mechanics by R.K. Patharia, Pergamon Press
8. Funadamentals of Statistical Mechanics by F. Reif, Mc Graw Hill Companies
9. Statistical Mechanics by R.K. Srivastava & J.Ashokm Printice Hall of India
10. Fundamentals of Statistical Mechanics by John D. Walecka, World Scientific
11. Landau and Lifshitz, Landau theory of phase transition Statistical Physics

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## PHY – 403: Electrodynamics-I & Programming in –C

Here in the first unit the boundary effects on the propagation of electromagnetic waves will be examined. In the second unit the behavior of electromagnetic waves in the vicinity of the boundaries of the waveguides will be studied. The most efficient way of transmitting energy over short distances is by using wave guides. They have practical importance in electronic and in optical communication systems.

Units III & IV of C- Programming Language:

(i) Provides basic understanding of control structures such as if, switch, while, for, continue and break.

(ii) Provides concepts of arrays and discusses the array handling techniques

(iii) Describes use of functions, various category of functions and variables

(iv) Write programs using different logics based on above concepts.

**UNIT – I: Electromagnetic waves in Matter**

Propagation in linear media, Reflection and transmission of plane waves at normal incidence, Reflection and transmission at oblique incidence, Total internal reflection, reflection from the surface of a metal, The frequency dependence of permittivity, Illustrative examples.

**UNIT-II: Waveguides**

Propagation of waves between conducting planes, Waves in guides of arbitrary cross- section, waveguide of rectangular cross section, co-axial waveguides, resonant cavities, dielectric waveguides, Illustrative examples.

**UNIT- III: Programming in C**

Keywords, Identifiers, Constants, Variables, Data Types, Operators, Expressions, Precedence and Associativity of operators, Type conversions, I/O operations

Branching: if, simple if, if-else, nesting of if-else, else if ladder, switch, conditional operator

Looping: while, do while, for, continue and break, goto.

**UNIT- IV: Programming in C**

Arrays: One dimensional arrays, declaration and initialization of arrays, two dimensional and multi-dimensional arrays

Character strings: Declaration and initialization of string variables, reading and writing of strings, arithmetic operations on characters, concatenation, comparing, copying and finding length of strings, string handling functions, table of strings

**Reference books:**


1. Griffiths, Introduction to electrodynamics, Prentice Hall India Ltd. ($2^{nd}$ ed.)
2. Laud B. B., Electromagnetics, Wiley Eastern, ($2^{nd}$ ed.)
3. E. C. Jordan and K. G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall of India, New Delhi, 1976
3. Balagurusamy E, Programminng in ANSI-C (IInd.Ed.), TMH Pub.
4. P.Day and M.Ghosh, Programming in C, Oxford University press, 2007
5. Gottfried B. S, Programming with C
6. Kenetker Y, Let us C, BPB Pub.
7. Kernighan B.W and Ritchie D.K C programming language, PH pub.

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## M. Sc. (Physics) Semester - I
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## PHY – 404: Solid State Physics & Electronics-I

Most of the solid matter is crystalline i.e. nature favours the crystalline state of solids. Thus study of the solid state physics helps to understand many phenomena of physics, like crystal bonding, lattice vibration defects and superconductivity.

By studying the topics on power amplifiers students will know about the types of the large signal amplifiers their merits and demerits. They also learn to analyze the large signal amplifiers. To make students familiar with the types of multivibrators, their working and applications topic of multivibrators is introduced. Some basic characteristics and applications of operational amplifiers are studied by the students at undergraduate level. In continuation of this study some more applications and characteristics of the operational amplifiers are introduced here.

**UNIT-I: Energy Bands**

Introduction, Nearly Free Electron Model, Origin of energy gap, Magnitude of the energy gap. Bloch Functions, Kronig-Penney Model, Wave Equation of Electron in a Periodic Potential**,** Restatement of the Bloch theorem, crystal momentum of an electron, solution of the central equation, empty lattice approximation, Approximate solution Near Zone Boundary, Number of orbitals in a band, Metals and Insulators.

**UNIT-II: Fermi Surfaces and Metals**

Introduction, Reduced zone scheme, Periodic zone scheme, construction of Fermi surfaces, electron orbits, hole orbits and open orbits, Calculations of energy bands, Tight binding method for energy bands, Wigner -Seitz method, cohesive energy, Pseudopotential method, Experimental methods in Fermi Surface studies**,** Quantization of orbits in a magnetic field, de - Haas - Van Alphen Effect, Extremal orbits, Magnetic breakdown.

**UNIT – III: Power Amplifiers & Multivibrators**

Power Amplifiers: Class - A large signal amplifiers, transformer coupled Class - A amplifier, second harmonic distortion, push - pull Class - A amplifier, Class - B Push - Pull amplifiers.

Multivibrators: Astable, Monostable, Bistable Multivibrators and Schmitt Trigger circuits using transistors. (With analysis)

**UNIT-IV: Operational Amplifiers & Its Applications**

Frequency compensation and slew rate, DC and AC amplifiers, Integrator and differentiator, Voltage to current and current to voltage converter, Bridge amplifier, electronic analog computation, sine, square, triangular and saw tooth wave generators, Schmitt trigger.

**Reference books:**


1. Kittle C., Introduction to Solid State Physics, 7th edition Wiley Eastern Limited, New Delhi
2. J.P.Srivastava: Elements of solid state physics, PHI, India.
3. Millman and Halkias, Integrated Electronics, International Students Edition.
4. John D. Ryder, Electronic fundamental and Applications, Prentice Hall, 5th edition, 1992.
5. Allen Mottershed, Electronic Devices and Circuits, Prentice Hall.
6. Gupta and Kumar, Handbook of Electronics, Pragati Prakashan, Merut,
7. Bapat Y. N., Electronic Devices and Circuits, Tata McGraw Hill Publishing Co., New Delhi.
8. Ramakant A. Gayakwad., : OPAMPS & Linear Integrated Circuits; PHI publication.

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## PHY – 405PR and PHY – 406PR : Practicals

1. Ultrasonic Interferometer
2. Phonon dispersion relation using Lattice dynamics kit
3. Efficiency of a G.M. Counter
4. Performance of a vacuum pump and verify Gaede's equation
5. OPAMP parameters
6. OPAMP as an inverting / non-inverting amplifier
7. Universal gates (NAND and NOR)
8. RC Phase shift oscillator
9. Astable multivibrator
10. Diagonalization of Symmetric matrix (3x3).
11. Regulated Power Supply
12. C- programming
13. Characteristics of Optoelectronics devices
14. Study of Numerical Aperture using Fiber Optics kit
15. Study of Electron Spin Resonance

15% of new experiments can be introduce AND / OR replace as per the need, with the permission of the Chairman of Board of studies.