Faculty of Science

# Department of Physics

Proposed Syllabus

for

## M.Sc. in Physics

From Academic Year 2019-2020

Submitted

to

Academic Council

of

Anekant Education Society's

**TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE AND COMMERCE, BARAMATI**

**(Autonomous Status)**

(Affiliated to Savitribai Phule Pune University, Pune)

# INDEX

## PREAMBLE

Physics, a core discipline, is the fundamental and foremost to all natural sciences. It has been significant and influential through advances in its understanding that have translated into new technologies. Physics interact with the society and other discipline such as Medicine, Chemistry, Agriculture, Engineering etc. in many important ways. Physics department in Tuljaram Chaturchand College has highly qualified faculty members and support staffs and is committed towards the development of innovative and handy ways of teaching at graduate, post graduate and developing a core research group for carrying out cutting edge research in various research fields like Condensed Matter Physics, Solid State Physics, Electronics, Theoretical Physics, Atomic & Molecular Physics and Nuclear Physics. The department also offers Doctoral Programme in order to nurture young minds towards embracing various scientific challenges. Extra care is taken to pay individual attention to the students in their laboratory work and tutorial sessions. Project work and problem sessions are encouraged to develop innovative and analytical approach to physics learning.

## GOALS

The goal of the Physics education is to provide the student with a broad understanding of the physical principles of the universe, to help them develop critical thinking and quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments. It's provide training for students and planning careers in physics including research, teaching, industrial jobs, government jobs or other sectors of our society.

## OBJECTIVES

1. To endow with a conducive and friendly environment that nurtures excellence and high standards of professionalism in teaching, learning and research.
2. To augment the level of participation in research, dissemination and preservation of knowledge for both academic and social development.
3. Prepare the student in assets of Physics and the principles of analytical methods required for the conclusion of physical tests.

4. Provide an opportunity for students to deepen his/her knowledge in the branches of Physics so that views on the outskirts of contemporary science.
5. Training the students on the way of scientific research and enable it to contribute to it under the supervision.
6. Continued development of faculty members by sending them for training courses so as to maintain a high degree of efficiency and performance.
7. Support and encourage the scientific cooperation between faculty members in the department and co-operation with other departments in the field of multi-purpose research.
8. Spread the spirit of competition and encouragement and give the opportunity to all members.
9. Preparation of national cadres by basic physics and knowledge that contribute to community service.
10. To establishes collaborations with other eminent institution.

Proposed Structure of M.Sc. degree in Physics and syllabus for first year degree in Physics as follows:

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# M.Sc I & II Proposed Syllabus Structure

## M.Sc-I

## Semester-I

| Course Number | Course Code | Course Name | Credit |
|---|---|---|---|
| 1 | PHY4101 | Mathematical Methods in Physics | 4 |
| 2 | PHY4102 | Classical Mechanics | 4 |
| 3 | PHY4103 | Quantum Mechanics-I | 4 |
| 4 | PHY4104 | Electronics | 4 |
| 5 | PHY4105 | Electronics Laboratory | 4 |
| | | | 20 |

### Semester-II

| Course Number | Course Code | Course Name | Credit |
|---|---|---|---|
| 6 | PHY4201 | Physics of Semiconductor Devices | 4 |
| 7 | PHY4202 | Atoms, Molecules & Laser | 4 |
| 8 | PHY4203 | Quantum Mechanics-II | 4 |
| 9 | PHY4204 | Electrodynamics | 4 |
| 10 | PHY4205 | Basic Physics Laboratory | 4 |
| | | | 20 |

# M.Sc-II

## Semester-III

| Course Number | Course Code | Course Name | Credit |
|---|---|---|---|
| 11 | PHY5301 | Statistical Physics | 4 |
| 12 | PHY5302 | Solid State Physics | 4 |
| 13 | PHY5303 | CB Group –I<br>1) Physics of thin films-I<br>2) Electronic Instrumentation-I<br>3) Biomedical Instrumentation-I | 4 |
| 14 | PHY5304 | CB Group –II<br>1) Laser-I<br>2) Nano-technology-I<br>3) Energy Studies-I<br>4) Microcontroller– I | 4 |
| 15 | PHY5405 | Special Lab-I | 4 |
| 16 | PHY5406 | Project-I | 2 |
| | | | 22 |

**Semester-IV**

| Course Number | | Course Name | Credit |
|---|---|---|---|
| 17 | PHY5401 | Nuclear & Particle Physics | 4 |
| 18 | PHY5402 | Material Science | 4 |
| 19 | PHY5403 | CB Group –III<br>1) Physics of thin films-II<br>2) Electronic Instrumentation-II<br>3) Biomedical Instrumentation-II | 4 |
| 20 | PHY5404 | CB Group –IV<br>1) Laser-II<br>2) Nano-technology-II<br>3) Energy Studies-II<br>4) Microcontroller– II | 4 |
| 21 | PHY5405 | Special Lab-II | 4 |
| 22 | PHY5406 | Project-II | 2 |
| | | | 22 |

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**TULJARAM CHATURCHAND COLLEGEOF ARTS, SCIENCE AND COMMERCE, BARAMATI**

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**Course Structure for M.Sc I Physics**

## Semester-I

| Course Number | Course Code | Course Name | Credit |
|---|---|---|---|
| 1 | PHY4101 | Mathematical Methods in Physics | 4 |
| 2 | PHY4102 | Classical Mechanics | 4 |
| 3 | PHY4103 | Quantum Mechanics-I | 4 |
| 4 | PHY4104 | Electronics | 4 |
| 5 | PHY4105 | Electronics Laboratory | 4 |
| | | | 20 |

## Semester-II

| Course Number | Course Code | Course Name | Credit |
|---|---|---|---|
| 6 | PHY4201 | Physics of Semiconductor Devices | 4 |
| 7 | PHY4202 | Atoms, Molecules & Laser | 4 |
| 8 | PHY4203 | Quantum Mechanics-II | 4 |
| 9 | PHY4204 | Electrodynamics | 4 |
| 10 | PHY4205 | Basic Physics Laboratory | 4 |
| | | | 20 |

**M. Sc-I (Physics)**

**MATHEMATICAL METHODS IN PHYSICS**

**Credit: 04** **Total No. of Lectures: 60**

**Unit 1: Matrix Algebra** **(15L)**

Introduction, Matrix representation, Rank of matrix, Similarity transformations, Eigen values and eigenvectors, Inner product, Orthogonality, Gramm-Schmidt orthogonalization procedure, Self adjoint and Unitary transformations, Eigen values & eigenvectors of Hermitian & Unitary transformations, Diagonalization, Problem Solving.

**Unit 2: Basic Mathematical Methods and Linear vector spaces** **(15L)**

Introduction, Plotting of graph, curve fitting, data analysis, Elementary probability theory, random variables, binomial, Poisson and normal distributions, Calculus: vector algebra and vector calculus. Linear algebra. Elementary complex analysis. Vector spaces and subspaces, Linear dependence and independence, Basis and Dimensions, linear operators, Problem Solving.

**Unit 3: Fourier series and Integral transforms** **(15L)**

Introduction, Fourier Series : Linear differential equations, Definition, Dirichlet's condition, Convergence, Fourier Integral and Fourier transform, Convolution theorem, Parseval's identity, Applications to the solution of differential equations, Laplace transform and its properties, Fourier transform & Laplace transform of Dirac Delta function, Introduction to Gamma and Beta Integral, Problem Solving.

**Unit 4: Complex Analysis** **(15L)**

Introduction, Elements of complex analysis: residues and evaluation of integrals; Introduction & types of tensors, Introductory group theory. Elements of computational techniques: roots of functions, interpolation, extrapolation, integration by trapezoid and

Simpson's rule, solution of first ODE using Runge-Kutta method; Finite difference methods, Problem Solving.

**Reference Books:**


1. Complex Variables and Applications – J. W. Brown, R. V. Churchill – (7th Edition) - Mc-Graw Hill
2. Complex Variables – Seymour Lipschutz
3. Mathematics for Physical Sciences – Mary Boas, John Wiley & Sons
4. Mathematical methods in Physics – B. D. Gupta
5. Linear Algebra – Seymour Lipschutz, Schaum Outlines Series- Mc-Graw Hill edition
6. Matrices and Tensors in Physics, A. W. Joshi, 3rd Edition, New Age International
7. Mathematical methods for Physicists – Arfken & Weber – 6th Edition-Academic Press- N.Y.
8. Mathematical methods in Physics – Satyaprakash
9. Fourier Series - Seymour Lipschutz, Schaum Outlines Series
10. Laplace Transform - Seymour Lipschutz, Schaum Outlines Series 11. Fourier Series and Boundary value problems - R. V. Churchill, McGraw Hill

11.Mathematical physics, Rajput, Pragati prakashan

12 Mathematical physics, H. K. Dass

**M. Sc-I, Sem -I [Physics]**
**Classical Mechanics**

**Credit: 04** **No. of Lectures: 60**

**Unit 2: Constrained Motion and Lagrangian formulation** **(15 L)**

Constrained Motion, Constraints and their Classification**,** Degrees of freedom, Generalized coordinates, Virtual Displacement, Principle of Virtual Work, D'Alembert Principle, Configuration space, Lagrange's equation of motion, Theorem on total energy, Cyclic coordinates, Generalized momenta, Invariance under Galilean transformation.

**Problems solving**.

**Unit 2: Hamilton's formulation & Variational Principle** **(15 L)**

Hamilton's function and Hamiltonian equation of motion, Phase space, Jacobi integrals and energy conservation, Lagrangian and Hamiltonian of relativistic particles and light rays, Variational principle, Euler's equation, Applications of Variational principle, Concept of symmetry.

**Problems solving**.

**Unit 3: Canonical Transformations and Poisson's Bracket** **(15 L)**

Introduction- Background and definition, Legendre transformations, Generating function, Conditions for canonical transformation, Poisson's bracket-definition, identities, Poisson's theorem, Jacobi Poisson theorem, Jacobi identity, Invariance of Poisson Bracket under canonical transformation.

**Problems solving.**

**Unit 4: Central Force** **(15 L)**

Introduction, definition and properties of Central Force, Two body central force problem, Stability of orbit, Orbits of artificial satellite, Keplers problem, Inertial forces in rotating frame, Coriolis force and its effect, Foucault's pendulum, Virial theorem.

**Problems solving.**

**Reference Books:**


1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House.
2. Classical mechanics by N.C. Rana and P.S. Joag, Tata Mc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V. Panat, Narosa publishing Home, New Delhi.
4. Classical Mechanics by Kumar, Gupta, Sharma.
5. Classical Mechanics by H. Goldstein, Narosa Publishing Home, New Delhi.
6. Classical Mechanics by D. S. Mathur.
7. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
8. Classical Dynamics of Particles and Systems by Marion and Thomtron, Third Edition, Horoloma Book Jovanovich College Publisher.
9. Analytical Dynamics E.T. Whittaker, Cambridge, University Press.

**M. Sc-I [Physics]**

## PHY4103: QUANTUM MECHANICS- I

**Credit: 04** **Total No. of Lectures: 60**

**Unit 1: Revision and general formalism** **(15 L)**

**Revision: Why QUANTUM MECHANICS?**

Introduction, Inadequacy of classical Physics, wave packets and uncertainty relations. Schrodinger wave equation and probability interpretation, Simple one dimensional problems: potential well, potential barrier and simple harmonic oscillator (1-D, 3-D), Applications of Schrodinger steady state equation: Free particle, Particle in infinitely deep potential well, Barrier penetration and tunneling effect (1-D, 3-D), Particle in three dimension rigid box, Step potential. Spherically symmetric potentials: Schrodinger's equation in spherical polar co-ordinate system. Rigid rotator, Hydrogen atom, Problem solving.

**Formalism of quantum mechanics:**

**Hilbert space and wave function**: The linear Vector Space, Hilbert's Space, Dimension and Basis of vector Space, Square Integral Functions: Wave functions, Dirac's bra and ket notation, **Dynamical variables and linear operators:** projection operators, unit operator, unitary operator, matrix representation of an operator: Change of basis, unitary transformation, Adjoint and self adjoint operators, eigen functions and eigen values, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigen values, eigen functions and expansion coefficients, Eigen values and Eigen functions of momentum operator. Eigen values and Eigen functions of simple harmonic oscillator by operator method.

**Unit 2: Postulates of quantum mechanics:** **(15 L)**

**Basic Postulates of Quantum Mechanics**: The state of System: Probability density, The superposition principle, Observables and operators: Measurement in **Quantum Mechanics**, Time Evolution of the System's State, Symmetries and Conservation Laws, Connecting Quantum Mechanics to Classical Mechanics.

**Unit 3: Angular Momentum** **(15 L)**

Orbital Angular Momentum, General formalism of Angular Momentum, Matrix representation of Angular Momentum, Geometrical Representation of Angular Momentum, Spin Angular Momentum, Eigen function of Angular Momentum: Eigen values and eigen functions of $L^2$ and $L_z$ operators, ladder operators $L_+$ and $L_-$ (Harmonic Oscillator), Pauli's theory of spins (Pauli's matrices) , matrix representation of J in |jm> basis. Rotations in Quantum Mechanics: Infinitesimal rotations, finite rotations, properties of rotations, Eular rotations, Representation of rotation operator, Rotation matrices and Spherical harmonics. Addition of angular momenta: general formalism, Computation of Clebsch-Gordon coefficients in simple cases ($J1= \frac{1}{2}$, $J2 = \frac{1}{2}$), Scalar, Vector and Tensor operator, Wigner-Eckart Theorem.

**Unit 4: Approximation Methods** **(15 L)**

Time-independent Perturbation theory: Non degenerate and degenerate perturbation, Stark effect, anharmonic oscillator, Zeeman Effect, Time dependent Perturbation theory: Transition amplitude 1st and 2nd order, Introduction to WKB approximation, Variational method: Basic principles and applications to particle in box, simple harmonic oscillator.

**Reference Books:**

1. Quantum Mechanics by Nouredine Zettili, A John Wiley and Sons, Ltd.
2. Modern Quantum Mechanics by J. J. Sakurai.
3. A Text-book of Quantum Mechanics by P. M. Mathews and K. Venkatesan.
4. Quantum mechanics by A. Ghatak and S. Lokanathan.
5. Quantum Mechanics by L. I. Schiff.
6. Quantum Physics by R. Eisberg and R. Resnick.
7. Introduction to Quantum Mechanics by by David J. Griffiths.
8. Introductory Quantum mechanics by Granier, Springer Publication.

9. Introductory Quantum Mechanics by Li boff, 4th Edition, Pearson Education Ltd.
10. Principles of Quantum Mechanics by Shankar R. IInd Edition (Plenum, 1994).

**M. Sc-I [Physics]**

**Electronics**

**Credit: 04** **No. of Lectures: 60**

**Unit 1: Study and applications of Operational Amplifiers (15L)**

Concept of input/output impedance, Input bias current, offset input voltage, slew rate, CMMR, Gain, frequency response, Applications of Operational Amplifiers: Inverting and Non-inverting amplifier, Adder and Substractor, Integrator and Differentiator, Active filters: LPF, HPF, BPF, and Notch filter 1st and 2nd order with designing, Instrumentation Amplifier, Function Generator – Square wave, triangular, saw tooth, sine wave. Half wave and full wave precision rectifiers. Sample and hold circuits.

**Unit 2: Communication Electronics (15L)**

Basic principle of amplitude, frequency and phase modulation, Simple circuits for amplitude modulation and demodulation, Digital modulation (PCM) and demodulation, Fundamentals of optical communication, Microwave Oscillators (reflex, klystron, magnetron and Gunn diode), Radio detector.

**Unit 3: Digital Logic circuits (15L)**

Combinational Logic: Review of Boolean identities and its use to minimize Boolean Expressions. Minimization of Boolean Expressions using Karnaugh map: SOP and POS Sequential Logic, Flip-flops: RS, JK, MS-JK, D and T, Shift registers using IC 7495: Applications as SISO, SIPO, PISO, PIPO, Counters: Review of synchronous, asynchronous and combinational counters, Decade counter IC 7490 with applications, Up-down counter

**Unit 4: Data Converters (15 L )**

Digital to analog Converters, Binary weighted type, R-2R ladder, Study of IC 0808, Analog to digital converters, Single slope, Dual slope, Flash/Simultaneous type, Counter type, Successive approximation type.

**Reference Books:**


1. Operational Amplifiers – G.B.Clayton (5th edition ) Newnes
2. Operational Amplifiers Applications – G.B.Clayton
3. Electronic Principles – A. P. Malvino (TMH Publication)
4. Op-amps and Linear Integrated circuits – Gayakwad (Prentice Hall)
5. Linear Integrated circuits – D.Roy Choudhury, Shail Jain
6. Integrated circuits – Botkar
7. Digital Principles and Applications : Leach and Malvino
8. Data Converters – B.S. Sonde.

# M. Sc.-I (SEM-I)
## PHY410: Electronics Laboratory
**(Any 10 Experiments)** **4-Credits**

1. Precision rectifier.
2. Voltage to Frequency / Frequency to voltage converter using OP-AMP.
3. Diode pump using UJT.
4. DAC (R-2R and Binary type for 4-bit).
5. Active filter- Low pass, High pass, Band pass, and Notch Filter using OP-AMP.
6. Function generator using OP-AMP/IC –8038.
7. Study of optocoupler, MCT2E and their application
8. Constant current source using OP-AMP.
9. Crystal oscillator
10. Study of Clocked RSFF and DFF Using NOR/NAND gates.
11. Instrumentation Amplifier.
12. Sample and hold circuits.
13. Decade counter 7490.
14. Shift Register using 7495.
15. Analog to Digital Converter using ADC 0808.
16. Amplitude/ Frequency Modulation and Demodulation.

**M. Sc-I [Physics]**

## PHY4201: Physics of Semiconductor Devices

**Credit: 04** **No. of Lectures: 60**

**Unit 1: Properties of Semiconductors (15L)**

An introduction to semiconductors, their crystal structure and their band structure. Intrinsic and extrinsic semiconductors. Charge carriers and their effective masses. Carrier concentration at thermal equilibrium for intrinsic and doped semiconductors, Carrier energy distribution, applications of Fermi factor to semiconductors, Density of available states, Excess carriers, carrier transport phenomena, Recombination Process, Basic equation for semiconductor device operation.

**Unit 2: PN Junction (15L)**

Basic device technology, Depletion region and depletion capacitance, Current Voltage Characteristics: Ideal case, Shockley Equation, Generation recombination process. High injection condition, Diffusion capacitance, Narrow base diode, Junction breakdown.

**Unit 3: Junction Transistor & Field Effect Devices (15L)**

Formation of transistor, Basic current Voltage relationship, Current gain in transistor, Injection efficiency, base transport factor, Depletion layer and surface recombination, Static characteristics common base and common emitter configurations, Power transistor, General consideration, second breakdown switching transistor, Schottky diode, Semiconductor controlled rectifier, Basic characteristics static characteristics, Dynamic characteristics, Current limiter.

**Unit 4: Metal Semiconductor & Metal Insulator Semiconductor Devices (15L)**

Schottky effect, Energy Band relation at metal semiconductor contact, Ideal condition and surface states depletion Layer, General expression for barrier height Current, Transport Theory in Schottky barrier, Thermionic Emission Theory, Diffusion theory, Measurement of Schottky barrier height current voltage measurement, Forward characteristics, Reverse characteristics.

**Reference Books:**


1. Physics of Semiconductor Devices – S.M. Sze
2. Physics Solid State Devices – Streetman B.B.
3. Semiconductor Physics – Smith
4. Fundamentals of Semiconductor Devices – J. Lindmayer and C.Y. Wrigley
5. Physics of Semiconductor Devices – Michael shur
6. Introduction to Semiconductor devices – K.J.M. Rao

**M. Sc-I [Physics]**

## PHY4202: ATOMS, MOLECULES & LASER

**Credit: 04** **No. of Lectures: 60**

**Unit 1: Atoms** **(15L)**

Introduction, Atomic structure and spectra, quantum states of an electron in an atom, [Exclusion principle and electronic configuration, electron spin, Hund's rule, Maximum multiplicity], Coupling scheme, origin of spectral lines, spectrum of He and alkali atoms, fine and hyperfine structure, isotropic shift, Zeeman and Paschen effect, Stark effect, Selection rule, Problem solving.

**Unit 2: Molecules and Resonance Spectroscopy** **(15L)**

Introduction, Origin of molecule spectra, Rotational and vibrational spectra for diatomic molecule, vibrational course structure, frank-condon principle, Born–Oppenheimer approximation, electron spectrum and Raman spectrum in diatomic molecule, Electron Spin Resonance (ESR) and Nuclear Magnetic Resonance (NMR) chemical shift , Problem solving.

**Unit 3: Lasers.** **(15L)**

Introduction, Basic of LASERs (Absorption, spontaneous & Stimulated emission, population inversion), metastable state, Types of Pumping, Gain, Einstein's coefficient, threshold condition, Rate equations for Two level, Three level and Four level laser, rate equation, Problem solving.

**Unit 4: Lasers and its applications.** **(15L)**

Introduction, Different types of lasers, He-Ne laser, $CO_2$ laser, Nd-YAG, Ruby, Excimer laser, Dye laser, semiconductor laser, Applications of Lasers , Industrial applications-Cutting, molding, melting, welding, drilling, Medical applications-Skin therapy, Laser eye surgery, Holography- principle & construction.

**Reference Books**


1. Molecular structure and spectroscopy, G. Aruldas
2. Fundamentals of molecular spectroscopy, Collin N, Banwell & Elaine M.
3. Atomic and molecular Physics, J. B. Rajam
4. Principles of Laser and their applications, Rhods
5. An introduction to laser theory and application, M. N. Avdhanulu-S. Chand Publication
6. Lasers, A. G. Sigman-Oxfaord University Press 1986.

**M. Sc-I [Physics]**

## PHY4203:QUANTUM MECHANICS II

**Credit: 04** **Total No. of Lectures: 60**

**Revision and general formalism:**

Time-independent Perturbation theory: Non degenerate, degenerate, Introduction to Time-dependent Perturbation theory.

**Unit 1: Approximation Methods II** **(15 L)**

Introduction, Time dependent Perturbation theory: Transition amplitude, $1^{st}$ and $2^{nd}$ order, selection rules, Fermi's golden rule, Harmonic perturbation, dipole approximation, Einstein coefficient for spontaneous emission.

Variational method: Basic principles and application to hydrogen atom, helium atom, deuteron problem, Vander walls interaction.

WKB approximation: General formalism, Bound states for potential wells – with no rigid walls, with one rigid wall, with two rigid walls. Bohr’s quantization condition, Application to tunneling, field emission.

**Unit 2: Theory of Scattering** **(15 L)**

Introduction, Collisions in 3-D and scattering: Laboratory and CM reference frames; scattering amplitude, differential scattering cross section and total scattering cross section: scattering by spherically symmetric potentials, Method of partial waves, Phase shift, Ramsauer-Townsend effect, scattering by a perfectly rigid sphere and by square well potential, Yukawa potential. The Born approximation, Lippman-Schwinger equation, applications and validity of the Born approximation.

**Unit 3: Symmetries in quantum mechanics and Identical Particles** **(15 L)**

Conservation laws and degeneracy associated with symmetries; Continuous symmetries, space and time translations, rotations; Rotation group, homomorphism between SO (3) and SU

(2); Explicit matrix representation of generators for j = $\frac{1}{2}$ and j = 1; Rotation matrices; Irreducible spherical tensor operators, Wigner-Eckart theorem; Discrete symmetries, parity and time reversal.

**Identical Particles:**

Meaning of identity and consequences, Symmetric and antisymmetric wave functions, Slater determinant, Symmetric and antisymmetric spin wave functions of two identical particles, Collisions of identical particles, Pauli's exclusion principle and Slater determent.

**Unit 4: Relativistic Quantum Mechanics (15 L)**

Klein-Gordon equation, Feynman-Stuckelberg interpretation of negative energy states and concept of antiparticles, Dirac equation, covariant form, adjoint equation, Plane wave solution and momentum space spinors, Spin and magnetic moment of the electron, Non relativistic reduction, Helicity and chirality, Properties of $\gamma$ matrices, Charge conjugation, Normalisation and completeness of spinors.

**What NEXT with Quantum Mechanics? : Anticommunication numbers, Quantisation of electromagnetic field, 'reverse time' using algorithm on a computer, past and future.**

**Reference Books:**

1. Quantum Mechanics by Nouredine Zettili, A John Wiley and Sons, Ltd.
2. Modern Quantum Mechanics by J. J. Sakurai.
3. A Text-book of Quantum Mechanics by P. M. Mathews and K. Venkatesan.
4. Quantum mechanics by A. Ghatak and S. Lokanathan.
5. Quantum Mechanics by L. I. Schiff.
6. Quantum Physics by R. Eisberg and R. Resnick.
7. Introduction to Quantum Mechanics by by David J. Griffiths.
8. Introductory Quantum mechanics by Granier, Springer Publication.
9. Introductory Quantum Mechanics by Li boff, 4$^{th}$ Edition, Pearson Education Ltd.
10. Principles of Quantum Mechanics by Shankar R. II$^{nd}$ Edition (Plenum, 1994).

**M. Sc. I (Sem-II)**

## PHY420: ELECTRODYNAMICS

**Credit: 04** **No. of Lectures: 60**

**Unit 1: Multipole Expansions and Time Varying Fields (15 L)**

Multipole expansions for a localized charge distribution in free space, linear quadrapole potential and field, static electric and magnetic fields in material media, boundary conditions, Time dependent fields, Faraday's law for stationary and moving media, Maxwell's displacement current, differential and integral forms of Maxwell's equations, Maxwell's equations for moving medium.

**Unit 2: Energy, Force, Momentum Relations and Electromagnetic Wave Equations (20 L)**

Energy relations in quasi-stationary current systems, Magnetic interaction between two current loops, Energy stored in electric and magnetic fields, Poynting's theorem, General expression for electromagnetic energy, Electromagnetic wave equations, Electromagnetic plane waves in stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth, wave guides , Dispersion relations(solid, liquid, gas)

**Unit 3: Inhomogeneous Wave Equations (15 L)**

Inhomogeneous wave equations, Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator, Hertz potential and its use in computation of radiation fields. Radiation from moving charges, radiation from a dipole.

**Unit 4: Relativistic Mechanics and Covariance (10 L)**

Galilean Transformation, Lorentz transformations, Relativistic velocity addition, Minkowski's space-time diagram, Four vector potential, electromagnetic field tensor, Lorentz force on a charged particle.

**References:**


1) Introduction to Electrodynamics, (3rd Edition) by David J. Griffith Publication: Prentice-Hall of India, New Delhi.
2) Introduction to Electrodynamics, by A.Z. Capri and P.V. Panat Narosa Publishing House.
3) Foundations of Electromagnetic theory by Reitz & Milford, World student series Edition.
4) Classical Electrodynamics, by J.D. Jackson, 3rd Edition John Wiley.
5) Electromagnetic theory and Electrodynamics by Satya Prakash, Kedar Nath and Co-Meerut.
6) Electromagnetics by B.B. Laud, Willey Eastern.
7) Matrices and Tensors in Physics by A. W. Joshi, 3rd Edition, New Age International.
8) Electrodynamics by Kumar Gupta and Singh.
9) Electromagnetic Theory by Umesh Sinha, Satya prakashan tech. India Publication.

# M. Sc.-I (SEM-II)
## PHY4205: Basic Physics Laboratory

**(Any 10 Experiments)** **4-Credits**

1. Young's Modulus of steel by Flexural Vibrations of A Bar.
2. Rigidity modulus of Brass.
3. Hall Effect.
4. Fabry Parot Etalon.
5. Resistivity by four-probe method.
6. Determination of Rydberg constant.
7. Michelson Interferometer.
8. Paramagnetic Susceptibility by Gauy method.
9. 'e' by Millikan oil drop method.
10. Skin depth in Al using electromagnetic radiation.
11. Stefan's constant – Black body radiation.
12. Franck – Hertz Experiment.
13. Thermionic Emission.
14. Electron Spin Resonance (ESR).
15. Determination of Rydberg constant.