M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM101	MATHEMATICAL PHYSICS - I

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	I	4	90

Course Objectives:

The objective of the course on **Mathematical Physics-I** is to equip the M.Sc. students with the mathematical skills that they need for understanding theoretical treatment in different courses taught in this class and for developing a strong background if they choose to pursue research in physics as a career.

Course Outcomes:

After the completion of this course students will be able to:

CO1: Explain the physical significance of Matrices

CO2: Discuss the significance of Eigen function, Laguerre and Hermite differential equations and Green's function.

CO3: Classify various singularities of complex functions.

CO4: Apply Cauchy residue theorem to evaluate integrals.

CO5: Apply beta and gamma function to evaluate integrals

CO6: Analyse special functions using Bessel, Hermite and Legendre functions.

CO7: Learn the fundamentals of representation of a group and Special Unitary Group SU (n).

UNIT 1 - MATRICES

Linear operators – Vector in n-dimensions – Matrix representation of vectors and operators in a basis – Linear independence, dimension – Inner product - Schwarz inequality- Orthonormal basis – Gram-Schmidt orthogonalization process – Eigenvalues and Eigenfunctions of operators/matrices – Hermitian and unitary operators/ matrices – Cayley-Hamilton theorem – Diagonalization of matrices.

UNIT 2 - LINEAR DIFFERENTIAL EQUATIONS AND GREEN'S FUNCTION

Second order linear differential equations with constant and variable coefficient – Superposition or linearity principle - Wronskian - Sturm-Liouville Theory - Orthogonality of Eigen functions. One and Three dimensional Green's function – Eigen function expansion of the Green's function - Reciprocity theorem.

UNIT 3 - SPECIAL FUNCTIONS - I

Gamma and Beta functions - Properties - Legendre polynomial and function - Generating function - Rodrigue formula – Orthogonality property - Associated Legendre function - Recurrence relations – - Bessel function - Generating function – Hankel function - Recurrence relations - Spherical Bessel function - Orthonormality relation

UNIT 4 - COMPLEX VARIABLES

Functions of a complex variable - Single and multivalued functions - Analytic functions - Cauchy - Riemann conditions - Singular points - Cauchy's integral theorem and integral formulae - Taylor and Laurent expansions – Zeros, singularities and poles – Residue theorem - Evaluation of real integrals.

UNIT 5 - GROUP THEORY

Basic definitions - Lagrange's Theorem – Invariant subgroup - Homomorphism and Isomorphism between groups - Representation of a group - unitary representations - Schur's lemmas - Orthogonality theorem – SU(n)- Special Unitary Group SU (2).

BOOKS FOR STUDY

1. **H.K.Dass,** 2010, Mathematical Physics, S. Chand & Co. Ltd.
2. **Satya Prakash,** 2014, Mathematical Physics, S. Chand & Co. Ltd.
3. **P.K. Chattopadhyay,** 1990, Mathematical Physics, Wiley Eastern, Madras.
4. **G. Arfken and H.J. Weber**, 2001, Mathematical Methods for Physicists, 5th Ed. (Harcourt (India), New Delhi.
5. **A.W. Joshi**, 1997, Elements of Group Theory for Physicists, 4th Edition, New Age International, New Delhi.
6. **A.W. Joshi**, 2006, Matrices and Tensors in Physics, 3rd Edition, New Age International (P) Ltd.
7. **M.D. Greenberg**, 1998, Advanced Engineering Mathematics, 2nd Edition, International Ed., Prentice – Hall International, NJ.
8. **F.A.Cotton,** Chemical Application of Group Theory. 3rd edition, John Wiely and Sons, New York.
9. **Erwin Kreyszig,** 2006, Advanced Engineering Mathematics, 9th edition, John Wiely and Sons, Singapore.

BOOKS FOR REFERENCE

1. **E.Butkov**, 1968, Mathematical Physics Addition, Wesley, Reading, Massachusetts.
2. **P.R. Halmos,** 1965 Finite Dimensional Vector Spaces, 2nd Ed. Affiliated East-West, New Delhi.
3. **C.R. Wylie and L.C. Barrett,** 1995, Advanced Engineering Mathematics, 6th Ed., International Ed. McGraw-Hill, NY.
4. **W.W. Bell**, 1968, Special Functions for Scientists and Engineers, (Van Nostrand, London.
5. **M.A. Abramowitz and I. Stegun (Editors),** 1972, Handbook of Mathematical Functions, Dover, New York.

6. **F.W.Byron, R.W. Fuller,** 1992, Mathematics of Classical and Quantum Physics, Dover.
7. **David W. Lewis,** 2001, Matrix theory, World Scientific Publishing Co. Pvt. Ltd.
8. **Tulsi Dass and Satish K.Sharma,** 1998, Mathematical methods in classical and Quantum Physics, University Press, Hyderabad.
9. **Mary L. Boas**, Mathematical Methods in Physical Sciences (Third Edition), Wiley India Pvt. Ltd.

WEB REFERENCES:

1. https://www.edx.org/course/introduction-to-linear-models-and-matrix-algebra
2. https://www.udemy.com/topic/differential-equations/
3. https://www.udemy.com/course/mastery-of-complex-numbers/
4. https://www.mooc-list.com/categories/sci-mathematics
5. https://cosmolearning.org/courses/abstract-algebra-groups-rings-fields/

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM102	QUANTUM MECHANICS – I

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	I	4	90

Course Objectives:

The aim and objective of the course on **Quantum Mechanics-I** is to introduce the students of M.Sc. class to the formal structure of the subject and to equip them with the techniques of vector spaces, angular momentum and perturbation theory so that they can use these in various branches of physics as per their requirement.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Derive Schrodinger Wave equation and Ehrenfest theorem

CO2: Can interpret the eigen values and eigen functions

CO3: Computes the evolution of the quantum simple harmonic oscillator.

CO4: Have a strong base in Linear vector spaces, Hilbert space, concepts of basis and operators and bra and ket notation

CO5: Solve problems in Addition of spin and orbital angular momenta

CO6: Extend their understanding of various approximation methods (Perturbation theory and The Variation method)

UNIT 1 - BASIC FORMALISM

The Schrodinger equation-Operator correspondence - Interpretation and Condition on wave function - Stationary states - Postulates of quantum mechanics - Linear operators and Self-Adjointness - Eigenvalue problem and degeneracy – Observables - Ehrenfest theorem - Completeness and normalization of eigen functions - Closure property - Physical interpretation of eigen values and eigen functions - Uncertainty relations and commuting observables.

UNIT 2 - EXACTLY SOLVABLE EIGENVALUE PROBLEMS

Particle in a square-well potential (bound states) - Square potential barrier and tunnelling - Simple harmonic oscillator-Ladder operator method - Angular momentum Operators - Spherical harmonics - Parity-Rigid rotator - Central potential - Hydrogen atom.

UNIT 3 - GENERAL FORMALISM

State vectors - Hilbert space - Dirac notation - Dynamical variables and linear operators - Representation theory - Coordinate and momentum representation-Unitary transformation involving time - Schrodinger, Heisenberg and interaction pictures - Translation and rotation - Symmetries and conservation laws - Time reversal.

UNIT 4 - ANGULAR MOMENTUM

Eigen value spectrum - Matrix representation - Spin Angular momentum - Pauli matrices - Non-relativistic Hamiltonian including spin - Addition of angular momenta - Clebsch-Gordan coefficients - Addition of spin and orbital angular momenta - Fine structure of alkali atoms.

UNIT 5 -APPROXIMATION METHODS:

Perturbation theory: -First and second order non-degenerate case-Degeneracy-Stark effect-Ground and first excited states of hydrogen atom- The Variation method:-Upper bound on ground state energy-Trial function linear in variational parameters- Hydrogen molecule.

BOOKS FOR STUDY:

1. **P.M. Mathews and K. Venkatesan** , 2007, A Text Book of Quantum Mechanics-Tata McGraw-Hill.
2. **B.K. Agarwal and Hari Prakash** , 2004, Quantum Mechanics-Prentice-Hall of India Pvt. Ltd, New Delhi.
3. **A. Ghatak and Loganathan**, 2002, Introduction to Quantum Mechanics, MacMillan India Ltd., Madras.
4. **V.K. Thankappan,** 2019, Quantum Mechanics, New Age International Publishers.
5. **V. Devanathan,** 2011, Quantum Mechanics, Alpha Science International Ltd.
6. **V. Murugan,** 2014, Quantum Mechanics, Pearson Education India
7. **Satya Prkash & Swati Saluja,** 2019, Quantum Mechanics, KNRN
8. **G. Aruldas,** 2013, Quantum Mechanics, 2013, PHI.

BOOKS FOR REFERENCE:

1. **David J. Griffiths**, 2002, Introduction to Quantum Mechanics, Prentice-Hall of India, Pvt. Ltd, New Delhi.
2. **E. Merzbacher**, 1970, Quantum Mechanics, 2nd Edition, Wiley International Edition.
3. **J.L. Powell and B. Craseman**, 1995, Quantum Mechanics Narosa Publishing, Madras.
4. **L.D. Landau** and **E.M. Lifshitz**, 1981, Quantum Mechanics, 3rd edition Elsevier.
5. **Y.K. Lim,** 2001, Problems and solutions on Quantum Mechanics, World Scientific Publishing Co. Pvt. Ltd, 2001.

WEB REFERENCES:

1. https://www.edx.org/course/quantum-mechanics-for-everyone
2. https://www.udemy.com/course/quantum-physics/
3. https://www.khanacademy.org/science/physics/quantum-physics
4. https://cosmolearning.org/courses/modern-physics-quantum-mechanics/
5. https://www.livescience.com/33816-quantum-mechanics-explanation.html

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM103	CLASSICAL MECHANICS

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	I	4	75

Course Objectives:

The aim and objective of the course on **Classical Mechanics** is to train the students of M.Sc. students in the Lagrangian and Hamiltonian formalisms so that they can use these in the modern branches of physics such as Quantum Mechanics, Condensed Matter Physics, etc.

Course Outcomes:

After successful completion of this paper, the student will be able to

- ***CO1:*** Apply principles of the Lagrangian and Hamiltonian approaches in classical mechanics.
- ***CO2:*** Determine the Kinematics and Dynamics of rigid body in detail and ideas regarding Euler's equations of motion
- ***CO3:*** Analyse the classical background of Quantum mechanics and get familiarized with Poisson brackets and Hamilton -Jacobi equation
- ***CO4:*** Interpret the theory of small oscillations in detail along with basis of Free vibrations.
- ***CO5:*** Explain various relativistic effects using Minkowski space and Lorentz transformations

UNIT 1 - LAGRANGIAN AND HAMILTONIAN FORMULATIONS

Hamilton's variational principle - Lagrange's equations of motion – Canonical momenta – Cyclic coordinates and conservation of corresponding momenta – Legendre transformation and Hamiltonian - Hamilton's equations of motion - Two-body central force problem –Kepler Problem and Kepler's laws.

UNIT 2 - MECHANICS OF RIGID BODIES

Rigid body motion – Kinematics – Euler angles – Infinitesimal rotations – Rate of change of a vector – Coriolis force - Dynamics - Angular momentum and kinetic energy - Moment of inertia tensor - Euler's equations of motion - Torque-free motion - Symmetrical top.

UNIT 3 - POISSON'S BRACKETS & HAMILTON – JACOBI THEORY

Poisson's bracket – canonical transformations – invariance of Poisson bracket with respect to canonical transformations – Hamilton-Jacobi theory – Action and Angle variable – Kepler's problem – solution of Harmonic oscillator problem by Hamilton-Jacobi equation.

UNIT 4 - SMALL OSCILLATIONS

General theory of small oscillation – Equation of motion for small oscillation – solution of eigen value equation – normal co-ordinates and normal frequencies of vibration – vibration of a linear triatomic molecule.

UNIT 5 - RELATIVISTIC MECHANICS

Relativistic energy – relation between momentum and energy and conservation law – transformation of momentum and energy – Force in relativistic mechanics – Minkowski space and Lorentz transformations – Four vectors.

BOOKS FOR STUDY:

1. **J.C. Upadhyaya**, 2007, Classical Mechanics, Himalaya Publishing House, 2nd edition.
2. **H. Goldstein**, 2008, Classical Mechanics, Narosa Publishing, 2nd edition.
3. **Gupta, Kumar, Sharma,** Classical Mechanics, Pragati Prakashan-Meerut.
4. **David Morin**, 2008, Introduction to Classical Mechanics, Cambridge University Press.
5. **Stephan T. Thornton and Jerry. B. Marion**, 2004, Classical dynamics of system of Particles, Thomson learning, Singapore.

BOOKS FOR REFERENCE:

1. **N.C. Rana and P.S. Joag**, 1991, Classical Mechanics, Tata McGraw. Hill, 1st edition.
2. **M.G. Calkin**, 2000, Lagrangian and Hamiltonian mechanics, Allied Publishers Ltd.
3. **P.V. Panat**, 2005, Classical Mechanics, Narosa Publishers.
4. **K.N. Srinivasa Rao**, 2003, Classical Mechanics, Universities Press (India) Pvt. Ltd.
5. Schaum's Outline Series, Lagrangian dynamics, McGraw-Hill.

WEB RESOURCES

1. https://www.mooc-list.com/tags/lagrangian-mechanics
2. https://www.edx.org/course/mechanics-rotational-dynamics
3. https://arxiv.org/abs/1604.08904
4. https://www.khanacademy.org/science/physics/mechanical-waves-and-sound
5. https://www.britannica.com/science/relativistic-mechanics

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020- 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM104	ATOMIC AND MOLECULAR SPECTROSCOPY

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	I	4	75

Course Objectives:

The aim and objective of the course on **Atomic and Molecular Spectroscopy** for the students of M.Sc. Physics is to equip them with the knowledge of Atomic, Rotational, Vibrational, Raman, and Electronic spectra.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Explain the rotational spectra of diatomic molecule and polyatomic molecules at microwave spectroscopy

CO2: Analyse the representation of molecular vibrations in symmetry co-ordinates and normal coordinates for diatomic molecules

CO3: Explain the rotational spectra of diatomic molecule and polyatomic molecules at infrared spectroscopy

CO4: Determine the structure through infrared and Raman spectroscopy

CO5: Explain the theory and design of NMR and ESR spectroscopy

UNIT 1: MICROWAVE SPECTROSCOPY

Rotational spectra of diatomic molecule – Polyatomic molecules – Linear and symmetric top molecules – Quadrupole Hyperfine Interactions – Experimental techniques – Stark effect.

UNIT 2: NORMAL CO-ORDINATE ANALYSIS

Selection rules for Raman and IR vibrational normal modes – Raman and IR activity C_2V and C_3V point groups – Representation of molecular vibrations in symmetry co-ordinates – Normal coordinates analysis for H_2O molecules

UNIT 3: INFRARED SPECTROSCOPY

Vibration of diatomic and simple polyatomic molecule – Anhormonicity – Fermi Resonance – Hydrogen bonding – Normal modes of vibration in a crystal – solid state Effects – Interpretation of vibrational spectra – instrumentation techniques – FTIR spectroscopy

UNIT 4: RAMAN SCATTERING

Vibrational and rotational Raman spectra – Mutual Exclusion principle – Raman spectrometer – polarization of Raman scattering light – structure determination through IR and Raman spectroscopy – Phase transition – Resonance Raman scattering

UNIT 5: NMR AND ESR SPECTROSCOPY

Quantum theory of NMR – Bloch equation – Design of CW NMR Spectrometer – Principle and block diagram of FT NMR – Chemical Shift – Application to molecular structure. Quantum theory of ESR – Design of ESR Spectrometer – Hyperfine Structure – Anisotropic system – Triplet state study of ESR – Application – Crystal defects – Biological studies.

BOOKS FOR STUDY

1. **C.N. Banwell** and **E.M. McCash**, 1994, "Fundamentals of Molecular Spectroscopy", 4th Edition, TMH, New Delhi.
2. **G. Aruldhas**, 2001, Molecular Structure and Spectroscopy, Prentice-Hall of India, New Delhi.
3. **D.N. Satyanarayana**, 2004, Vibrational Spectroscopy and Application, New Age International Publication.
4. **M.S. Yadav,** 2003, Anmol Publications Pvt. Ltd.

BOOKS FOR REFERENCE

1. **D.D. Jyaji** and **M.D Yadav** 1991, Spectroscopy, Amol Publications
2. **Attaur Rahman**, 1986, Nuclear Magnetic Resonance, Springer Verlag.
3. **D. A. Lang**, Raman Spectroscopy, McGraw- Hill International
4. **Raymond Chang**, 1980, "Basic Principles of Spectroscopy", McGraw- Hill Kogakusha Tokyo.

WEB RESOURSES

1. https://www.internetchemistry.com/chemistry/microwave-spectroscopy.php
2. https://serc.carleton.edu/NAGTWorkshops/mineralogy/mineral_physics/raman_ir.htm
3. https://www.edx.org/learn/spectroscopy
4. https://www.horiba.com/us/en/scientific/products/raman-spectroscopy/raman-academy/raman-faqs/what-is-resonance-raman-spectroscopy/
5. https://onlinelibrary.wiley.com/doi/10.1002/14356007.b05_471

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUMP101	GENERAL PRACTICAL – I

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	I	3	90

[External (Expt. – 60; Record – 15): 75 + Internal (Assn. – 10; Test – 10; Regularity – 5): 25]

Course Objectives:

The aim and objective of the laboratory on **General Physics Practical** is to expose the students of M.Sc. class to experimental techniques, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Acquire hands on experience of using various advanced instruments.

CO2: Handle interferometer and spectrometer for wavelength and luminosity.

CO3: Understand the basic of instruments safely management.

CO4: Perform scientific experiments as well as accurately record and analyse the results of experiments.

CO5: Solve applied physics problems with critical thinking and analytical reasoning.

General Practicals:

1. Cornu's Method – Young's Modulus and Poisson's ratio by Elliptical fringes.
2. GM Counter – Characteristics, inverse square law
3. GM Counter – Absorption Coefficient
4. Ultrasonic Interferometer – Velocity & Compressiblity
5. Laser: Wavelength and Particle Size
6. Michelson Interferometer – Wavelength, separation of wavelengths.
7. Susceptibility by Guoy's method
8. Stefan's Constant
9. Band gap Energy – Thermistor
10. Hydrogen Spectrum – Rydberg's Constant
11. Viscosity of liquid – Meyer's Disc
12. B-H loop of Ferrite Core using CRO

13. F. P. Etalon using spectrometer.
14. Air wedge method – Thickness of Insulation of Wire
15. Solar Spectrum – Harmann's Interpolation Formula
16. Specific Charge of an Electron Thomson Method

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM205	MATHEMATICAL PHYSICS – II

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	II	4	75

Course Objectives:

The aim and objective of the course on **Mathematical Physics-II** is to equip the M.Sc. Students with the mathematical techniques that they need for understanding theoretical treatment in different courses taught in this class and for developing a strong background.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Explain the Algebra of tensors, conjugate tensors and metric tensors

CO2: Discuss the significance of Laplace transform and its inverse.

CO3: Use Fourier series and transformations as an aid for analyzing experimental data.

CO4: Differentiate between Hermite polynomials and Laguerre polynomials.

CO5: Apply the probability theory to binomial and normal distribution.

CO6: Gets a wide knowledge of iteration methods to solve the equations

CO7: Identify a range of mathematical methods that are essential for solving numerical differentiation

UNIT 1 - VECTORS AND TENSORS

Gauss Divergence Theorem – Stokes Theorem – Greens Theorem – Tensors in Physics - Einstein's summation convention - Coordinate transformation – Contra and covariant tensors of rank one and two – Kronecker delta – Algebra of tensors - outer and inner products – Quotient rule – Levi-Civita tensor in three dimensions.

UNIT 2 – INTEGRAL TRANSFORM AND PARTIAL DIFFERENTIAL EQUATIONS

Laplace transform and its inverse- Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Solution of partial differential equations of first order - Solution of initial boundary value problem by Laplace transform method: Diffusion equation, wave equation - Finite Fourier sine and cosine transform methods

UNIT 3 - SPECIAL FUNCTION – II

Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations - Laguerre polynomials - Generating function - Orthogonality properties - Recurrence relation - Associated Laguerre polynomial - Properties - The error function and related functions

UNIT 4 - PROBABILITY

Definitions - Laws of probability - Mean, Standard deviation – Poisson distribution - Binomial distribution - Normal distribution – central limit theorem - The t - distribution - The Chi - Square distribution

UNIT 5 – NUMERICAL METHODS

Solution of Nonlinear equations: Newton - Raphson method – Newton forward & backward interpolation – Gauss elimination method - - Trapezoidal rule - Simpson's rule - Error estimates - Numerical solution of ordinary differential equations - Euler and Runge Kutta methods.

BOOKS FOR STUDY

1. **P.K. Chattopadhyay,** 1990, Mathematic Physics,Wiley Eastern, Madras.
2. **G. Arfken and H.J. Weber**, 2001, Mathematical Methods for Physicists, 5th Ed. (Harcourt (India), New Delhi.
3. **A.W. Joshi**, 2006, Matrices and Tensors in Physics, 3rd Edition, New Age International (P) Ltd.
4. **M.D. Greenberg**, 1998, Advanced Engineering Mathematics, 2nd Edition, International Ed., Prentice – Hall International, NJ.
5. **Erwin Kreyszig,** 2006, Advanced Engineering Mathematics, 9th edition, John Wiely and Sons, Singapore.

BOOKS FOR REFERENCE

1. **E.Butkov**, 1968, Mathematical Physics Addition, Wesley, Reading, Massachusetts.
2. **P.R. Halmos,** 1965 Finite Dimensional Vector Spaces, 2nd Ed. Affiliated East-West, New Delhi.
3. **C.R. Wylie and L.C. Barrett,** 1995, Advanced Engineering Mathematics, 6th Ed., International Ed. McGraw-Hill, NY.
4. **W.W. Bell**, 1968, Special Functions for Scientists and Engineers, (Van Nostrand, London.
5. **M.A. Abramowitz and I. Stegun (Editors),** 1972, Handbook of Mathematical Functions, Dover, New York.
6. **F.W.Byron, R.W. Fuller,** 1992, Mathematics of Classical and Quantum Physics, Dover.
7. **David W. Lewis,** 2001, Matrix theory, World Scientific Publishing Co. Pvt. Ltd.
8. **Tulsi Dass and Satish K.Sharma,** 1998, Mathematical methods in classical and Quantum Physics, University Press, Hyderabad.
9. **H.K.Dass,** 2010, Mathematical Physics, S. Chand & Co. Ltd.

WEB RESOURCES

1. http://mathworld.wolfram.com/Tensor.html
2. http://mth.vnit.ac.in/people/pmahale/teaching-2/current-courses/subject2/
3. http://mathworld.wolfram.com/HermitePolynomial.html
4. https://www.khanacademy.org/math/statistics-probability/probability-library
5. https://lecturenotes.in/subject/24/numerical-methods-nm

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM206	QUANTUM MECHANICS – II

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	II	4	75

Course Objectives:

The aim and objective of the course on **Quantum Mechanics-II** is to introduce the M.Sc. students to the formal structure of the subject and to equip them with the techniques of Relativistic quantum mechanics and Quantum field theory so that they can use these in various branches of physics as per their requirement.

Course Outcomes:

After successful completion of this paper, the student will be able to

- ***CO1:*** Apply the basic ideas of scattering theory to analyse Born approximation
- ***CO2:*** Describe the Time dependent perturbation theory
- ***CO3:*** Analyse adiabatic approximation and sudden approximation
- ***CO4:*** Analyse KG and Dirac equation and interpret negative energy states
- ***CO5:*** Explain the magnetic moment of an electron due to spin
- ***CO6:*** Analyse relativistic invariance of Dirac equation to determine probability density
- ***CO7:*** Perform calculations using Creation operators, annihilation operators and Commutation relations.

UNIT 1: SCATTERING THEORY

Scattering amplitude – Cross section – Born approximation – Effective range theory for S-wave – Transformation from centre of mass to Laboratory frame.

UNIT 2: PERTURBATION THEORY

Time dependent perturbation theory – Constant and harmonic perturbation – Transition probabilities – Adiabatic approximation – Sudden approximation – The density matrix – Semi classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation.

UNIT 3: RELATIVISTIC QUANTUM MECHANICS

Klein-Gordon equation – Dirac equation – Plane-wave solution – Interpretation of negative energy states – Antiparticle – Spin of electron – Magnetic moment of an electron due to spin.

UNIT 4: DIRAC EQUATION

Covarient form of Dirac equation – Dirac equation – Properties of the gamma Matrices – Traces – Relativistic invariance of Dirac equation – Probability density – Current four vector –

Bilinear covariant – Feynman's theory of positron (Elementary idea only without propagation formalism)

UNIT 5: SECOND QUANTIZATION

Second quantization of Klein-Gordon field – Creation and annihilation operators – Commutation relations – Quantization of electromagnetic field – Creation and annihilation operators – Commutation relations.

BOOKS FOR STUDY:

1. **P.M. Mathews** and **K. Venkatesan,** 1976, A Text Book of Quantum Mechanics, Tata McGraw-Hill, New Delhi.
2. **L.I. Schiff,** 1985, Quantum Mechanics, 3rd edition, International Student Edition, McGraw-Hill, New Delhi.
3. **E.Merzbacher,** 1970, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York
4. **V.K.Thankappan,** 1985, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi.
5. **J.D. Bjorken** and **S.D.Drell** ,1964, Relativistic Quantum Mechanics, McGraw-Hill, New York.
6. **V.Devanathan,** 2005, Quantum Mechanics, Narosa Publishing House, New Delhi.
7. **D. J. Griffiths,** 2004, Introduction to Quantum Mechanics, 2nd Editio, Prentice-Hall of India.

BOOKS FOR REFERENCE:

1. **P.A.M. Dirac**, 1973, The Principles of Quantum Mechanics, 4th Oxford University Press, London.
2. **L.D. Landau** and **E. M. Lifshitz**, 1958, Quantum Mechanics, Pergomon Press, London
3. **S. N. Biswas**, 1999, Quantum Mechanics, Books and Allied, Kolkata.
4. **G. Aruldhas**, 2002, Quantum Mechanics, Prentice-Hall of India, New Delhi.
5. **J.S. Bell, Gittfried** and **M. Veltman**, 2001, The Foundations of Quantum Mechanics, World Science.
6. **V. Devanathan**, 1999, Angular Momentum Technique in Quantum Mechanics, Kluwer Academic Publishers, Dordrecht.
7. **Nouredine Zettli,** 2016, Quantum Mechanics, 2nd Edition, Wiley India Pvt. Ltd.
8. **J.J. Sakurai,** Modern Quantum Mechanics.

WEB RESOURCES

1. http://galileo.phys.virginia.edu/classes/752.mf1i.spring03/ScatteringTheory.htm
2. http://vergil.chemistry.gatech.edu/notes/quantrev/node27.html
3. https://nptel.ac.in/courses/115108074/
4. https://quantummechanics.ucsd.edu/ph130a/130_notes/node45.html
5. https://physics.stackexchange.com/questions/322204/second-quantization-and-klein-gordon-equation

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020- 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM207	ADVANCED SPECTROSCOPY

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	II	4	75

Course Objectives:

The aim and objective of the course on **Advanced Spectroscopy** is to expose the students of M.Sc. class to the relatively advanced topics in Spectroscopy and nuclear reactions so that they understand the details of the underlying aspects.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Explain basic elements of UV spectroscopy and its applications

CO2: Distinguish between atomic absorption and emission spectroscopy

CO3: Explain and apply the concepts used in surface enhanced Raman scattering (SERS)

CO4: Correlate spectroscopic information of known and unknown molecules with their physical description

CO5: Explain the theory of nonlinear spectroscopic phenomena

UNIT 1: UV SPECTROSCOPY

Principle of UV spectra – Franck Condon Principle – Rotational fine structure of electronic vibration spectra – Electronic angular momentum in diatomic molecule – transition Probability, measurement of spectrum – Types of transition in Organic molecules – Selection rules – Application of UV Spectroscopy.

UNIT 2: NUCLEAR QUADRUPOLE RESONANCE

Quadrupole nucleus – Principle of nuclear quadrupole resonance – Transitions for axially symmetric system - Transitions for nonaxially symmetric system – Design of NQR spectrometer – Crystallographic Inequivalence – Application of NQR to chemical bonding.

UNIT 3: MOSSBAUER SPECTROSCOPY

Principle of Mosbauer spectroscopy – Schematic arrangements of a Mosbauer spectrosmeter – Cjhemical Isomer Shift – Magnetic Hyperfine interactions – Electric Qudropole Interactions – Application to molecular and electronic structures.

UNIT 4: SURFACE ENHANCED RAMAN SCATTERING (SERS)

Surfaces for SERS study – Enhancement mechanism – Instrumentation and sampling techniques - Surface selection rules – SERS microprobe – SERS study of bio molecules – SERS in medicine –

UNIT 5: LASER SPECTROSCOPY

Nonlinear optical effects – Frequency generation by nonlinear optical techniques – Hyper Raman Effect – Classical treatment and Experimental technique – Laser Induced fluorescence – Laser Magnetic resonance – Laser Stark spectroscopy.

BOOKS FOR STUDY

1. **C. N. Banwell and E. M. McCash,** 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata Mc Graw-Hill, New Delhi.
2. **G. Aruldhas,** 2001, Molecular structure and spectroscopy, Prentice Hall of India Pvt. Ltd., New Delhi
3. **H.Kaur,** 2009, Spectroscopy, 5th Edition, A Pragati Prakashan
4. **P. S. Sindhu,** 1990, Molecular Spectroscopy, Tata Mc Graw-Hill, New Delhi.
5. **D.N. Sathyanarayana,** Vibrational Spectroscopy, New age International Publishers.
6. **R. Wilfred Sugumar,** 2016, Molecular Spectroscopy, MJP Publishers.

BOOKS FOR REFERENCE:

1. **G. W. King,** 1964, Spectroscopy and molecular structure, Hoit Rinchart and Winsten Inc, London
2. **T. A. Carlson,** 1975, Photo electron and Auger spectroscopy, Plenum Press
3. **J. Loder,** 1970, Basic Laser Raman spectroscopy, Hezdan and Son Ltd.
4. **T. P. Das and E. L. Hehn,** 1958, NQR Spectroscopy, Academic Press
5. **Raymond Chang,** 1980, Basic Principles of Spectroscopy Mc Graw-Hill Kogakusha

WEB RESOURCES

1. https://www.edinst.com/techniques/uv-vis-spectroscopy/
2. https://www.labmanager.com/multimedia/2019/05/atomic-spectroscopy
3. https://www.semrock.com/surface-enhanced-raman-scattering-sers.aspx
4. https://photon-science.desy.de/research/research_teams/x_ray_physics_and_nanoscience/desy_nanolab_instrumentation/surface_spectroscopy/index_eng.html
5. https://www.sciencedirect.com/topics/engineering/nonlinear-optical-phenomenon
6. http://www.spectroscopyonline.com/multiphoton-spectroscopy

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM208	ELECTRONICS DEVICES AND CIRCUITS

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	II	4	75

Course Objectives:

The aim and objective of the course on **Electronics Devices and Circuits** is to introduce the students of M.Sc. class to the formal structure of the subject and to equip them with the knowledge of semiconductor physics, basic circuit analysis, OPAMP based analog circuits and introduction to digital electronics so that they can use these in various branches of physics as per their requirement.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Have a basic knowledge of semiconductor physics.

CO2: Have a strong base in FET, MOSFET, UJT, SCR, TRIAC, their principles, working and their applications.

CO3: Recall the basics of operational amplifier characteristics, OPAMP parameters, applications as inverter, integrator, differentiator etc.

CO4: To construct various circuits like A/D and D/A convertor.

CO5: Apply knowledge and skill in the design and development of Electronics circuits to cater to the needs of Electronic Industry.

CO6: Evaluate frequency response to understand behaviour of the transducers.

UNIT 1: PHYSICS OF SEMICONDUCTOR DEVICES

p-n Junction Diode: Basic Device Technology – Depletion region and depletion capacitance – Current Voltage characteristics – Junction Breakdown – Transient behaviour and Noise – Tunnel diode – p-i-n diode – Varactor diode.

UNIT 2: FIELD EFFECT TRANSISTORS AND THYRISTORS

Types of FET- Working principles, Importance and Advantages of JFET- MOSFET, UJT, SCR, TRIAC – Structure and constructional features – I-V Characteristics of SCR – Biasing of FET and MOSFET- UJT relaxation oscillator – SCR, TRIAC for power control – Photo detectors and LEDs.

UNIT 3: OPERATIONAL AMPLIFIERS APPLICATIONS

Ideal Op - Amp - inverting, non - inverting, logarithmic, summing and difference amplifiers - integrator and differentiator - as a comparator - CMRR – differential amplifier - Applications: Solving simultaneous and differential equations - Schmitt Trigger - Astable, Monostable Multivibrator – Triangular wave generator - Sine wave generator.

UNIT 4: REGISTERS AND COUNTERS

Digital flip flops – RS, JK, D and T– Counters Timer – Logic Circuit Designing – Design of random sequence counters – Serial parallel registers – Shift registers – Applications. Binary weighted resistor D/A convertor – R-2R ladder DAC – successive approximation and dual slope ADC.

UNIT V: TRANSDUCERS

Classification of transducers – Potentiometer – unbounded strain gage – Bonded strain gauge foil type strain gauge – Linear variable differential transducer (LVDT) – Rotational variable differential transducer (RVDT)

BOOKS FOR STUDY:

1. **S. M. Sze,** 1981, Physics of Semiconductor Devices, Wiley Eastern Ltd.
2. **H.S. Kalsi**, 2002, Electronic Instrumentation, Learning Materials centre, New Delhi, Second edition.
3. **S. Salivahanan, N. Suersh Kumar & A. Vallavaraj**, 2009, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.
4. **D. Roy Choudhury and Shail B.Jain**, 2012, Linear Integrated Circuits, New Age International Publishers,third edition.
5. **V. Vijayendran**, 2008, Introduction to Integrated electronics (Digital & Analog), S.Viswanathan Printers & Publishers Private Ltd, Reprint.

BOOKS FOR REFERENCE:

1. **John Douglas Ryder**, 1976, Electronic fundamentals and applications, 5th edition, Prentice – Hall.
2. **Donald P. Leach, Albert Paul Malvino**, 1986, Digital principles and applications, 4th edition, McGraw – Hill.
3. **V.K. Mehta and Rohit Mehta,** 2008, Principles of Electronics, S. Chand & Co, 12th Edition.
4. **D. Chattopadhyay** and **Rakshit,** 2010, Electronics – Fundamentals and Application, New Age Pulishers, 11th Edition.
5. **B.L. Theraja** and **A.K. Theraja,** 2004, A Textbook of Electrical technology, S. Chand & Co.

WEB RESOURCES:

1. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effect-controlled-thyristors/
2. https://www.electrical4u.com/applications-of-op-amp/
3. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
4. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/
5. https://www.elprocus.com/transducer-types-and-their-applications/

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM209	ENERGY PHYSICS

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	II	3	60

Course Objectives:

The aim and objective of the course on **Energy Physics** is to create concern among the students of M.Sc. class on energy conservation, sources of renewable energy, basics of the alternative energy sources like solar energy, tidal energy, etc., their advantages and disadvantages and their applications.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Describe the sources and prospectus of renewable energy sources

CO2: Interpret the ideas of tide energy utilization

CO3: Analyse the advantages and disadvantages of wind energy conversion systems

CO4: Get introduced to bio mass and bio gas conversion technologies

CO5: Learn the fundamentals and applications of solar energy

UNIT -1: INTRODUCTION TO ENERGY SOURCES

Energy sources and their availability – Types of energy sources – World energy futures- Energy sources and their availability – Need for alternatives, renewable energy sources – Prospects of renewable energy sources.

UNIT – 2: TIDAL ENERGY

Energy from oceans – energy utilization – energy from tides – basic principle of tidal power – utilization of tidal energy

UNIT -3: WIND ENERGY

Basic principles of wind energy conversion – power in the wind – forces in the blades – Wind energy conversion – advantages and disadvantages of wind energy conversion systems- (WECS) energy storage – Application of wind energy storage.

UNIT -4: ENERGY FROM BIOMASS

Biomass conversion technologies- wet and dry process- photosynthesis.

Biogas generation: Introduction - basic process and energetic – advantages of anaerobic digestion – factors affecting bio digestion and generation of gas - biogas from waste fuel – properties of biogas – utilization of biogas.

UNIT 5: SOLAR ENERGY

solar radiation and its measurements – solar cells for direct conversion of solar energy to electric powers – solar cell parameter – solar cell electrical characteristics – efficiency – solar water heater – solar distillation – solar cooking – solar greenhouse.

BOOKS FOR STUDY:

1. **G.D. Rai**, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi.
2. **S. Rao and Dr. Paru Lekar**, Energy technology.
3. **M.P. Agarwal**, Solar Energy, S. Chand and Co., New Delhi (1983).

BOOKS FOR REFERENCE:

1. **John Twidell and Tony Weir**, Renewable energy resources, Taylor and Francis group, London and New York.

WEB RESOURCES

1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1
2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/
3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy
4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/
5. https://www.acciona.com/renewable-energy/solar-energy/

M. Sc. DEGREE BRANCH: PHYSICS

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUMP202	ELECTRONICS PRACTICAL – II

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	II	3	60

[External (Expt. – 60; Record – 15): 75 + Internal (Assn. – 10; Test – 10; Regularity – 5): 25]

Course Objectives:

The aim and objective of the laboratory on **Electronics Lab** is to expose the students of M.Sc. class to experimental techniques in electronics so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Acquire hands on experience of handling and building electronics circuits.

CO2: Be familiar with the various components such as resistors, capacitor, inductor, IC chips and how to use these components in circuits.

CO3: Be able to recognize the construction, working principles and frequency responses of various devices such as UJT, FET oscillators.

CO4: Capable of using components of digital electronics for various applications

CO5: Able to design and perform scientific experiments as well as accurately record and analyze the results of experiments.

ELECTRONICS PRACTICAL

1. Op-Amp. – 4-bit Digital to Analog converter [R/2R ladder network]
2. Op-Amp. Active Filters: Low pass, High pass filters.
3. Op-Amp. Active Filters: Band pass filters (second order).
4. Solving simultaneous equations – IC 741/IC LM324
5. Design of a square wave oscillator using IC 741 – Triangular wave oscillator.
6. Construction of pulse generator using IC741- application as frequency divider.
7. Design of UJT relaxation oscillator for a frequency – Generation of positive and negative triggering pulses.
8. FET CS amplifier – Design, Frequency response, input impedance, output impedance.
9. Study of R-S, clocked R-S and D- Flip flops using NAND/NOR gates.
10. Study of J-K, D and T- Flip flops using IC 7476/ IC 7473.
11. IC 7490 as a scalar and display using IC 7447.

12. Construction of square wave generator using IC 555 – study of VCO.
13. Construction of pulse generator using IC741- application as frequency divider.
14. IC 7476/ IC7473 – Study of binary up/down counters.
15. IC 7476 – Shift register, ring counter and Johnson counter (twisted ring counter).
16. Arithmetic operations using IC 7483 – 4 bit binary addition and subtraction.

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM310	**THERMODYNAMICS AND STATISTICAL MECHANICS**

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	**III**	**4**	**75**

Course Objectives:

The aim and objective of the course on **Thermodynamics and Statistical Mechanics** is to equip the M.Sc. student with the techniques of Ensemble theory so that they can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Explain the phase transitions and Ehrenfest's classifications

CO2: Provide a critical analyse on entropy of an ideal gas using the microcanonical ensemble, entropy of mixing and Gibb's paradox.

CO3: Explain statistical physics and thermodynamics as consequences of the postulates of statistical mechanics

CO4: Grasp the basis of ensemble approach in calculation of statistical quantities

CO5: Study important examples of ideal Bose systems and Fermi systems

CO6: Explain Cluster expansion for a classical gas based on Ising model

CO7: Describe Fluctuations and transport phenomena using Brownian motion

UNIT 1: PHASE TRANSITION

Thermodynamic potentials - Phase Equilibrium - Gibb's Phase rule - Phase transitions and Ehrenfest's classifications - Third Law of Thermodynamics.

Order parameters - Landau theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

UNIT 2: STATISTICAL MECHANICS AND THERMODYNAMICS

Foundations of statistical mechanics - Specification of states of a system - Microcanonical ensemble - Entropy - Connection between statistics and thermodynamics - Classical ideal gas - Entropy of an ideal gas using the microcanonical ensemble - Entropy of mixing and Gibb's paradox.

UNIT 3: CANONICAL AND GRAND CANONICAL ENSEMBLES

Trajectories, Phase space and density of states - Liouville's theorem - Canoncial and grand canonical ensembles - Partition function – Calculation of statistical quantities.

UNIT 4: CLASSICAL AND QUANTUM STATISTICS

Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell - Boltzman statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas- Thermionic emission – Degenerate and Nondegenerate Semiconductors.

UNIT 5: REAL GAS, ISING MODEL AND FLUCTUATIONS

Cluster expansion for a classical gas - Viral equation of state - Ising model - Exact solutions in one dimension – Mean field theory of the Ising model in two dimension.

Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena – Fokker planck equation - Brownian motion - Langevin theory.

BOOKS FOR STUDY

1. **S. K. Sinha,** 1990, Statistical mechanics, Tata McGraw – Hill, New Delhi.
2. **B.K. Agarwal and M. Eisner**, Statistical Mechanics, Second Edition (New Age International, New Delhi.
3. **J.K. Bhattarcharjee,** 1996, Statistical Mechanics: An Introductory Text, Allied Publication, New Delhi.
4. **C. Kittel**, 1987, Thermal Physics. 2nd edition, CBS Publication, New Delhi.
5. **M. K. Zemansky,** 1968, Heat and Thermodynamics, 5th edition, McGraw-Hill, New York.
6. **R.K. Pathria**, Statistical Mechanics. 1996, 2nd edition, Butter Worth-Heinemann, New Delhi.

BOOKS FOR REFERENCES

1. **L.D. Landau and E.M. Lifshitz**, 1969, Statistical Physics, Pergomon Press, Oxford.
2. **W. Greiner, L. Neise and H. Stoecker**, Thermodynamics and Statistical Mechanics, Springer Verlang, New York.
3. **A.B. Gupta, H. Roy**, 2002, Thermal Physics - Books and Allied, Kolkatta, 2002.
4. **C. Kalidas, M.V. Sangaranarayanan**, Non-Equilibrium Thermodynamics, Macmillan India, New Delhi.
5. **M. Glazer and J. Wark**, Statistical Mechanics (Oxford University Press, 2001).
6. **L.P. Kadanoff**, 2001, Statistical Physics - Statics, Dynamics and Renormalization, World Scientific, Singapore.
7. **F.W. Sears and G.L. Salinger**, 1998, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd Edition, Narosa, New Delhi.
8. **Kerson Hung,** 1987, Statistical Mechanics, 2nd Edition, John Wiley & Sons, Singapore.

WEB RESOURCES

1. https://byjus.com/chemistry/third-law-of-thermodynamics/
2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5. https://en.wikipedia.org/wiki/Ising_model

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM311	**NUCLEAR AND PARTICLE PHYSICS**

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	III	4	75

Course Objectives:

The aim and objective of the course on **Nuclear and Particle Physics** is to familiarize the students of M.Sc. class to the basic aspects of Nuclear Physics like static properties of nuclei, radioactive decays, nuclear forces, nuclear models, and nuclear reactions so that they are equipped with the techniques used in studying these things.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Develop the understanding of nucleon-nucleon interactions and scattering

CO2: Learn about the concept of types of reactions and conservation laws

CO3: Acquire basic knowledge about various nuclear models

CO4: Acquire knowledge about nuclear decay processes and their outcomes. Have a wide understanding regarding beta and gamma decay

CO5: Analyse the basic forces in nature and classification of particles and study in detail conservations laws and quark models in detail

UNIT 1: NUCLEAR INTERACTIONS

Properties of Nuclei - Nuclear Force- Meson theory of nuclear forces – Yukawa potential – Scattering cross-section – Effective range theory – neutron-neutron scattering – proton-proton scattering

Conservation laws for nuclear reactions – Energetic of nuclear reactions – Threshold energy-Binding energy and Q-value - Direct reactions - Breit – Wigner one-level formula

UNIT 2: NUCLEAR MODELS

Liquid drop model – Bohr – Wheeler theory of fission – Evidences of existence of shell structure in nucleus- Shell model – Spin- Orbit coupling – Magic numbers – Comparison of liquid drop and shell model –collective model

UNIT 3: NUCLEAR DECAY

Alpha decay –Gamow's theory of Alpha decay – fine structure of alpha rays - Beta decay – Fermi theory of beta decay – Shape of the beta spectrum –Non-conservation of parity – Gamma decay – Interaction of gamma rays with matter- Multipole radiations in nuclei – parity selection rules – Internal conversion – Nuclear isomerism.

UNIT 4: PARTICLE ACCELERATOR

Detector: Ionisation counters - Ionisation chamber- Scintillation counter – diffusion cloud chamber- bubble chamber

Accelerator: Classification of accelerator – Synchrocyclotron - Betatron – Proton synchrotron – Linear accelerator.

UNIT 5: ELEMENTARY PARTICLE PHYSICS

Classification of elementary particles – Fundamental interaction- Symmetry and conservation laws – CPT theorem – CP violation in neutral K meson decays – Symmetry scheme of elementary particles - SU (3) multiplets of hadraons – Gell – Mann – Okuba mass formula for SU (3) multiplets – Quark model - Charm, button and top quarks.

BOOKS FOR STUDY

1. **K.S. Krane,** 1987, Introductory Nuclear Physics, Wiley, New Delhi, 1987.
2. **D. Griffiths,** 1987, Introduction to Elementary Particles, Harper and Row, New York.
3. **R.R. Roy and B.P. Nigam**, 1983, Nuclear Physics, New age Intl. New Delhi.

BOOK FOR REFERENCES

1. **H. A. Enge**, 1983, Introduction Nuclear Physics, Wiley, New York.
2. **Y.R. Waghmare**, 1981, Introductory Nuclear Physics, Oxford – IBH, New Delhi.
3. **Ghoshal**, Atomic and Nuclear Physics, Vol. 2.
4. **J.M. Longo**, 1971, Elementary Particles, McGraw-Hill, New York.
5. **M.K. Pal**, 1982, Theory of Nuclear Structure, Affiliated East -West, Madras.
6. **R.D. Evans**, 1955, Atomic Nucleus, McGraw-Hill, New York.
7. **I. Kaplan**, 1989, Nuclear Physics, 2nd Ed. Narosa, New Delhi.
8. **B.L. Cohen**, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.
9. **D.C. Tayal,** 2008, Nuclear Physics, 5th Edition, Himalaya Publishing house, Mumbai.
10. **A. Das and T.Ferbel,** 2007, Introduction to Nuclear and Particle Physics, 2nd World Scientific, Singapore.

WEB RESOURCES

1. http://www.scholarpedia.org/article/Nuclear_Forces
2. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/
3. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html
4. https://www.ndc-ed.org/EducationResources/HighSchool/Radiography/radioactivedecay.htm
5. http://abyss.uoregon.edu/~js/ast123/lectures/lec07.html

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM312	ELECTROMAGNETIC THEORY

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	III	4	75

Course Objectives:

The **Electromagnetic Theory** course covers Electrostatics and Magnetostatics including Maxwell equations, and their applications to propagation of electromagnetic waves in dielectrics, waveguides.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Describe the polarization and displacement vectors

CO2: Assess and critique Laplace equation in three dimension

CO3: Deduce and justify the concepts of Biot-Savart Law

CO4: Formulate and apply the Maxwell's equations

CO5: Have an insight in linear and circular polarization, refraction and reflection at a plane interface

CO6: Deduce the Lorentz transformation for space and time in four vector.

UNIT 1: ELECTROSTATICS

Boundary value problems and Laplace equation – Boundary condition and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and Spherical polar co-ordinates – Examples of solution for boundary value problems.

Polarization and displacement vectors – Boundary conditions – Dielectric sphere in a uniform field – Electrostatic energy in the presence of dielectric – Multipole expansion.

UNIT 2: MAGNETOSTATICS

Biot- Savart Law – Ampere's law – Magnetic vector potential and magnetic field of a localized current distribution – Magnetic moment distribution in an external field – Magnetostatic energy – Magnetic induction and magnetic field in microscopic media – Boundary conditions.

UNIT 3: MAXWELL EQUATIONS

Faraday's laws of Induction – Maxwell's displacement current – Maxwell's equations – Vector and Scalar potentials – Gauge invariance – Coulomb and Lorentz gauges – Energy and momentum of the field – Poynting's theorem – Lorentz force – Conservation laws for a system of charges and electromagnetic fields.

UNIT 4: WAVE PROPAGATION

Wave equation and Plane wave solutions – Plane waves in non-conducting media – Linear and circular polarization, refraction and reflection at a plane interface – Waves in a conducting medium – Propagation of waves in a rectangular wave guide.
Inhomogeneous wave equation and related potentials – Radiation from a localized source – Oscillating electric dipole.

UNIT 5: RELATIVISTIC ELECTRO DYNAMICS

Lorentz transformation for space and time in four vector – Invarience of D'Alembertian operator – Invarience of Maxwell's field equation in terms four vectors – electromagnetic field tensor – Maxwell's equation in covariance four tensor form – Lorentz transformations of electromagnetic fields – Invarience of electromagnetic field.

BOOKS FOR STUDY:

1. **D.J. Griffiths**, 2002, Introduction to Electrodynamics, 3rd Edition, Prentice-Hall of India, New Delhi.
2. **J.R. Reitz, F.J. Milford** and **R.W. Christy**, 1986, "Foundations of Electromagnetic Theory" 3rd Edition, Narosa Publication, New Delhi.
3. **Chopra and Agarwal**, Electrodynamics,
4. **Gupta, Kumar and Singh**, Electrodynamics, S.Chand & Co., New Delhi
5. **Jordan and K.G. Balmai,** 1968, Electromagnetic wave and radiating system, Prentice Hall.

BOOKS FOR REFERENCE:

1. **W. Panofsky** and **M. Phillips**, 1962, Classical Electricity and Magnetism, Addison Wesly, London.
2. **J.D. Kraus** and **D.A. Fleisch**, 1999, Electromagnetics with Applications, 5th Edition, WCB McGraw-Hill, New York.
3. **J.D. Jackson,** 1975, "Classical Electrodynamics", Wiley Eastern Ltd. New Delhi.
4. **B. Chakraborty**, 2002, Principles of Electrodynamics, Books and Allied, Kolkata.
5. **F.P. Feynman, R.B. Leighton,** and **M. Sands**, 1998, The Feynman Lectures on Physics, Vols. 2, Narosa, New Delhi.
6. **Andrew Zangwill,** 2013, Modern Electrodynamics, Cambridge University Press, USA.
7. **Edward. M.Purcell,** 1985, Electricity and Magnetism, Berkeley Physics course, Vol 2, 2nd Edition, McGraw-Hill Book, New Delhi.

WEB RESOURCES

1. https://www.cliffsnotes.com/study-guides/physics/electricity-and-magnetism/electrostatics
2. https://www.comsol.co.in/multiphysics/magnetostatics-theory
3. http://galileo.phys.virginia.edu/classes/109N/more_stuff/Maxwell_Eq.html
4. https://www.elprocus.com/wave-propagation-definition-equation-and-types/
5. https://en.wikipedia.org/wiki/Relativistic_electromagnetism

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM313	**MICROPROCESSOR AND MICROCONTROLLER**

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	**III**	**4**	**75**

Course Objectives:

The aim and objective of the course on **Microprocessor and Microcontroller** is to familiarize the students of M.Sc. class to the basic aspects of programing and interfacing with microprocessor and microcontroller thereby designing various microcontroller based applications.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Draw and describe architecture, instructions and programing of 8085

CO2: Learn about the architecture, instruction sets and programing of 8086

CO3: Learn common applications of microprocessors like Analog to Digital convert,7 segment LED displays through 8255

CO4: Study the Organization and internal architecture of the microcontroller 8051

CO5: Write assembly language program for microcontrollers.

CO6: Design microcontroller based system for various applications.

UNIT 1: INTEL 8085 MICROPROCESSOR: ARCHITECTURE, INSTRUCTIONS AND PROGRAMMING

INTEL 8085 - Architecture – Pin diagram – Instruction Cycle – Fetch and Execute operations - Timing diagram – Op-code Fetch – Memory read and write – I/O read and write– interrupts Instruction set– Addressing modes – Intel 8085 instructions – Assembly language program for addition, subtraction, Multiplication and division–sum of a series of 8-bit numbers – Arrange an array of data in ascending and descending order – block transfer.

UNIT 2: INTEL 8086 ARCHITECTURE AND INSTRUCTION SET

CPU architecture-addressing modes-instruction formats-instruction set-execution timing. Assembly language program for addition, subtraction, Multiplication and division–sum of a series of 8-bit numbers – Arrange an array of data in ascending and descending order – block transfer.

UNIT 3: INTERFACING PERIPHERAL I/O SYSTEMS

Programmable peripheral device 8255 – Interfacing keyboard – Matrix Scanning – Interfacing multiplexed 7 segment display – DAC and ADC Interface – Waveform generation using DAC interface – Stepper motor interface – clockwise, anticlockwise.

UNIT 4: 8051 MICROCONTROLLER HARDWARE

Introduction – features of 8051 – 8051 microcontroller hardware: Pin – out of 8051, central processing unit (CPU), Internal RAM, Internal ROM, Register set of 8051 – Memory organizing of 8051 – input/output pins, ports and circuits – external data memory and program memory: external program memory, external data memory.

UNIT 5: 8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAM

Addressing modes – data moving (data transfer) instructions: instructions to access external data memory, external ROM/ program memory, PUSH and POP instructions , data exchange instructions – logical instruction: byte and bit level logical operations, rotate and swap operations – Arithmetic instructions: Flags , incrementing and decrementing , addition , subtraction , multiplication and division, decimal arithmetic – jump and CALL instructions: Jump and CALL program range, Jump, CALL and subroutines – programming.

BOOKS FOR STUDY:

1. **V. Vijayendran**, 2005, Fundamentals of Microprocessor-8085", 3rd Edition S.Visvanathan Pvt, Ltd.
2. **Douglas V. Hall**, 2005, Microprocessor interfacing, Programming and Hardware, Tata McGraw-Hill.
3. **Muhammad Ali Mazidi, Janice Gillipsie Mazidi**, 2006, The 8051 Microcontroller and Embedded Systems, Pearson Prentice Hall, First Impression.

BOOKS FOR REFERENCES:

1. **Barry B. Brey**, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi.
2. **J. Uffrenbeck**, "The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.
3. **W. A. Tribel, Avtar Singh**, "The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.

WEB RESOURCES

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm
2. https://www.javatpoint.com/instruction-set-of-8086
3. https://www.tutorialspoint.com/microprocessor/microprocessor_8086_overview.htm
4. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/
5. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/
6. http://www.circuitstoday.com/8051-microcontroller
7. https://www.elprocus.com/8051-assembly-language-programming/

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUMP303	COMPUTATIONAL MICROCONTROLLER PRACTICAL-III

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	III	3	60

Course Objectives: The aim and objective of the course on **Computational Practical** is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using any high level language such as C, and also programming using microcontrollers 8051.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Apply basics knowledge of computational Physics in solving various physical problems.

CO2: Program with the C or any other high level language.

CO3: Use various numerical methods in describing/solving physics problems.

CO4: Program with the microcontroller 8051.

CO5: Solve problem, critical thinking and analytical reasoning as applied to scientific problems.

Numericals Methods (C PROGRAM):

1. Lagrange interpolation with Algorithm, Flow chart and output.
2. Newton forward interpolation with Algorithm, Flow chart and output.
3. Newton backward interpolation with Algorithm, Flow chart and output.
4. Curve-fitting: Least squares fitting with Algorithm, Flow chart and output.
5. Numerical integration by the trapezoidal rule with Algorithm, Flow chart and output.
6. Numerical integration by Simpson's rule with Algorithm, Flow chart and output.
7. Numerical solution of ordinary first-order differential equations by the Euler method with Algorithm, Flow chart and output.
8. Numerical solution of ordinary first-order differential equations by the Runge- Kutta method with Algorithm, Flow chart and output.

Microcontroller 8051:

9. 8 – bit addition and subtraction, multiplication and division.
10. Sum of a series of 8 –bit numbers, average of N numbers.
11. Factorial numbers, Fibonacci series of N terms.
12. Sorting in ascending and descending order. Picking up the smallest and largest number in an array.
13. LED interface – Binary up/down counter.
14. LED interface – BCD up/down counter.
15. Interfacing seven segment display.
16. Stepper motor interfacing.

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM304	**MICROPROCESSOR PRACTICAL - IV**

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	**III**	**3**	**60**

[External (Expt – 60; Record – 15): 75 + Internal (Assn. – 10; Test – 10; Regularity – 5): 25]

Course Objectives:

The aim and objective of the course on **Microprocessor Practical** is to familiarize the of M.Sc. students to solve problem, critical thinking and analytical reasoning as applied to design and perform interfacing with microprocessors (8085 and 8086).

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Plan the flowchart and process of program execution

CO2: Familiar with the working of assembly language programs.

CO3: Solve basics and advanced programing using 8085 microprocessors.

CO4: Solve basics and advanced programing using 8086 microprocessors.

CO5: Able to design and perform interfacing with microprocessors.

<u>Microprocessor 8085:</u>

1. 8 – bit addition and subtraction, multiplication and division.
2. Sum of a set of N data (8 –bit numbers).
3. Sorting in ascending and descending order. Picking up the smallest and largest number in an array.
4. Code conversion (8 –bit numbers) – a) Binary to BCD b) BCD to Binary
5. Addition of multi-byte numbers, Factorial
6. Interfacing of seven segment display.
7. Interfacing R/2R ladder DAC (IC 741) – waveform generation.
8. Interfacing of DC stepper motor – Clockwise, Anti-clockwise.
9. Interfacing of Temperature controller and Measurement.

Microprocessor 8086:

10. 8 – bit addition and subtraction, multiplication and division.
11. Multibyte addition and subtraction (64 and 128 bit numbers)
12. Sum of a set of N data (8 –bit numbers), average of N numbers.
13. Square and square root of 8 bit number.
14. Sorting in ascending and descending order.
15. Picking up the smallest and largest number in an array.
16. Generation of Fibonacci series.

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM414	**CONDENSED MATTER PHYSICS**

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	**IV**	**4**	**90**

Course Objectives:

The aim and objective of the course on **Condensed Matter Physics** is to expose the students of M.Sc. class to the topics like elastic constants, lattice vibrations and energy band theory so that they are equipped with the techniques used in investigating these aspects of the matter in condensed phase.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Develop a clear concept of the crystal classes and symmetries

CO2: Calculate the Braggs conditions for X-ray diffraction in crystals.

CO3: Comprehends in depth about inelastic scattering by phonons

CO4: Explain the theory of metals and semiconductors of solid state systems.

CO5: Learn the basics of the Magnetic behaviour of various materials.

CO6: Gain basic knowledge of experimental facts and theoretical explanation about superconductivity.

UNIT 1 - CRYSTAL PHYSICS

Lattice points and Space lattice - Miller indices – Space group: Characteristics and Determination- Liquid crystals - Bragg's law – Bragg's law in three dimension – Geometrical structure factor (sc, bcc, fcc) - Brillouin zone and Reciprocal Lattice (sc, bcc, fcc) - Madelung constant.

UNIT 2 - LATTICE VIBRATION AND PHONONS

Lattice mode of vibration – Phase velocity and Group velocity of harmonic waves – Lattice vibration spectrum - Concept and Momentum of Phonons - Umkalapp processes - Inelastic scattering by Phonons by Phonons, X-Ray by Phonons, Neutrons by Phonons

UNIT 3 - THEORY OF METALS AND SEMICONDUCTORS

Free electron gas in three dimensions - Electronic heat capacity - Wieldemann - Franz law - Hall effect - Band theory of metals and semiconductors - Bloch theorem - Kronig - Penney model – Elementary theory of Semiconductors – Types of Semiconductors (n and p) - Mobility - Impurity conductivity – Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect.

UNIT 4 – MAGNETISM

Classification of Magnetic material- Diamagnetic material and its properties – Wiess and Quantum theory of paramagnetism -Hund's rule- Quantum theory of ferromagnetism - Curie point- Neel temperature. - Ferromagnetic domains - Magnons - Theory of anti-ferromagnetism - Ferrimagnetism and Ferrites

UNIT 5 - SUPERCONDUCTIVITY

Experimental Aspects: Sources and Occurrence of superconductivity - Effect of Magnetic and Gyromagnetic fields - Meissner effect - Heat capacity - Energy gap - Type I and II Superconductors.

Theoretical Aspects: London equations - BCS Theory of Superconductivity - DC & AC Josephson effects - High Temperature Superconductors – SQUIDS- Cryotron switches

BOOKS FOR STUDY:

1. **C. Kittel**, 1996, Introduction of Soild State Physics, 7th Ed. Wiley Eastern Ltd, NewYork.
2. **M. Ali Omar**, 1974, Elementary Solid State Physics – Principles and Applications, Addison – Wesley.
3. **H.P. Myers**, 1998, Introductory Solid State Physics, 2nd Ed.
4. **S.O. Pillai**, 1997, Solid State Physics, New Age International, New Delhi.
5. **R.L. Singhal,** 1998, Solid State Physics, 6th Edition, Kedar Nath Ram Nath & Co. Meerut.

BOOKS FOR REFERENCE:

1. **J.C. Anderson, K.D. Leaver, R.D. Rawlings and J.M.Alexander**, 1990, Materials Science, 4th Edition, Chapman Hall, London.
2. **J.S. Blakemore**, Solid State Physics, 1974, 2nd Edition (W.B.Saunder, Philadelphia, 1974).
3. **A.J. Dekker**, Solid State Physics (Macmillan India).
4. **H.M. Rosenburg**, 1993, The Solid State, 3rd Edition, Oxford University Press, Oxford.
5. **C.M. Kachhava**, 1990, Solid State Physics, Tata McGraw- Hill, New Delhi.
6. **M.A. Wahab,** 2005, Structure and Properties of Materials, 2nd edition, Narosa Publishing house.

WEB RESOURCES

1. https://www.britannica.com/science/crystal
2. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations
3. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Semiconductors/Band_Theory_of_Semiconductors
4. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Map%3A_Inorganic_Chemistry_(Housecroft)/06%3A_Structures_and_energetics_of_metallic_and_ionic_solids/6.08%3A_Bonding_in_Metals_and_Semicondoctors/6.8B%3A_Band_Theory_of_Metals_and_Insulators

5. https://www.nationalgeographic.org/encyclopedia/magnetism/
6. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Electronic_Structure_of_Atoms_and_Molecules/Electronic_Configurations/Hund's_Rules
7. https://www.brainkart.com/article/Super-Conductors_6824/

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM415	**CRYSTAL GROWTH**

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	**IV**	**4**	**90**

Course Objectives:

The objective of the course on **crystal growth** is to familiarize the students of M.Sc. class to the basic aspects of crystal growth like nucleation, different types of crystal growth techniques and various techniques of characterization of materials in to develop a strong background in crystal growth if they choose to pursue research in physics as a career.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: An idea about all types of nucleation and crystal growth theories

CO2: Analyse the wide range of crystal growth techniques from solution.

CO3: Describe various processes involved in melt and vapour growth of crystals

CO4: Elaborate the understanding of Gel growth medium and flux growth of crystals

CO5: State of the art facts and various techniques of characterization of materials

UNIT 1: NUCLEATION AND CRYSTAL GROWTH THEORIES

Nucleation concept – Kinds of nucleation (Homogeneous and Heterogeneous nucleation) – Classical theory of nucleation – Energy of formation of a critical nucleus - Spherical nucleus – Cylindrical nucleus – Free energy of formation of a critical heterogeneous cap shaped and disc shaped nuclei –Nucleation rate - Surface energy theory – Diffusion theory

UNIT 2: CRYSTAL GROWTH FROM SOLUTION

Low temperature solution growth – Solution and Solubility – Preparation of solution - Principle of low temperature solution growth - Mier's solubility diagram – Measurement of solubility – Measurement of Ostwald-Mier's metastable zone width – Achievement of super-saturation. Crystal Growth methods – Slow cooling method – Holden's rotary crystallizer – Mason Jar method – Slow evaporation method – Johnson's rotating crystal method – Temperature gradient method – Kruger and Fink U tube method.

UNIT 3: MELT GROWTH AND VAPOR GROWTH

Growth of crystal from melt – Bridgman method – Czochralski method – Verneuil method – Zone melting method- Principle and Techniques of Zone refining.

Physical vapour deposition – Chemical vapour deposition – Open and closed systems – Physical and thermo - chemical factors affecting growth process.

UNIT 4 : GEL GROWTH AND FLUX GROWTH

Gel growth – Principle, types, structure and importance of gel techniques – Experimental procedure – Single diffusion technique – Double diffusion technique – Chemical reduction method- Biological crystallization.

High temperature solution growth (Flux growth) – Principle of flux growth – Slow cooling method – Slow evaporation method – Top seeded solution growth.

UNIT- 5 : CHARACTERIZATION TECHNIQUES

Single crystal XRD -UV-Visible-NIR spectroscopy-Experimental set ups for Fourier Transform Infrared analysis -Nonlinear optical phenomenon (qualitative)-Kurtz powder SHG method-photoconductivity and schematic set up for measurements-negative photoconductivity.

BOOKS FOR STUDY

1. **M. Ohora** and **R. C. Reid**, "Modeling of Crystal Growth Rates from Solution"
2. **J. C. Brice,** 1986, " Crystal Growth Processes"
3. **J. C. Brice**, "The Growth of Crystals from Melt"
4. **D. Elwell** and **H. J. Scheel,** "Crystal Growth from High Temperature Solution"
5. **Heinz K. Henish**, 1973, "Crystal Growth in Gels", Cambridge University Press. USA.
6. **V G Dmitriev, G.G. Gurzadyan, D.N. Nikigosyan,** 1991, 'Handbook of Nonlinear optical crystals' Springer- Verlag.
7. **Douglas A. Skoog, F. James Holler and Stanley R. Crouch,** 2006, 'Principles of Instrumental analysis', 6th edition , Brooks cole Cenage learning, 2006.

BOOK FOR REFERENCES

1. **P. Ramasamy** and **F. D. Gnanam,** 1983, "UGC Summer School Notes".
2. **P. SanthanaRaghavan** and **P. Ramasamy,** "Crystal Growth Processes", KRU Publications.
3. **P. Santhanaraghavan and P. Ramasamy**, 2001, Crystal growth Process and Methods, KRU Publications, Kumbakonam.
4. **H.E. Buckley,** 1951, Crystal Growth, John Wiley and Sons, NewYork .
5. **B.R. Pamplin,** 1980, Crystal Growth, Pergman Press, London.

WEB RESOURCES

1. https://advances.sciencemag.org/content/5/4/eaav7399.full
2. https://web.mit.edu/x-ray/cystallize.html
3. https://www.britannica.com/science/crystal/Growth-from-the-melt
4. https://www.mtixtl.com/fluxmethodforpreparingcrystals.aspx
5. https://www.mri.psu.edu/materials-characterization-lab/characterization-techniques

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUM416	MEDICAL PHYSICS AND ULTRASONICS

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	IV	4	90

Course Objectives:

The objective of the course on **Medical Physics and Ultrsonics** is to familiarize the students of M.Sc. class to the basic aspects of medical instrumentations and to familiarize in studying the intermolecular interactions in liquid mixtures using ultrasonic interferometer which will help them to pursue a career research in physics.

Course Outcomes:

After successful completion of this paper, the student will be able to

CO1: Acquire basic knowledge about electrocardiography, electromyogram and magnetic resonance imaging.

CO2: An idea about microprocessor based ventilators and dialysis process.

CO3: Learn about medical applications of lasers

CO4: Interpret two technological importance of ultrasonic velocity and adiabatic compressibility of the liquids

CO5: Acquire basic knowledge about applications of ultrasound

UNIT 1: DIAGNOSTIC DEVICES

Blood Pressure and its Measurement – Eye Pressure Measurement - Electrical Signals from Heart: Electrocardiography (ECG) – Electrical Signals from brain: Electroencephalogram (EEG) - Electrical Signal from muscles: Electromyogram (EMG) – Magnetic Resonance Imaging (MRI).

UNIT 2: THERAPEUTIC DEVICES

Microprocessor based ventilators – AC and DC defibrillator – Pacemaker – Versatile Electro Therapeutic Stimulator – Anesthesia Machine – Ventilator – Dialysis Process – Comparison between Hemodialysis and Peritoneal Dialysis - Peritoneal Dialysis unit.

UNIT 3: MEDICAL APPLICATIONS OF LASERS

Laser Based Blood Cell Counter – Laser Doppler Blood Flow meter – Laser in Angioplasty – Principle and theory of fluorescence – Reflectance and Light Scattering Spectroscopy – Laser Spectroscopy Cancer Detection

UNIT 4: ULTRASONIC STUDY OF LIQUID MIXTURES AND SOLUTIONS

Preparation of multi component liquid mixtures: Mole fraction – Weight fraction – Volume fraction. Measurement techniques: Ultrasonic Interferometer – Continuous wave method – Density – Viscosity

Pure liquids and binary Mixtures: Free Length Theory – Collision Factor Theory – Nomoto's Relation Acoustical Parameters – Adiabatic Compressibility – Acoustic Impedance – Intermolecular Free Length – Molar Volume – Free Volume – Internal Pressure.

UNIT 5: Applications of Ultrasound

Low Frequency – High Intensity Applications: Ultrasonic Welding – Ultrasonic Cleaning – Applications – Food Industry – Length Meters.

High Frequency – Low Intensity Applications: Level Meters – Thickness Measurements – Ultrasonic Microscopy – Acoustic Holography (Transmission Acoustic Holography)

BOOK FOR STUDY:

1. **Dr .M. Arumugam**, 2005, Biomedical Instrumentation, Anuradha publications, Chennai.
2. **S. Svanberg**, 2010, Atomic & Molecular Spectroscopy (Basic aspects & Practical applications), 4th Edition, WILY Publications.
3. **Baldevraj, V.Rajendran and P.Palanichamy**, 2009, Science and Technology of Ultrasonics, 4th Edition, Narosa Publications, New Delhi.

BOOK FOR REFERENCE:

1. **John R. Cameron and James G. Skofronick**, 2009, Medical Physics, John Wiley Interscience Publication, Canada, 2nd edition.

WEB RESOURCES

1. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692
2. https://www.technicalsymposium.com/alllecturenotes_biomed.html
3. https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78
4. https://www.modulight.com/applications-medical/
5. https://www.researchgate.net/publication/322992337_Introduction_of_ultrasonic_interferometer_and_experimental_techniques_for_determination_of_ultrasonic_velocity_density_viscosity_and_various_thermodynamic_parameters
6. https://www.realclearscience.com/articles/2017/05/12/five_futuristic_applications_of_ultrasound.html
7. https://www.aplustopper.com/ultrasound-and-its-applications/

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUMP405	GENERAL PRACTICAL– V

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	IV	3	90

[External (Expt – 60; Record – 15): 75 + Internal (Assn. – 10; Test – 10; Regularity – 5): 25]

Course Objectives:

The aim and objective of the laboratory on **General Practical** is to expose the students of M.Sc. class to experimental techniques, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

Course Outcome:

After successful completion of this paper, the student will be able to

CO1	Acquire hands on experience of using various advanced instruments.
CO2	Acquire hands on experience of using particle detectors such as GM counter
CO3	Understand the basic of nuclear safely management.
CO4	Perform scientific experiments as well as accurately record and analyse the results of experiments.
CO5	Explore new areas of research in physics and allied fields of science and technology
CO6	Solve applied nuclear problems with critical thinking and analytical reasoning.

GENERAL PRACTICAL

1. Cornu's Method – Young's Modulus and Poisson's ratio by Hyperbolic fringes.
2. Michelson Interferometer – Thickness of Thin Sheet.
3. GM counter –Feather's Analysis.
4. GM counter –Dead Time.
5. Ultrasonic interferometer – velocity and compressibility of liquids.
6. Solar Constant
7. Susceptibility by Quincke's method.
8. Hall effect.
9. Edser and Butler fringes – Thickness of air film.
10. Laser: Study of laser beam parameters.
11. Conductivity measurement using four probe method.
12. B-H loop of transformer using CRO

13. Diffraction Method – Thickness of Insulation of Wire
14. Conductivity Measurement using Four Probe Method
15. Dielectric Constant
16. Planck's Constant – Photo Cell

M. Sc. DEGREE **BRANCH: PHYSICS**

SYLLABUS

(Effective for students admitted from the academic year 2020 - 21)

SUBJECT CODE	TITLE OF THE PAPER
20MUMQ401	PROJECT

YEAR	SEMESTER	CREDITS	LECTURE HOURS
II	IV	3	60

[External (Dissertation – 50; Viva voce – 25): 75 + Internal ((Seminar – 10; Mock Viva – 10; Regularity – 5): 25]

Course Objectives:

The aim and objective of introducing the **Project** will help the students of M.Sc. class to learn and apply the principles of Physics and explore the new research avenues.

Course Outcomes:

After successful completion of this project, the student will be able to

CO1: Demonstrate a sound technical knowledge of their selected project topic

CO2: Undertake problem identification, formulation and solution

CO3: Perform scientific experiments and analyze the results of experiments.

CO4: Explore novel research ideas in science and technology

Introduction

In the course of the project the student will refer books, Journals or collect literature / data by the way of visiting research institutes/ industries. He may even do experimental /theoretical work in his college and also other research institutions, submit a dissertation report with a minimum of 40 pages not exceeding 50 pages.

Format for Preparation of Dissertation

The sequence in which the dissertation should be arranged and bound should be as follows

1. Cover Page and title Page
2. Declaration
3. Certificate
4. Abstract (not exceeding one page)
5. Acknowledgement (not exceeding one page)
6. Contents (12 Font size, Times new Roman with 1.5-line spacing, both side)
7. List of Figures/ Exhibits/Charts
8. List of tables
9. Symbols and notations
10. Chapters
11. References