APPROVED SYLLABUS

OF

MASTER OF SCIENCES (PHYSICS)

Semester- I to IV

(Subject to Changes by the Academic Council)

SCHOOL OF SCIENCES

ABHILASHI UNIVERSITY
CHAIL CHOWK, TEH. CHACHYOT,
DISTT. MANDI-175028, HP, INDIA

PROGRAMME STRUCTURE

M.Sc. PHYSICS

Semester	Course Code	Course	L	T	P	C
I	MPHY-101	Mathematical Physics-I	4	0	0	4
	MPHY-102	Classical Mechanics	4	0	0	4
	MPHY-103	Quantum Mechanics –I	4	0	0	4
	MPHY-104	Electronics	4	0	0	4
	MPHYL-105	Physics Laboratory-I	0	0	3	3
	MPHYL-106	Computational Physics Laboratory	0	0	2	2
		Sub Total	**16**	**0**	**5**	**21**
II	MPHY-201	Mathematical Physics - II	4	0	0	4
	MPHY-202	Quantum Mechanics – II	4	0	0	4
	MPHY-203	Statistical Mechanics	4	0	0	4
	MPHY-204	Digital Electronics	4	0	0	4
	MPHYL-205	Physics Laboratory - II	0	0	3	3
	MPHYL-206	Electronics Lab	0	0	3	3
		Sub Total	**16**	**0**	**6**	**22**
III	MPHY-301	Classical Electrodynamics	4	0	0	4
	MPHY-302	Condensed Matter Physics –I	4	0	0	4
	MPHY-303	**Special paper (Any one):** (I) Opto-Electronics (II) Science of Renewable Energy Sources	4	0	0	4
	MPHY-304	Atomic and Molecular Physics	4	0	0	4
	MPHYL-305	Nuclear Physics Lab	0	0	3	3
	MPHYSS-306	Synopsis &Seminar (Literature Search Review and synopsis submission)	0	0	1	1
		Sub Total	**16**	**0**	**4**	**20**
IV	MPHY-401	Nuclear and Particle Physics	4	0	0	4
	MPHY-402	Condensed Matter Physics-II	4	0	0	4
	MPHY-403	Material Science	4	0	0	4
	MPHYPR-500	Project (Experiments and Results Analysis ; Project report Submission)	0	0	10	10
		Sub Total	**12**	**0**	**10**	**22**
		Grand Total	**60**	**0**	**25**	**85**
Total Credits: 60 + 25 = 85						

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

Theory courses

Sub-component	Weightage
First Sessional Examination	**10**
Assignment and Seminar	**05**
Attendance	**05**
Second Sessional Examination	**20**
End-Semester Examination	**60**

Practical courses

<table>
<tr><th>Examination</th><th>Sub-component</th><th>Weightage</th><th>Total</th></tr>
<tr><td rowspan="4">Mid-Sessional Practical Exam (Internal examination)</td><td>Viva-voce + Written exam</td><td>15</td><td rowspan="4">50</td></tr>
<tr><td>Practical record file</td><td>15</td></tr>
<tr><td>Continuous lab performance</td><td>10</td></tr>
<tr><td>Attendance</td><td>10</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="3">End-Semester Practical Exam (External examination)</td><td>Viva-voce + Written exam</td><td>25</td><td rowspan="3">50</td></tr>
<tr><td>Practical record file</td><td>15</td></tr>
<tr><td>Attendance</td><td>10</td></tr>
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M.SC 1ST SEMESTER

MATHEMATICAL PHYSICS I

COURSE CODE: MPHY -101	Max. Marks:			Credits			
Total Teaching Hours: 48	Internal	External	Total	L	T	P	Total
	40	60	100	4	0	0	4

Objectives: The aim and objective of the course on Mathematical Physics I is to equip the M.Sc student with the mathematical techniques for understanding theoretical treatment in different courses e.g.to evaluate various definite integrals, to solve various differential equations including Laplace equation, Schrodinger equation, equations used in electronic circuits, electrical circuits, nuclear decays etc., Concepts of Complex analysis, Dirac Delta function, beta, gamma functions, Special functions: Bessel, Legendre, Hermite, Lagurre functions for developing a strong background if he chooses to pursue research in Physics as a career.

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

I. **Complex Variables:** Introduction, Cauchy Riemann conditions. Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals. Dispersion relation.

UNIT II

II. **Delta and Gamma Functions:** Dirac delta function. Delta sequences for one dimensional function, properties of delta function, gamma function, factorial notation and applications. Beta function.

UNIT III

III. **Differential Equations:** Partial differential equations of theoretical physics, separation of variables, singular points, series solutions, second solution.

UNIT IV

IV. **Special Function:** Bessel function of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality.

Legendre function: generating function, recurrence relations and special properties, orthogonally. Various definitions of Legendre polynomials, Associated Legendre functions: recurrence relations, parity and orthogonality. Hermite functions. Lagurerre function.

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:

1. Mathematical methods for Physicists : G. Arfken and H.J. Weber (Academic Press, San Diego) (sixth edition) (2005)
2. Group Theory for Physicists: A.W. Joshi (Wiley Eastern, New Delhi) (2005)
3. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co. Kolkata) (1961).
4. A First Course in Computational Physics: P.L. Devries (Wiley, New York) (1994).
5. Matrices and Tensors in Physics: A.W. Joshi (Wiley Eastern, New Delhi) (2002)
6. Mathematical Physics: P.K. Chatopadhyay (Wiley Eastern, New Delhi) (2005)
7. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) (2004).

CLASSICAL MECHANICS

COURSE CODE: MPHY-102	**Max. Marks:**			**Credits**			
Total Teaching Hours: 48	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Objectives: The aim and objective of the course on Classical Mechanics is to train the students of M.Sc class in the Lagrangian and Hamiltonian formalism , conservation theorems ,rigid body motion , Hamilton’s equations , Canonical Transformations to an extent that they can use these in the modern branches like Quantum Mechanics, Quantum field theory , Condensed matter Physics, Astrophysics etc.

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

I. **Lagrangian Formulation:** Mechanics of a system of particles: constraints of motion. Generalized coordinates, D'Alembert's Principle and Lagrange's velocity – dependent force and the dissipation function. Application of Lagrangian formulation.

II. **Hamilton Principle:** Calculus of variations. Hamilton principle. Lagrange's equation from Hamilton's principle. Extension to non-holonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

UNIT II

III. **Rigid Body Motion:** Independent co-ordinates of rigid body, orthogonal transformation. Eulerian Angles and Euler's theorems. Infinitesimal rotation. Rate of change of vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation. Euler equations of motion. Torque free motion of rigid body, motion of a symmetrical top.

UNIT III

IV. **Small Oscillations:** Eigen value equation. Free vibrations. Normal Coordinates. Vibrations of a tri atomic molecule.

V. **Hamilton's Equations:** Legendre Transformations. Hamilton's equations of motion. Cyclic-co-ordinates. Hamilton's equations from variational principle, principle of least action.

UNIT IV

VI. **Canonical Transformation and Hamilton- Jacobi Theory:** Canonical transformation and its example, Poission brackets. Equations of motion, Angular momentum. Possion's Bracket relations, infinitesimal canonical transformation. Conservation Theorems. Hamilton – Jacobi equations for principal and characteristic functions. Harmonic oscillator problem, Action angle variables for system with one degree of freedom.

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:

1. Classical Mechanics: H. Goldstein (Narosa, New Delhi) 1992.

2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi)(2006)
3. Analytical Mechanics: L.N. Hand and J.D. Finch (Cambridge University Press, Cambridge) 1998.
4. Classical Mechanics: V.D. Barger and M.G. Olsson, (McGraw-Hill, New York) 1973.
5. Classical Mechanics: N.C. Rana and P.J. Joag (Tata McGraw Hill, New Delhi) (2004)

QUANTUM MECHANICS I

COURSE CODE: MPHY-103	Max. Marks:			Credits			
Total teaching hour: 50	Internal	External	Total	L	T	P	Total
	40	60	100	4	0	0	4

Objectives: The aim and objective of the course on Quantum Mechanics I is to introduce the students of M.Sc to the formal structure of the subject and to equip them with techniques of linear vector space and matrix mechanics, Stationary state approximate methods , angular momentum , perturbation theory, Variational method with the application to ground states of harmonic oscillator, hydrogen atom etc., Fermi's Golden rule so that they can use these in various branches of Physics as per requirement.

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

Unit - I

I. Introduction: Time Independent Schrödinger wave equation & its application (Particle in a box & Free Particle) **MATRIX FORMULATION OF QUANTUM MECHANICS:**
Matrix Algebra: Matrix addition and multiplication, Null unit and Constant Matrices, Trace, Determinant and Inverse of a Matrix, Hermitian and unitary Matrices, Transformation and diagonalization of Matrices, Function of Matrices and matrices of infinite rank. Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

Unit –II

II Linear Vector Space and Matrix Mechanics: Vector spaces, Sehwarz inequality, Ortho normal basis. Schmidt ortho-normalisation method, Operators, projection operator. Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators. Postulates of quantum mechanics, uncertainly relation. Exchange operator and identical particles.

Unit – III

Angular Momentum: Angular part of the Schroedinger equation for a spherically symmetric potential, orbital angular momentum operator, Eigenvalues and eigenvector of L2 and Lz, Spin angular momentum. General angular momentum, Eigenvalues and eigenvectors of J2 &Jz. Representation of general momentum operator. Addition of general angular momentum, C.G. co-efficients.

Unit – IV

Stationary State Approximate Methods: Non- Degenerate and degenerate perturbation theory and its application to anharmonic oscillator, Variational method with application to the ground states of harmonic oscillator, hydrogen atom, helium. **Time Dependent Perturbation:** General expression for the probability of transition from one state to another. Constant and harmonic perturbations. Fermi's golden rule and its application to radiative transition in atoms. Selection rules for emission and absorption of light

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:

1. Quantum Mechanics : M.P. Khanna ,(HarAnand, New Delhi)(2009)

2. A text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, NewDelhi) (2004).

3. Quantum Mechanics: V.K Thankappan (New Age, New Delhi)(2005).

4. Quantum Filed Theory: H. Mandl and G. Shaw, (Wiley, New York) (1993).

5. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi) (1998).

6. Quantum Physics: S. Gasiorowicz (Wiley – India Edition) (2009).
7. Modern Quantum Mechanics: J.J. Sakurai (Pearson –Education, India)(2009).
8. Advanced Quantum Mechanics: J.J. Sakurai (Pearson –Education, India)(2009).

ELECTRONICS

COURSE CODE: MPHY-104	Max. Marks:			Credits			
Total teaching hour: 48	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**5**	**0**	**0**	**5**

Objectives: The Electronics I course covers linear wave shaping which throws light on high pass and low pass RC circuits and response to various wave forms, Clamping and clipping circuits, diode clippers, transistor clippers, clamping circuit theorem, operation of transistor as a switch, Multivibrators: A stable, Mono stable and Bi stable modes and their applications, Counting circuits, operational amplifier, communication systems, IC fabrication : basic ideas of integrated circuits, various steps of fabrication of Monolithic integrated circuits.

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

Semiconductor Devices: FET, JFET and its operation. Characteristics. Pinch off voltage. MOSFET. Enhancement and depletion mode. Comparison of JFETs and MOSFETs. Thermistor. Barretters. Gunn diode, Zener diode. IMPATT and TRAPATT devices, PIN diode, Tunnel diode. Thyristor, SCR, TRIAC, DIAC, UJT, Photo-conductive devices, Photo-conductive cell, Photodiode, Solar cell, LED, LCD.

UNIT II

Number Systems: Binary, octal and hexadecimal number systems. Arithmetic operations: Binary fractions, Negative binary numbers, Floating point representation, Binary codes: weighted and non-weighted binary codes, BCD codes, Excess-3 code, Gray codes, binary to Gray code and Gray to binary code conversion, error detecting and error correcting codes.

UNIT III

Operational Amplifier: Difference Amplifier, Transfer Characteristics, Frequency response, IC Operational Amplifier, Compensation in Operational Amplifiers. Application of Op-Amp as Adder, Multiplier, Differentiator, Integrator, Logarithmic and Anti-logarithmic Amplifier, Application of Operational Amplifier to Analog Computation

UNIT IV

Communication systems: Generation and detection of amplitude modulated, Single- side band, Double-side band suppressed carrier and Frequency modulated wave.

IC Fabrication: Standard gate assemblies, Fabrication of integrated Circuits and Devices: Basic ideas of integrated circuits, Epitaxial growth, Diffusion, Masking, Etching, Fabrication of Monolithic Integrated circuits.

TUTORIALS: Relevant problems given in the books listed below:

1. Pulse Digital and Switching Wave Forms: J. Millman and H. Taub (Tata McGraw-Hill, New Delhi) (2008)

2. Integrated Electronics, J. Millman and C.C. Halkias (Tata McGraw-Hill, New Delhi) (2008)

3. Electronics Communication System: George Kennedy (Tata McGraw Hill, New Delhi) (1977)

PHYSICS LABORATORY-I

COURSE CODE: MPHYL-105	**Max. Marks:**			**Credits**			
Total teaching hour: 4/week	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	50	**50**	**100**	**0**	**0**	**3**	**3**

Objectives: The aim and objective of the courses on Physics Laboratory I is to expose the students of M.Sc. to the experimental techniques in general Physics, electronics, nuclear Physics and condensed matter Physics so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.

Note:

1. Students are expected to perform at least 10 experiments in one semester.
2. Duration of the examination will be 4 hours.

List of Practical / Experiments:

1. To find the refractive index of transparent liquid using the hollow prism and a spectrometer.
2. To find the wavelength of sodium light using Michelson Interferometer.
3. To study the dependence of energy transfer on the mass ration of colliding bodies using air track.
4. To verify the law of conservation of linear momentum in collision using air track apparatus.
5. To obtain the potential energy curve due to magnet-magnet interactions using air track apparatus.
6. To study oscillations in a rectangular potential well using air track apparatus.
7. To find wavelength of given laser light using diffraction grating.
8. To study the angular divergence of a He-Ne Laser.,
9. To find the wavelength of He-Ne laser using vernier calipers/measuring metallic scale.
10. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
11. To find the numerical aperture and losses in optical fiber.

COMPUTATIONAL PHYSICS LABORATORY

COURSE CODE: MPHYL-106	Max. Marks:			Credits			
Total teaching hour: 4/week	Internal	External	Total	L	T	P	Total
	50	50	100	0	0	2	2

I. **Introduction to Numerical methods:** Computer algorithms, interpolations –cubic spline fitting, Numerical differentiation – Lagrange interpolation, Numerical integration by Simpson and Weddle's rules, random generators, Numerical solution of differential equations by Euler, predictor-corrector and Runge-Kutta methods, Monte carlo technique, problems.

II. Computer hardware, software, programming languages, C/C++, classification of data, variables, dimension and data statement, input/output, format, branching, IF statements, DO statements, subprograms, operations with files.

III. List of Numerical Problems:

1) Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.
2) Choose a set of 10 values and find the least squared fitted curve.
3) Generation of waves on superposition like stationary waves and beats.
4) Fourier analysis of square waves.
5) To find the roots of quadratic equations.
6) Wave packet and uncertainty principle.
7) Find first order derivative at given x for a set of 10 values with the help of Lagrange interpolation.
8) To generate random numbers between (i) 1 and 0, (ii) 1 and 100.
9) Perform numerical integration on 1-D function using Simpson and Weddle rules.
10) To find determinant of a matrix - its eigenvalues and eigenvectors.

Books:

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co.) 4th edition.
2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition 2011.
3. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition 2008.
4. Computational Physics: R.C.Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 1st edition 2005.
5. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 2nd edition 2002.

2ND SEMESTER

MATHEMATICAL PHYSICS - II

COURSE CODE: MPHY-201	**Max. Marks:**			**Credits**			
Total teaching hour: 48	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Objectives: The aim and objective of the course on Mathematical Physics II is to equip the M.Sc student with the mathematical techniques for understanding theoretical treatment in different courses. The knowledge of Fourier analysis, Laplace transforms, tensor analysis, integral equations help to solve plenty of problems in higher Physics. Numerical analysis helps to solve problems of computational physics and develop a strong background if he chooses to pursue research in Physics as a career.

Note:

1. The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

I. **Group Theory:** Basic definitions, Multiplication table, conjugate elements and classes. Subgroups, Isomorphism and Homomorphism. Definition of representation and its properties. Reducible and irreducible presentation. Characters of a representation. Example of C4ν. Topological groups and Lie groups, three dimensional rotation group. Unitary groups. Applications of group Theory.

UNIT II

II. **Fourier series and Integral Transforms:** Fourier series, Dirichlet conditions, General properties, Advantages and applications, Gibbs phenomenon. Fourier transforms. Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives, Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation.

UNIT III

III. **Integral Equations:** Definitions and classifications, Neumann series, Separable kernels, Hilbert-Schmidt theory. Green's function in one dimension.

IV. **Tensors:** Introduction, definitions, contraction, direct product, Quotient rule. Levi-Civita symbol, Non Cartesian tensors, metric tensor. Covariant differentiation.

UNIT IV

V. Elementary Numerical Analysis: Numerical differentiation, Numerical integration by Simpson and Weddle's rules. Numerical solution of differential equations by Euler and Runge-Kutta Method, Linear and non-linear least square fitting, generation of random numbers, Monte-Carlo technique, solution of simultaneous equations (simplex method)

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books

1. Mathematical methods for Physicists: G. Arfken and H.J. Weber (Academic Press, San Diego) (Sixth edition) (2005).

2. Group Theory for Physicists: A.W. Joshi (Wiley Eastern, New Delhi) (2005).

3. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co. Kolkata) (1961).

4. A First Course in Computational Physics: P.L. Devries (Wiley, New York) (1994).

5. Matrices and Tensors in Physics: A.W. Joshi (Wiley Eastern, New Delhi) (2002).

6. Mathematical Physics: P.K. Chatopadhyay (Wiley Eastern, New Delhi) (2005).

7. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) (2004).

QUANTUM MECHANICS - II

COURSE CODE: MPHY-201	Max. Marks:			Credits			
Total teaching hour: 48	Internal	External	Total	L	T	P	Total
	40	60	100	4	0	0	4

UNIT I

Scattering Theory : Scattering Cross-section and scattering amplitude, partial wave analysis, Phase shift, Low energy scattering, Green's function in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Electron scattering by an atom, Optical theorem, Scattering of identical particles.

UNIT II

Relativistic Quantum Mechanics: Klein- Gordon equation, Dirac equation and its plane wave solution, significance of negative energy solutions, spin angular momentum of the Dirac particle, non-relativistic limit of Dirac equation. Electron in electromagnetic fields, spin magnetic moment.

spin – orbit interaction, Dirac equation for a particle in a central field. fine structure of hydrogen atom, Lamb shift.

UNIT III

Field Quantization: Resume of Lagrangian and Hamiltonian formalism of a classical field. Second **quantization:** Concepts and illustrations with Schroedinger field. Quantization of a real scalar field and its application to one meson exchange potential.

UNIT IV

Relativistic Quantum Field Theory: Quantization of a complex scalar field. Dirac field and e.m. field. Commutation relations. Covariant perturbation theory. Introduction to Feynman Diagrams.

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:

1. Quantum Mechanics: M.P. Khanna (Har Anand, New Delhi)(2009)
2. A text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) (2004).
3. Quantum Mechanics: V.K Thankappan (New Age, New Delhi) (2005).
4. Quantum Filed Theory: H. Mandl and G. Shaw, (Wiley, New York) 1993.
5. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi) (1998).
6. Quantum Physics: S. Gasiorowicz (Wiley India Edition, New Delhi) (2009).
7. Modern Quantum Mechanic: J.J. Sakurai (Pearson Education, India) (2009).
8. Advanced Quantum Mechanics: J.J. Sakurai (Pearson Education, India) (2009).

STATISTICAL MECHANICS

COURSE CODE: MPHY-203	**Max. Marks:**			**Credits**			
Total teaching hour: 48	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Objectives: The aim of the course is to familiarize the students with the techniques of ensemble theory and relate the statistics and thermodynamics, Gibbs paradox, micro canonical ensemble theory and its application to ideal gas of monatomic particles, equipartition and virial theorems, physical significance of various statistical quantities, energy fluctuations, a system of harmonic oscillators as canonical ensemble, statistics of paramagnetism, thermodynamics of magnetic systems and negative temperatures, significance of statistical quantities, Ising model and Heisenberg models, Fluctuations so that he/she can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents.

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

UNIT I

The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.

Elements of Ensemble Theory: Phase space and Liouville's Theorem, The micro canonical ensemble theory and its application to ideal gas of monatomic particles, equipartition and virial theorems, canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, a system of quantum harmonic oscillators as canonical ensemble, statistics of para-magnetism.

UNIT II

The grand canonical ensemble: Equilibrium between a system and a particle-energy reservoir and significance of statistical quantities. Classical ideal gas in grand canonical ensemble theory. Density and energy fluctuations.

Elements of Quantum Statistics: Quantum states and phase space, quantum statistics of various ensembles. An ideal gas in quantum mechanical ensembles, statistics of occupation numbers.

UNIT III

Ideal Fermi Systems: Thermodynamic behaviour of an ideal fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli para-magnetism

Ideal Bose Systems: Basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, Discussion of gas of photons (the radiation fields) and phonons (The Debye field), Liquid helium and superfluidity.

UNIT IV

Elements of Phase Transitions: Introduction, a dynamical model of phase transitions, Ising and Heisenberg models.

Fluctuations: Thermodynamic Fluctuations, random walk and Brownian motion, introduction to non-equilibrium processes, diffusion equation

TUTORIALS: Relevant problems given in the end of each chapter in the text book.

Books:

1. Statistical Mechanics: R.K. Pathria (Butterworth-Heinemann, Oxford) 2nd edition (2005).

2. Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi) 2011.

3. Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) 1988.

4. L. D.Landau and E. M. Lifshitz, Statistical Physics part I, 3rd edition 1980.

5. F. Reif ,'Fundamental of Statistical and thermal physics (Mc Graw Hill,1965).

DIGITAL ELECTRONICS

COURSE CODE: MPHY-204	**Max. Marks:**			**Credits**			
Total teaching hour: 48	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Objectives: The Electronics II covers the logic systems : concepts of dc positive, negative systems, logic gates in DL, RTL, DTL and TTL logic families, number systems, Karnaugh map representation of logic functions, Multiplexers and Flip Flops, Registers , Analog to digital converters, digital to analog converters, Semiconductor memory devices : Organizations , operations, classification and characteristics of memories, digital display, Seven segment display, charged couple device memory and applications , Fundamentals, types and various concepts of Microprocessors

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

Unit I

Logic Systems: Basic concepts of dc positive, negative and dynamic logic systems, Logic gates (AND, OR, NOT, NOR, NAND and EX-OR gates) in DL, RTL, DTL and TTL logic families. Number systems, Binary arithmetic, Boolean algebra, De-Morgan laws. Karnaugh map representation of logic functions and simplification of logic functions (up to three variables).

Unit II

Multiplexers, demultiplexers, adders, subtractors, comparators, Latch, FLIP FLOPS (SR, JK, T, D, MASTER SLAVE) Registers, shift registers(serial and parallel operations), Asynchronous counters (up, down, up down, decade) and synchronous counter (up, down, up-down, decade). Analog-to-digital converters, digital-to-analog converters.

Unit III

Semiconductor memory devices: organizations, operations, Classification and characteristics of memories, read only memory (ROM organization, PROM, EEPROM), RAM (Bipolar RAM, MOS RAM), Memory Storage Cell(both Bipolar and MOS RAM), Digital display, Seven Segment Display, Charged Couple Device Memory, Applications

Unit IV

Fundamentals of Microprocessors, ideal microprocessor, data bus, address bus, control bus, ALU, Registers, program counters, flags, timing and control sections, microprocessor based system, basic operations, Programming Languages (introduction and basic instructions)

Books:

1. Integrated Electronics, J. Millman and C.C. Halkias (Tata McGraw-Hill, New Delhi) (2008).
2. Digital Computer Electronics, A.P. Malvino and J.A. Brown (Tata McGraw-Hill, New Delhi) (2008).
3. Modern Digital electronics, R. P. Jain (Tata McGraw-Hill, New Delhi) (2006).

PHYSICS LABORATORY-II

COURSE CODE: MPHYL-205	Max. Marks:			Credits			
Teaching hour: 6/week	Internal	External	Total	L	T	P	Total
	50	50	100	0	0	3	3

Note: Students are expected to perform at least 10 experiment distributed over all the section in one semester. Duration of the examination will be 4 hours.

List of Practicals /Experiments

1. **Four probe (band gap):** To measure the resistivity of semi-conductor by four probe method and determine its band gap
2. **BH loop of a ferrite material:** To draw the BH loop of ferrite material and determine the resonance and coercive fields
3. **Lattice dynamics:** To determine the lattice dynamics and dispersion relation for themo no-atomic and diatomic lattices
4. **SCR :** To study the DC characteristics and applications of SCR
5. **Hall-effect:** To determine the Hall coefficient of a given semi-conductor,
6. To identify type of semi-conductor and estimate the charge carrier concentration in it
7. **Lande's factor of DPPH:** Determination of Lande's factor of DPPH using electron spin resonance (ESR) spectrometer
8. **Ultrasonic interferometer:** To find out the velocity of ultrasonic waves in a liquid using ultrasonic interferometer
9. **Photo-Voltaic cell:** To study the series, parallel and Spectral characteristics of a Photo Voltaic cell
10. **Magnetic properties of Semiconductors:** To measure the magneto-resistance of doped semiconductors.
11. **Dielectric properties of materials:** To measure the dielectric constant and the curie temperature of ferroelectric materials

ELECTRONICS LABORATORY

COURSE CODE: MPHYL-206	Max. Marks:			Credits			
Teaching hour: 6/week	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	50	**50**	**100**	**0**	**0**	**3**	**3**

Objectives: The aim and objective of the courses on Physics Laboratory I and Physics Laboratory II is to expose the students of M.Sc. to the experimental techniques in general Physics, electronics, nuclear Physics and condensed matter Physics so that they can co-relate the theoretical concepts with the experimental ones and develop confidence to handle sophisticated equipments wherever necessary.

Note: Students are expected to perform at least 10 experiments in one semester.

The Duration of the examination will be 4 hours

List of Practicals /Experiments

1. Design of Regulated power supply and study of its characteristics.
2. To trace I-V characteristic curves of diodes and transistors on a CRO, and learn their uses in electronic circuits.
3. To study the characteristics of given a stable multivibrator.
4. To study the use of digital to analog and analog to digital converter.
5. Study the clipper and clamper circuits.
6. MOSFET characteristics, biasing and its applications as an amplifier.
7. To study the demodulation of AM wave. (ii) To study various aspects of frequency modulation and demodulation.
8. To study the frequency response of an operational amplifier & to use operational amplifier for different mathematical operations.
9. Use of timer IC 555 in astable and monostable modes and applications involving different relays and LDR.
10. To study logic gates and flip flop (JK, RS and D) circuits using on a bread-board.
11. 8085 microprocessor kit – familiarization and introductory programming.
12. Design, and verify the 4-bit synchronous counter.

M.SC. 3RD SEMESTER

CLASSICAL ELECTRODYNAMICS

COURSE CODE: MPHY-301	Max. Marks:			Credits			
Total teaching hour: 50	Internal	External	Total	L	T	P	Total
	40	60	100	4	0	0	4

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

Unit I

Electrostatics and Magnetostatics: Gauss' law, Applications of Gauss' Law, Laplace equations, Poisson equations, Biot-Savart law, Ampere's theorem, Electromagnetic induction

Unit II

Boundary Value Problems: Uniqueness Theorem, Dirichlet Boundary conditions, Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic Boundary value problem, Formal solution Magnetostatic Boundary value problem.

Unit III

Time Varying Fields and Maxwell Equations: Displacement current, Maxwell equations in free space, Maxwell equations in linear isotropic media, Scalar potentials, Vector potentials, Hertz potential, Gauge transformation, Gauge invariance, Coulomb Gauge, Lorentz gauge, Boundary conditions on the electric and magnetic fields at interfaces

Unit IV

Electromagnetic Waves: Wave equation, Plane waves in free space, Plane waves in isotropic dielectrics, Energy transmitted by a plane wave, Reflection and Refraction of electromagnetic waves at plane surface, Polarization of EM waves

Unit V

Radiation from Localized Time Varying Sources: Solution of the in-homogenous wave equation in the absence of boundaries, Radiation of a localized oscillating source, Fields of a localized oscillating source, Electric dipole, Electric quadrupole fields

Unit VI

Charged Particle Dynamics and Waveguides: Dynamics of charged particles instatic electromagnetic fields, Dynamics of charged particles in uniform electromagnetic fields, Non-relativistic motion in slowly varying magnetic field, E.M. wave guides, Rectangular wave guides

Text Books:

1. Introduction to electrodynamics by D. J Griffiths, Prentice-hall, 4thEdition, (2012)

References:

1. Classical electrodynamics by S.P. Puri, Tata Mcgraw hill, 1st Edition,(1999)
2. Electromagnetic wave and radiating systems by E.C. Jordan and K.G. Balmain, Prentice Hall of India, 1st Edition, (1997)
3. Classical electrodynamics by J.D Jackson, Wiley Eastern, New York,3rd Edition, (2007)

CONDENSED MATTER PHYSICS - I

COURSE CODE: MPHY-302	**Max. Marks:**			**Credits**			
Total teaching hour: 50	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Objectives: The aim and objective of the course on Condensed Matter Physics I is to make the students of M.Sc class familiar to the topics like elastic constants, lattice vibrations, dielectric properties, energy band theory and transport theory so that they are prepared with the techniques used in investigating these aspects of the matter in condensed phase.

UNIT I

Elastic constants: Resume of binding in solids; Stress components, stiffness constant, elastic constants, elastic waves in crystals. **Lattice Dynamics and Thermal Properties:** Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamic properties of crystal, anharmonic effects and thermal expansion.

UNIT-II

Energy Band Theory: Review of electrons in a periodic potential; nearly free electron model; tight binding method; Impurity levels in doped semiconductors, Band theory of pure and doped semiconductors.

UNIT-III

Transport Theory: Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation, calculation of relaxation time in metals; thermal conductivity of metals and insulators; thermoelectric effects; Hall Effect and magneto resistance; Transport in semiconductors.

UNIT-IV

Dielectric Properties of Materials: Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity.

TUTORIALS: Relevant problems given in the books listed below:

Text Books:

1. Introduction to Solid State Physics (VII ed): C. Kittel (7th edition, Wiley, New York) 1995.
2. Quantum Theory of Solids: C. Kittel (2nd edition, Wiley, New York) 1987.
3. Principles of the Theory of Solids: J. Ziman (2nd edition, Cambridge Univ. Press, Cambridge) 1979.
4. Solid State Physics: H. Ibach and H. Luth (4th edition, Springer Berlin) 2009.

5. Solid State Theory: Walter A, Harrison (Tata McGraw- Hill, New Delhi) 1970.
6. Theory of Lattice Dynamics in the Harmonic Approx: AA Maradudin et al (Academic Press) 2011.

NOTE: Special paper (Any one):

OPTO ELECTRONICS

COURSE CODE: MPHY-303(I)	Max. Marks:			Credits			
Total teaching hour: 48	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

UNIT I

Injection luminescence: Recombination processes, the spectrum of recombination radiations, Direct and Indirect band gap Semiconductors, The Internal Quantum Efficiency, The External Quantum Efficiency.

UNIT II

The basic principles of laser actions: spontaneous and stimulated emission and absorption, the condition for the laser action, Types of laser, Semiconductor lasers; Theory of Laser action in Semiconductors , condition for gain, The threshold conditions for oscillations, rates of spontaneous and stimulated emission , effect of refractive index, calculation of the gain coefficients , relation of the gain coefficient to current density, Semiconductor Injection Laser :Efficiency, Stripe geometry LED materials, commercial LED materials, LED construction, Response time of LED's, LED derive circuitry.

UNIT III

Optical Detectors: Introduction, Device types, Optical Detection. Principles, Absorption, quantum efficiency, Responsivity, Long wavelength cut off, Photoconductive Detectors, Characteristics of particular photoconductive materials. Solar cell, Holography and its applications,Liquid crystal displays The Optical Fiber , Multimode and Single Mode Fibers, Glass Fibers, Plastic Optical Fibers,Fiber-Optic Bundle, Fabrication of Optical Fibers ,Preform fabrication, Fiber Fabrication ,Free Space Optics

UNIT IV

Junction Detectors : detectors performance parameters Semiconductors p-i-n diodes, General Principle, quantum efficiency, Materials and design for p-i-n photodiodes. Impulse & frequency response of p-i-n photodiodes. Avalanche photodiodes detectors. The multiplication process. Avalanche photodiodes (APD) design, APD bandwidth, phototransistors

Reference Books

1. Optical communication systems: John Gowar, Prentice Hall of India Pvt.Ltd., New Delhi,1987.

2. Optical fibre communications-Principles and practice: John M Senior, Prentice Hall International, 1985.

3. Optoelectronics-An Introduction: J Wilson, JFB Hawkes, Prentice Hall International, 2nd ed., 1989.

4. Physics of the semiconductor devices: SM Sze,Wiley Eastern Ltd., 2nded.,1983.

5. Fiber Optics And Lasers –The Two Revolutions: Ajoy Ghatak, K Thyagarajan.

SCIENCE OF RENEWABLE ENERGY SOURCES

COURSE CODE: MPHY-303(II)	Max. Marks:			Credits			
Total teaching hour: 60	Internal	External	Total	L	T	P	Total
	40	60	100	4	0	0	4

UNIT I

Introduction: Classification of Energy Sources, Production alternatives and reserves of energy sources in the world and in India; need of renewable energy sources, energy security and energy conservation, Energy and its environmental impacts, Distributed generation

UNIT II

Solar Energy: Solar thermal and solar photovoltaic technologies and their applications; solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, Types of solar cells, p-n junction solar cell, current density, open circuit voltage and short circuit current, Fill factor, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, power conversion efficiency, Solid-liquid junction solar cells: principles of photo-electrochemical solar cells, Dye sensitized solar cells, Perovskite solar cells, Elementary ideas of Tandem solar cells.

UNIT III

Hydrogen Energy: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel in vehicles and electrical power generation, hydride batteries

UNIT IV

Other sources: Wind energy, wave energy, ocean thermal energy conversion (OTEC).

ATOMIC AND MOLECULAR SPECTROSCOPY

COURSE CODE: MPHY-304	**Max. Marks:**			**Credits**			
Total teaching hour: 50	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Course Objectives:

• Students will understand the features of the various spectra of atoms and molecules.

• The students will understand the concept of hyperfine structures.

• The students will be able to differentiate the rotational and vibrational spectra of a molecule.

Unit – I

Spectra of one and two valance electron systems: Magnetic dipole moments; Larmor's theorem; Space quantization of orbital, spin and total angular momenta; Vector model for one and two valance electron atoms; Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology; Spectroscopic notations for L-S and J-J couplings; Spectra of alkali and alkaline earth metals; Interaction energy in L-S and J-J coupling for two electron systems; Selection and Intensity rules for doublets and triplets

Unit – II

Breadth of spectral line and effects of external fields: The Doppler effect; Natural breadth from classical theory; natural breadth and quantum mechanics; External effects like collision damping, asymmetry and pressure shift and stark broadening; The Zeeman Effect for two electron systems; Intensity rules for the zeeman effect; The calculations of Zeeman patterns; Paschen-Back effect; LS coupling and Paschen –Back effect; Lande's g factor in LS coupling; Stark effect

Unit – III

Microwave and Infra-Red Spectroscopy: Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven, The vibrating diatomic molecule as a simple harmonic and an harmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations, Outline of technique and instrumentation, Fourier transform spectroscopy.

Unit – IV

Raman and Electronic Spectroscopy: Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, ,Electronic spectra of diatomic molecules, Born Oppenheimer approximation- The Franck Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, Example of spectrum of molecular hydrogen.

Text and Reference Books:

1. Introduction to Atomic Spectra: H.E. White-Auckland Mc Graw Hill, 1934.
2. Fundamentals of molecular spectroscopy: C.B. Banwell-Tata Mc Graw Hill, 1986.
3. Spectroscopy Vol. I, II & III: Walker &Straughen
4. Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo Mc Graw Hill, 1962.
5. Spectra of diatomic molecules: Herzberg-New York, 1944.

6. Molecular spectroscopy: Jeanne L McHale.

NUCLEAR PHYSICS LAB

COURSE CODE: MPHYL-305	Max. Marks:			Credits			
Teaching hour: 48	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**0**	**0**	**3**	**3**

1. Pulse-Height Analysis of Gamma Ray Spectra.
2. Calibration of Scintillation Spectrometer.
3. Least square fitting of a straight line.
4. Study of absorption of gamma rays in matter.
5. Study of Compton Scattering Effect.

6. To study the characteristics of a G.M. Counter.
7. To determine the Dead time of a G.M. Counter.
8. Absorptions of Beta Particles in Matter.
9. Source strength of a Beta Source.
10. Window thickness of a G.M. Tube.
11. To investigate the statistics of radioactive measurements.
12. Study of Poisson Distribution.
13. Study of Gaussian Distribution.

Synopsis &Seminar (Literature Search, Review and synopsis submission)

COURSE CODE: MPHYSS-306	Max. Marks:			Credits			
Total teaching hour: 2 hrs/week	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**1**	**0**	**0**	**1**

M.Sc.- 4th SEMESTER

NUCLEAR AND PARTICLE PHYSICS II

COURSE CODE: MPHY-401	Max. Marks:			Credits			
Total teaching hour: 48	Internal	External	Total	L	T	P	Total
	40	60	100	4	0	0	4

Note: The question paper is expected to contain problems with a weightage of 30 to 40% of the total marks.

Unit I

Nuclear Interactions: Nucleon Nucleon interaction, Exchange forces, Tensor forces, Nucleon Nucleon scattering, Effective range theory, Spin dependence of nuclear forces, Charge independence of nuclear forces, charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction

Unit II

Nuclear Reactions: Direct nuclear reaction mechanisms, compound nuclear reaction mechanisms, Cross sections in terms of partial wave amplitudes, Compound nucleus, Scattering matrix, Reciprocity theorem, Breit Wigner one level formula, Resonance scattering

Unit III

Nuclear Decay: Beta decay, Fermi theory of beta decay, Shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions, Selection rules, Parity violation, Gamma decay, Multipole transitions in nuclei, Internal conversion, Nuclear isomerism

Unit IV

Elementary Particle Physics: Historical survey of elementary particles and their classification, Types of interaction between elementary particles, Hadrons and leptons, the electric charge, baryon number, lepton and muon number, hypercharge (strangeness), the nuclear isospin, Gell-Mann Nishijima formula

TUTORIALS: Relevant problems given at the end of each section in the text books.

Books:

1. Introduction to High Energy Physics: D.H. Perkins (Cambridge University Press, Cambridge) (2001).

2. Elementary Particles: I.S. Hughes (Cambridge University Press, Cambridge) (1996).

3. Introduction to Quarks and Partons : F. E. Close (Academic Press, London) (1981).

4. Introduction to Particle Physics: M.P. Khanna (Prentice Hall of India, New Delhi) (2004).

CONDENSED MATTER PHYSICS II

COURSE CODE: MPHY 402	**Max. Marks:**			**Credits**			
Total teaching hour: 50	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Objectives: The aim and objective of the course on Condensed Matter Physics II is to expose the M.Sc. students with relatively advanced topics like optical properties, magnetism, superconductivity, magnetic resonance techniques and disordered solids so that they are confident to use the relevant techniques in their later career.

Note: The question paper is expected to contain problems with a weightage of 30 to 40 % of the total marks.

UNIT I

Optical Properties: Resume of macroscopic theory – generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect; interband transitions.

UNIT II

Magnetism: Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian and resume of the results; Ferro-, ferri- and antiferro-magnetism; spin waves; specific heat - Bloch law. **Magnetic Resonance Techniques:** Principles of ESR and NMR

UNIT III

Superconductivity: Experimental Survey, Basic phenomenology, Type I and Type II superconductors; BCS pairing mechanism,; High Tc superconductors.

UNIT IV

Defects and Disorder: Elementary ideas of point defects and dislocations; Brief introduction to nanostructures.

TUTORIALS: Relevant problems given at the end of each chapter in the books listed below.

Books :

1. Introduction to Solid State Physics: C. Kittel (7th edition Wiley, New York) 2008.
2. Quantum Theory of Solids: C. Kittel (2nd edition, Wiley, New York)1987.
3. Solid State Physics: H. Ibach and H. Luth (4th edition, Springer, Berlin) 2010.
4. Intermediate Quantum Theory of Solids: A.O.E. Animalu (East-West Press, New Delhi).
5. Solid State Physics: Ashcroft and Mermin (Reinhert& Winston, Berlin, 11th reprint-2011).

MATERIAL SCIENCE

COURSE CODE: MPHY-403	Max. Marks:			Credits			
Total teaching hour: 50	**Internal**	**External**	**Total**	**L**	**T**	**P**	**Total**
	40	**60**	**100**	**4**	**0**	**0**	**4**

Unit I

Vacuum Technology: Basic ideas about vacuum, Through put, Conductance, Vacuum pumps: rotary pump, diffusion pump, ion pump, molecular pump, cry pump, Vacuum gauges: pirani gauge, penning gauge, ionization gauge (hot cathode ionization gauge, cold cathode ionization gauge).

Unit II

Thin Film: Thin Film and growth process, Influence of nature of substrate and growth parameters (substrate temperature, thickness, deposition rate). Thin film deposition, techniques: thermal evaporation, chemical vapor deposition, spray pyrolysis, sputtering. Epitaxial growth, Thin film thickness measurement techniques: film resistance method, optical method, microbalance method.

Unit III

Polymers, Ceramics, Liquid Crystals and Nano phase Materials: Characteristics, Application and Processing of polymers: Polymerization, Polymer types, Stress- Strain behavior, melting and glass transition, thermo sets and thermo plasts. Characteristics, Application and Processing of Ceramics, glasses and refrectories, Liquid Crystals: classification and applications, Nano phase materials: synthesis and applications.

Unit IV

Characterization of Materials Powder and single crystal X-ray diffraction, Transmission electron microscopy, Scanning electron microscopy, Low Energy Electron Diffraction (LEED), Auger electron microscopy, Atomic force microscopy.

Books:

1. Vacuum Technology: A. Roth-North Holland Pub. Co., 1976
2. Thin Film Phenomenon: K.L. Chopra-R E Kriegn Pub. Co., 1979.
3. High Temperature Superconductors: E.S.R. Gopal & SV. Subramanyam-Wiley, 1989
4. Material Science and Engg: W.D. Callister-.Wiley, 1994
5. Nanostructure Materials: J.C. Ying-Wiley-. Academic Press, 2001
6. Methods of Surface Analysis: J.M. Walls- CUP Archive, 1990.

7. Introduction to Nanotechnology - Charles P.Pooler, Frank J. Owens- IEEE, 2003

PROJECT

COURSE CODE: MPHY PR-500 **Max. Marks: 200;**

Credits: 10

The aim of project work in M.Sc. 4th semesters is to expose some of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data etc. Project work can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report of about 30 pages about the work done in the project will be submitted by a date to be announced by the committee. Assessment of the work done under the project will be carried out by a committee formed by the department consisting of three members (one external & two internal including supervisor), on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva voce/seminar, etc. as per guidelines prepared by the committee.

This load (equivalent to 2 hours per week) will be counted towards the normal teaching load of the teacher.