DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

Curriculum under Choice Based Credit & Grading System

M.Sc. I Year

Physics

Semester–I to II

run at college level from the Academic Year 2015-16 & onwards

Dr. Babasaheb Ambedkar Marathwada University,

Aurangabad – 431004 (MS)

Department of Physics

Course Structure and Curriculum

for

M. Sc. Physics

(Effective from June 2011 onwards)

Syllabus for M.Sc. (Physics) Academic Autonomy
(Choice Based Credit System)

The M.Sc. (Physics) programme is divided into four semesters having 104 credits. There are 16 theory courses subdivided into 11 core courses, 4 specialized courses and 1 elective course. Besides there are 7 laboratory courses, a final semester project and seminar / tutorials. This programme offers four specializations viz. Electronics, Condensed Matter Physics, Nuclear Physics and Spectroscopy.

Eligibility:

Those who have completed B. Sc. with Physics as an optional subject from any recognized University/ Institution are eligible for registration subject to the rules and regulations laid down by Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. Preference will be given to the candidates who have completed their B. Sc. with Physics and Mathematics.

Admission / Promotion Process:

In response to the advertisement for registration, interested students will have to register themselves. Admission will be done on the basis of performance of students at their qualifying graduate level examination. Once the student is admitted he / she will be promoted to the next semester with full carryon, however students have to register themselves for every consecutive semester. Dropout students will be allowed to register for respective semester as and when the concerned courses are offered by the department, however he / she should not exceed more than twice the duration of the course from the date of first registration at parent department. The admission of the concern student will be automatically cancelled if he / she fails to complete the course within a period of maximum four years / eight semesters.

Choice Based Credit System (CBCS) :

The choice based credit system has been adopted by this department. This provides flexibility to make the system more responsive to the changing needs of our students, the professionals and society. It gives greater freedom to students to determine their own pace of study. The credit based system also facilitates the transfer of credits.

- Students will have to earn 104 credits for the award of M.Sc. degree.
- Out of 104 credits, students will have to earn 100 credits (Core courses worth 44 credits, specialized courses worth 16 credits, elective course worth 4 credits, laboratory courses worth 20 and seminar / tutorials worth 16 credits) from physics department.
- Remaining 04 credits can be earned through opting service course either from the parent department (inter specialization) or other departments of the University (Subject to approval by the Departmental Committee of Physics Department). If the course opted by the students from other department is having less / more than 4 credits, it will be converted into 4 equivalent credits.
- If the service course from other university departments is not available, student will have to opt service course from other specialization from the physics department. (Choice of service course from the same specialization will not be allowed)

Credit-to- contact hour Mapping:

One contact hour per week is assigned 1 credit for theory and 0.5 credits for practical / laboratory course. Thus a 4 - credit theory course corresponds to 4 contact hours per week and same analogy will be applicable for practical / laboratory course.

Course Structure:

Semester I

Course	Course Title	Teaching time/week	Marks	Credit
PHY-401	Mathematical Methods in Physics	4 hours	100	4
PHY-402	Classical Mechanics	4 hours	100	4
PHY-403	Quantum Mechanics-I	4 hours	100	4
PHY-404	Linear And Digital Electronics	4 hours	100	4
PHY-451	Lab course 1 (General Physics + Nuclear Physics)	4 hours	50	2
PHY-452	Lab course 2 (Condensed Matter Physics + Electronics)	4 hours	50	2
PHY-453	Seminars / Tutorials	5 hours	100	4

Semester II

Course	Course Title	Teaching time/week	Marks	Credit
PHY-405	Quantum Mechanics - II	4 hours	100	4
PHY-406	Statistical Mechanics	4 hours	100	4
PHY-407	Electrodynamics and Plasma Physics	4 hours	100	4
PHY-408	Atomic and Molecular Physics	4 hours	100	4
PHY-454	Lab Course 3 (General Physics + Nuclear Physics)	4 hours	50	2
PHY- 455	Lab Course 4 (Condensed Matter Physics + Electronics)	4 hours	50	2
PHY- 456	Seminars / Tutorials	5 hours	100	4

Semester III

Course	Title	Teaching time/week	Marks	Credit
PHY- 409	General Condensed Matter Physics	4 hours	100	4
PHY- 410	General Nuclear Physics	4 hours	100	4
PHY- 411	Special paper – 1 : A1-Electronics/B1- Spectroscopy/ C1- Nuclear Physics/D1- Condensed Matter Physics	4 hours	100	4
PHY- 412	Special paper – 2: A2-Electronics/B2- Spectroscopy/ C2- Nuclear Physics/D2- Condensed Matter Physics	4 hours	100	4
PHY- 457	Lab course 5 (A1/B1/C1/D1)	6 hours	50	3
PHY- 458	Lab course 6 (A2/B2/C2/D2)	6 hours	50	3
PHY- 459	Seminars / Tutorials	5 hours	100	4

Semester IV

Course	Title	Teaching time/week	Marks	Credit
PHY- 413	Numerical Methods in Physics	4 hours	100	4
PHY- 421	Elective Paper	4 hours	100	4
PHY- 414	**Special Paper – 3:** A3-Electronics/B3- Spectroscopy/ C3- Nuclear Physics/D3- Condensed Matter Physics	4 hours	100	4
PHY- 415	**Special Paper – 4:** A4-Electronics/B4- Spectroscopy/ C4- Nuclear Physics/D4- Condensed Matter Physics	4 hours	100	4
PHY- 460	Lab course 7 (A3/B3/C3/D3)	6 hours	50	3
PHY- 461	Project	6 hours	50	3
PHY- 462	Seminars / Tutorials	5 hours	100	4

List of Elective papers (Any one of the following)

Course	Title	Teaching time/week	Marks	Credit
PHY- 421 E1	Communication and Industrial Electronics	4 hours	100	4
PHY- 421 E2	Advanced Communication Electronics	4 hours	100	4
PHY- 421 E3	Industrial Instrumentation	4 hours	100	4
PHY- 421 E4	Modern Trends in Spectroscopy	4 hours	100	4
PHY- 421 E5	Quantum Theory of Solids	4 hours	100	4
PHY- 421 E6	Reactor Physics	4 hours	100	4
PHY- 421 E7	Physics of Nanomaterials	4 hours	100	4
PHY- 421 E8	Renewable Energy	4 hours	100	4

Following courses will be offered to other departments (as well to the students of other specialization in the physics department) as service courses (subject to approval by the Departmental Committee). The time table for these service courses will be arranged on Friday and Saturday (every week).

PHY- 441: Modern Trends in Spectroscopy
PHY- 442: Reactor Physics
PHY- 443: Physics of Nanomaterials
PHY- 444: Renewable Energy
PHY -445: Advanced Sensor Technology

Notes: (1) Tutorials consists of conceptual as well as numerical problems / questions based the respective theory courses in the semester covering all five (05) units. Total marks assigned for tutorials will be 80 (20 for each theory course). Remaining 20 marks are assigned for seminar based on laboratory course.

(2) Each course / paper should be taught for 40 to 45 contact hours.

(3) Teaching duration for LAB COURSES in first and second semesters should be of 4 hours and for those in third and fourth semesters and project should be 06 hours per week per batch

(4) Each of the courses is divided into five units.

(5) The content of theory course / paper as well laboratory (practical) course may be modified time to time (with the approval DC) to keep pace with the recent developments and trends in the subject.

Attendance:

Students must have 75 % of attendance in each core, specialized, elective and laboratory course for appearing examination otherwise he / she will not be strictly allowed for appearing the examination of each course. However, students having 65 % attendance with medical certificate may request Head of the Department for the condonation of attendance. Monthly attendance of the students for each course will be displayed on the notice board.

Registration for Service Course:

- Students will have to register themselves for the service course of his / her interest after the start of semester in the department on official registration form. The teacher in-charge of the respective course will keep the record of the students registered. Maximum fifteen days period will be given from the date of admission for completion of registration procedure. The departmental committee shall follow a selection procedure after counseling to the students to avoid the overcrowding to a particular course at the expense of some other courses.
- No student shall be permitted to opt more than one service course in a semester.
- Normally no service course shall be offered unless a minimum of 10 students are registered.
- Students will have to pay the prescribed fees per course per semester / year for the registration as decided by the university.

Departmental Committee:

The existing Departmental Committee (DC) will monitor the smooth functioning of M. Sc. programme.

Results Grievances / Redressal Committee

Grievances / redressal committee will be constituted in the department to solve all grievances relating to the evaluation. The committee shall consist of Head of the department and the concerned teacher of a particular course.

Evaluation Methods:

- The grades for courses will be based on 20: 80 ratio of continuous internal assessment (CIA) and semester end examination (SEE).

Internal Evaluation Method:

- There will be two mid semester examinations (20 marks each) as a part of continuous internal assessment (CIA), first based on 40 percent of the syllabus taught and second based on 60 percent of the syllabus taught. The setting of the question paper and the assessment will be done by the concerned teacher who has taught the course. Average score obtained out of two mid semester examinations will be considered for the preparation of final sessional marks / grades.

Term end Examination and Evaluation:

- Semester end examination (SEE) time table will be declared by the departmental committee and accordingly the concern course teacher will have to set question paper, conduct theory examination, conduct practical examination with external expert, evaluate, satisfy the objection / query of the students (if any) and submit the result to DC in one week time from the date of examination of that particular course / paper.

- The semester end theory examination in each theory course / paper will be of 80 marks. The total marks shall be 100 for each theory course / paper (80 marks semester end exam + 20 marks internal tests) and this is equivalent to 4 credits.
- Pattern of semester end question paper will be as below:
  - The semester end examination of theory course / paper will have two parts (20+60 = 80 Marks)
  - Part A will carry short questions of 2-3 marks (fill in the blanks/ answer in sentence / multiple choice questions) as compulsory question and it should cover entire syllabus (20 Marks)
  - Part B will carry 7 questions (12 marks each) out of which there shall be at least one question from each unit. Students will have to attempt any five questions (60 Marks).
  - 20 to 30% weightage can be given to problems wherein use of non-programmable scientific calculator may be allowed.
  - Number of sub questions (with allotment of marks) in a question may be decided by the examiner.
- Semester end practical examination will be of 50 marks each (semester end examination only). Student must perform at least six experiments from each lab course. The final practical / project examination will be conducted at the end of each semester along with the theory examination. Students will be examined by one external and one internal examiner.
- At the end of each semester the Departmental Committee will assign grades to the students. The result sheet will be prepared in duplicate.
- Every student shall have the right to scrutinize answer scripts of mid semester / semester end examinations and seek clarifications from the teacher regarding evaluation of the scripts immediately thereafter or within 3 days of receiving the evaluated scripts.
- The Head of the Department shall display the grade points and grades for the notice of the students.
- The Head of the Department shall send all records of evaluation for safekeeping to the Controller of Examination in two week time after declaration of results.

Earning Credits:

At the end of every semester, a letter grade will be awarded in each course for which a student had registered. A student's performance will be measured by the number of credits that he/she earned by the weighted Grade Point Average (GPA). The SGPA (Semester Grade Point Average) will be awarded after completion of respective semester and the CGPA (Cumulative Grade Point Average) will be awarded at the end of the 4th semester.

Grading System:

- The grading reflects a student-own proficiency in the course. A ten point rating scale shall be used for the evaluation of the performance of the students to provide letter grade for each course and overall grade for the Master Programme. Grade points are based on the total number of marks obtained by him / her in all heads of the examination of the course. The grade points and their equivalent range of marks are shown in Table-I

Table – I : Ten point grade and grade description

Sr No	Marks Obtained (%)	Grade Point	Grade	Description
1	90-100	9.00- 10	O	Outstanding
2	80-89	8.00-8.90	A^{++}	Excellent
3	70-79	7.00-7.90	A^{+}	Exceptional
4	60-69	6.00-6.90	A	Very Good
5	55-59	5.50-5.90	B^{+}	Good
6	50-54	5.00-5.40	B	Fair
7	45-49	4.50-4.90	C^{+}	Average
8	41-44	4.1-4.40	C	Below Average
9	40	4.0	D	Pass
10	< 40	0.0	F	Fail (Unsatisfactory

- Non appearance in any examination / assessment shall be treated as the students have secured zero marks in that subject examination / assessment.
- Minimum D grade (4.00 grade points) shall be the limit to clear / pass the course / subject. A student with F grade will be considered as 'failed" in the concerned course and he / she has to clear the course by appearing in the next successive semester examinations. There will be no revaluation or recounting under this system.
- Every student shall be awarded grade points out of maximum 10 points in each subject (based on 10 point scale). Based on the grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results will be announced at the end of each semester and CGPA will be given on the completion of M. Sc. programme.

Computation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average)

Grade in each subject / course will be calculated based on the summation of marks obtained in internal and semester end examination.

The computation of SGPA and CGPA will be as below

- Semester Grade Point Average (SGPA) is the weighted average points obtained by the students in a semester and will be computed as follows

$$\text{SGPA} = \frac{\text{Sum (Course Credit X Number of Grade Points in concern Course Gained by the Student}}{\text{Sum (Course Credit)}}$$

The SGPA will be mentioned on the mark sheet at the end of every semester.

- The Cumulative Grade Point Average (CGPA) will be used to describe the overall performance of a student in all semester of the course and will be computed as under.

$$\text{CGPA} = \frac{\text{Sum (All four Semester SGPA)}}{\text{Total Number of Semester}}$$

The SGPA and CGPA shall be rounded off to the second place of decimal.

Grade Card

Results will be declared by the Physics Department and the grade card (containing the grades obtained by the student along with SGPA) will be issued by the university after completion of every semester. The grade card will be consisting of following details.

- Title of the courses along with code opted by the student.
- Credits associated with the course.
- Grades and grade points secured by the student.
- Total credits earned by the student in a particular semester.
- Total credits earned by the students till that semester.
- SGPA of the student.
- CGPA of the student (at the end of the IVth semester).

Cumulative Grade Card

The grade card sheet showing details grades secured by the student in each subject in all semester along with overall CGPA will issued by the University at the end of IVth semester.

PHY-401 : Mathematical Methods in Physics : Credits 4

1. Matrices: Special matrices and their properties: Hermitian, anti Hermitian, symmetric, antisymmetric, unitary, orthogonal, rotation matrix in two and three dimensions, trace of a matrix, rank of a matrix, inverse of matrix and its application for solution of systems of linear simultaneous equations. Eigen values and eigen vectors, Cayley Hamilton's theorem, diagonalization of matrices,

   Elementary complex analysis: Complex numbers and their representations, complex algebra, Euler formula, De Moivre's theorem, powers and roots of a complex number, elementary functions. Analytic functions of a complex variable, Cauchy-Riemann conditions, singular points, poles, harmonic functions,

2. Differential equations: Second order differential equations with variable coefficients, ordinary and singular points of an ODE, series solution about an ordinary point, series solution about singular point. Solutions of the following differential equations by series expansions: Legendre, Bessel, Hermite and Laguerre differential equations.

3. Special Functions: Legendre polynomials: Rodrigue's formula, generating function and recurrence relations, orthogonality.
   Bessel functions of the first kind: recurrence relations, orthogonality.
   Hermite Polynomials: generating function, recurrence relations, and orthogonality.
   Lauguerre Polynomials: recurrence relations, orthogonality.

4. Fourier series: Definition, Evaluation of coefficients, Derichlet's conditions, Derichlet's theorem (without proof), extension of the interval. Fourier series representation of even and odd functions, complex representation of a Fourier series, Applications of Fourier series to half wave rectifier, full wave rectifier.
   Fourier transforms: Definition, Fourier transform of elementary functions, Fourier transform of rectangular aperture (Diffraction due to rectangular slit). Fourier transform of derivatives, Fourier transform of Dirac delta function, Fourier sine and cosine transforms, convolution theorem. Applications for solving integrals.

5. Laplace transform: Definition and properties, Laplace transform of elementary functions, Laplace transform of derivative and integral of a function, Laplace transform of Dirac delta function, convolution theorem,
   Inverse Laplace transform by partial fraction expansion: linear unrepeated and repeated factors, quadratic repeated and unrepeated factors,
   Applications of Laplace transform for solution of differential equations and problems in physics

Books:

1. Mathematical methods in the Physical Sciences , by Mary L. Boas, John Wiley and Sons Inc., N.Y.
2. Introduction to Mathematical Physics, by Charlie Harper, Prentice-Hall of India Pvt. Ltd.
3. Mathematical Methods for Physicists (4ht Ed), by George Arfken and H.J. Weber, Academic Press, San Diago (1995)
4. Laplace Transforms and Control Systems Theory for Technology, by Theodore F. Bogrt Jr., PE, John Wiley and Sons, N.Y.
5. Mathematical Methods of Physics ,by Jon Mathew and R. L. Walker, Pearson Education,(2nd Ed.).
6. Mathematical Methods for Physics and Engineering, by K.F. Riley, M.P. Hobson and S. J. Bence, Cambridge U.P.
7. Theory and Problems of Laplace Transforms- Schaum's outline series- , by Murray R. Spigel- Mc Graw Hill Bok Company, International Ed.
8. Theory and Problems of Fourier analysis with applications to boundary value problems -- ,Schaum's outline series- Murray R. Spigel- Mc Graw Hill Bok Company
9. Mathematical methods, by M C Potter and Jack Goldber, Prentice Hall of India
10. Mathematical Physics, by B.S. Rajput, Pragati prakashan, Meerut,
11. Mathematical Physics, by Gupta, and R.P.S. Yadav

PHY-402 : Classical Mechanics : Credits 4

1. Mechanics of a particle:

Mechanics of a particle, Mechanics of a system of particles, Constraints; their classification, D'Alembert's principle and Lagrange's equations, Simple application of the Lagrangian formulation. Hamilton's principle, Techniques of calculus of variations, Some applications of calculus of variations, Derivation of Lagrange's equations from Hamilton's principle, Extension of Hamilton's principle to nonholonomic systems, Conservation theorem and symmetry properties, Energy function and conservation of energy.

2. The two body central force problem:
Reduction to the equivalent one-body problem, the equation of motion and first integrals, the equivalent one dimensional problem and classification of orbits, The differential equation for the orbit, and integrable power law potentials, the Kepler problem: inverse square law of force, scattering in a central force field for Rutherford's scattering.

3. Hamiltonian mechanics:
Hamiltonian canonical equations, Cyclic co-ordinates, canonical transformations, generating functions, Examples of canonical transformations, Poisson brackets and its invariance under canonical transformations, Equations of motion in Poisson bracket notation, Jacobi,s identity, Examples, Hamiltonian –Jacobi equation for Hamiltonian characteristic function, Action and angle variables.

4. Rigid body motion:
Eulerian angles, Equations of motion in rotating frame, Coriolis force, Inertia tensor, Euler equations, Symmetric top.

5. Theory of small vibrations:
Small oscillations, Normal co-ordinates and applications to vibrations of linear in triatomic molecules.

Test Book:
1. *Classical Mechanics*, by H. Goldstein, 2 nd Edition (Narosa Pub.House Pvt. Ltd)
2. Classical Mechanics, by H. Goldstein, Charles Poole, J. L. Safco, 3 rd Edition (Pearson Education Asia)

Reference books:
1. *Classical Mechanics*, by N.C. Rana and P.S. Joag (TataMcgraw-Hill, 1991)
2. *Mechanics*, by A. Sommerfeld (Academic Press, 1952)
3. *Introduction to Dynamics*, by I. Perceival and D Richards(Cambridge Univ. Press. 1982).
4 *Classical Mechanics*, P. V. Panat (Narosa Pub. House Pvt.Ltd)
5. Classical Mechanics, by Gupta, Kumar and Sharma, Pragati Prakashan, Meerut.
6. Classical Mechanics, by J C Upadhyaya (Himalaya Publication, Nagpur)

PHY-403 : Quantum Mechanics – I : Credits 4

1. Origin of quantum mechanics, particle aspects of radiation, wave aspect of radiation, particles versus waves, intermediate nature of microphysical world, quatizations rules, wave packets
2. Wave function, Operators, Schrodinger equation, continuity equation, expectation values. Ehrenfest's theorem stationary states, boundary and continuity conditions, degeneracy orthogonality and parity. Simple one-dimensional problems, particle in a box, step potential, tunneling through a barrier, potential well, harmonic oscillator
3. Spherically symmetric potentials, Hydrogen atom conversion to spherical polar coordinates, separation and solutions of θ, φ and r parts. Wave functions of Hydrogen atom. Angular momentum operators and L_+, L_- operators in spherical polar coordinates, spherical harmonics.
4. Dirac's bra and ket algebra, linear operators, observables, completeness condition. Linear harmonic oscillator using creation and annihilation operators, wave function, matrices of creation and annihilation operators and of x and p. Unitary transformations. Evolution of system with time. Hisenberg, Schrodinger and Interaction pictures.
5. Angular momentum, commutation relations between L_x, L_y, L_z, p_x, p_y, p_z , L^2, r^2 etc. Angular momentum and rotations. Orbital and Spin angular momentum. Ladder operators J_+ and J_- eigen values of J^2 and J_z. Lower and upper bounds. Angular momentum matrices for $j = {}^1/_2$ or $j = 1$, Pauli spin matrices. Addition of angular momenta. Possible values of j, Clebsch Gordan coefficients for $j_1 = j_2 = {}^1/_2$

Tutorial: Simple problems given in the books related to the topics.

Books:
1. *Quantum Mechanics, Theory and applications* 4th edition by Ajoy Ghatak and S Loknathan. Macmillan India Limited
2. *Introductory* Quantum *Mechanics* by Richard L Liboff 4th edition Pearson education Ltd.
3. *Quantum Mechanics* by G. Aruldhas, Prentice-Hall India Private Ltd.
4. *Quantum Mechanics- Concepts and Applications* by Nouredine Zettili, John Wiley

PHY-404 : Linear And Digital Electronics : Credits 4

1. **Operational amplifier** Symbol and terminals, the ideal op-amp, the practical op-amp. Operational amplifier parameters: Input offset voltage, Input offset current, Input bias current, Input impedance, Output impedance, Open loop voltage gain, Common – Mode rejection ratio, Slew rate. Inverting, non - inverting amplifier,
2. **Applications of Operational Amplifier:** Adder, Subtractor, Integrator, differentiator, Comparator & Schmitt's trigger; Wave form generators: Astable Multivibrator, Monostable Multivibrator, and Wien Bridge Oscillator.
3. **Timing Circuits, Numbers systems, and Codes**: Integrated circuit timer: Block diagram of IC – 555, Monostable, Astable Multivibrator using IC-555.Decimal, Binary, & Hexadecimal numbers systems, and its arithmetic's. BCD and Gray code. AND, OR, NOT operations, NAND and NOR operations, NAND and NOR as building blocks, Exclusive – OR operation.
4. **Combinational Logic:** Boolean algebra, Standard Representation for Logical Functions, Karnaugh-map. Half & Full adder, Parallel 4-bit adder, encoder (decimal to binary), Decoder (BCD to decimal), BCD to seven segment decoder, Multiplexer: (4:1) and (8:1), Demultiplexer: (1:8) and (1:16) and their applications.
5. **Sequential Logic:** Flip-Flops: S-R, D- type, T-type, J-K and J-K master-slave. Shift registers: Serial in Serial out, Serial in parallel out, Parallel in Parallel out, Parallel in Serial out. Ripple counters: Mod-16, Mod – 12 and Mod- 10. Synchronous counters: Mod-8 and Mod-16. Semiconductors Memories: Read only memory, Programmable ROMs(PROMs & EROMs), Read/Write Random Access Memories.

Books:

1. Electronic Devices, by Thomas L Floyd, Charles E. Merrill Publishing company.
2. Operational amplifier with Linear integrated circuits, by William D Stanev Fourth Edition, LPE PEARSON Education.
3. Op-Amp and Linear Integrated Circuits, R. A. Gaikwad 4th. Ed, Prentice Hall of India, 2002, ISBN 81 –203–2058–1.
4. Modern Digital Electronics , by R P Jain, 3rd Edition, Tata McGraw – Hill Publishing Company Ltd.
5. Digital Fundamentals , by Thomas L Floyd, 2nd Edition Charles E. Merrill Publishing Company.

PHY-451 : Lab course 1 (General Physics + Nuclear Physics) : Credits 2

1. To determine Planck's constant using a photocell.
2. Measurement of thickness of thin wire using He-Ne laser
3. To determine Determination of e/m by helical method
4. To determine λ and dλ for sodium light using Michelson interferometer
5. Determination of operating voltage of G.M. tube and dead time of a G.M. tube by double source method.
6. Mass absorption coefficient of β particles for Al
7. Solution of algebraic equations by bisection method
8. Method of least squares to fit a straight to the given data
9. Study of coil in A.C. circuit

PHY-452 : Lab course 2 (Condensed Matter Physics + Electronics): Credits 2

1. Determination of magnetic susceptibility by Quinke's method
2. Determination of velocity and wavelength of ultrasonic waves in liquids.
3. OP-AMP as (a) inverting and (b) non inverting amplifier
4. MOD 16 ripple counter
5. OP-AMP as Wein bridge oscillator
6. Astable multivibrator using IC 555
7. OP-AMP as (a)Basic comparator (b) Schmitt trigger: U.T.P., L.T.P. hysteresis
8. Study of CE amplifier (Input impedance, Output impedance, frequency response and 3 dB gain)
9. Study of characteristic x-rays of copper

PHY- 453 : Tutorials and Seminars : Credits 4

PHY- 405 : Quantum Mechanics – II : Credits 4

1. The WKB approximation. Application to bound states connecting formulae Bohr sommerfield Quantization rules, WKB application to transmission problem, Variational method, H_2^+ ion.
2. Time independent Perturbation theory, non-degenerate and degenerate case. Application to anharmonic potentials of the form x^3 and x^4.
3. Time dependent perturbation theory, Fermi's rule, Harmonic perturbation, adiabatic and sudden approximations.
4. Scattering: Scattering cross section, scattering amplitude. Partial wave analysis. Phase shifts. Center of mass frame. Born approximation. Scattering by a hard sphere, attractive potential
5. The Klein-Gordon equation, Its interpretation and limitations, Dirac equation for free particle, Dirac matrices, plane wave solutions, electron in an electromagnetic field, spin of Dirac particle, magnetic moment of electron, spin-orbit interaction

Tutorial:. Simple problems given in the books related to the topics.

Books:

1. *Quantum Mechanics, Theory and applications* 4^{th} edition by Ajoy Ghatak and S Loknathan. Macmillan India Limited
2. *Introductory* Quantum *Mechanics* by Richard L Liboff 4^{th} edition Pearson education Ltd.
3. *Quantum Mechanics* by G. Aruldhas, Prentice-Hall India Private Ltd.
4. *Quantum Mechanics- Concepts and Applications* by Nouredine Zettili, John Wiley

PHY- 406 : Statistical Mechanics : Credits 4

1. **The Statistical Basis of Thermodynamics**
   Postulates of classical statistical Mechanics. Macroscopic and microscopic states. Phase space.Ensemble-microcanonical, canonical and grand canonical, Statistical equilibrium, density distribution of phase point, Liouville's theorem.
2. **Ideal classical gas**
   Partition function of a classical ideal gas, Thermodynamical potentials in terms of partition function for an ideal monoatomic gas in microcanonical and grand canonical ensembles, entropy of mixing and Gibbs paradox, Maxwell-Boltzmann distribution law, Entropy of a monoatomic gas.
3. **Quantum Statistical Mechanics**
   Postulate of Quantum Statistical Mechanics. Density matrix, statistics of indistinguishable particles, MB statistics, FD statistics, BE statistics, Thermal properties of Bose Einstein gas, Statistical photon gas, Bose Einstein condensation .
4. **Cluster Expansion and Co-operative phenomenon**
   Cluster Expansion of classical gas, virial equation of state, first order phase transition, co-operative phenomenon, Ising model in one and two dimensions. Landau's theory of phase transitions.
5. **Fluctuations**
   Fluctuation and transport Phenomenon, Brownian motion, transport equation,Langevin theory of Brownian motion, Einstein's theory of Brownian motion, Fokker-Plank equation, fluctuation dissipation theorem.

Books:

1. Statistical Mechanics; B.K.Agrawal, Melvin Eisner, New Age International Pvt.Ltd.New Delhi.
2. Fundamental of Stastical Mechanics; B.B.Laud, New Age International Pvt.Ltd.New Delhi.
3. Statistical Mechanics;R.K.Patharia, Butterworth-Heinmann Published By Elsevier a division of Reed Elsevier India Pvt.Ltd.New Delhi.
4. Statistical Mechanics; Gupta, Kumar, Pragati prakashan Meerut.
5. Introduction to Statistical Mechanics,S.K. Sinha, Narosa publishing house Pvt.Ltd New Delhi-110002

PHY: 407 : Electrodynamics and Plasma Physics : Credits 4

1. **Electromagnetic wave equation and field vectors**: Maxwell's equations in free space, Plane waves in free space. Dispersion of electromagnetic waves, Poynting vector in free space. Polarization of electromagnetic waves, electric field vector in terms of scalar and vector potential, Wave equation in terms of scalar and vector potential, concept of Retarded potentials, Lienard Wiechert potential.

2. **Reflection and Transmission of electromagnetic waves -I:** Laws of reflection and refraction, Incident wave polarized with its E vector normal to the plane of incidence, oblique incidence: Incident wave polarized with its E vector parallel to the plane of incidence, Reflection and Refraction at the interface between two non-magnetic dielectrics (loss-less).
3. **Reflection and Transmission of electromagnetic waves -II:** concept of Brewster's angle, derivation of Brewster's angle in terms of media parameters, total reflection, Reflection and refraction at the surface of good conductor, oblique incidence of uniform plane waves on a perfectly conducting surface: E wave parallel to the plane of incidence.
4. **Relativistic Electrodynamics:** Four vectors, field tensor, electrodynamics in tensor notation, relativistic potentials. Motion of charged particles in uniform static magnetic field, motion in combined uniform static electric and magnetic fields, particle drifts in nonuniform magnetic fields.
5. **Plasma Physics:** Elementary concepts of plasma, derivation of moment equations from Boltzman equation. Plasma oscillation, Debye shielding, plasma confinement, magneto plasma.
   Fundamental equations, hydromagnetic waves: magnetosonic waves, Alfven waves, wave propagation parallel and perpendicular to magnetic field.

Books :

1. Electromagnetic Waves and Fields, R. N. Singh, Tata Mc Graw Hill.
2. Classical Electromagnetic Radiation, J. B. Marion
3. Introduction to Electrodynamics, David J. Griffith PHI publications.
4. Classical Electrodynamics, Jackson. John Wiley & Sons, Inc.
5. Electromagnetism Theory and Applications, Ashutosh Pramanik, PHI publication.
6. Electrodynamics, Gupta ,Kumar,Singh, Pragati Prakashan
7. Electromagnetics, B. B. Laud, 2nd Edition, Wiley Eastern Ltd

PHY- 408 : Atomic and Molecular Physics : Credits 4

1. Stern Gerlach experiment, Quantum states of an electron. Quantum numbers. Spectra of Hydrogen atom. Spin angular momentum, orbital angular momentum. Coupling of spin and orbit. Fine structure, spectroscopic terms, selection rules. Spectra of the alkali elements.
2. Interaction energy in L-S and j-j coupling, Hund's rule and term reversal. Zeeman effect in one valence electron atoms, interaction energy, selection rules, Zeeman patterns. Paschen-Back effect, Pauli principle. Hyper fine structure (Qualitative)
3. **Rotational spectroscopy**: Classification of molecules, Interaction of radiation with rotating molecule, IR spectra of diatomic molecules, Rigid rotator, energy levels, eigen functions and spectrum of rigid rotator, non-rigid rotator, isotopic substitution, effect of vibration on rotation, Intensities of rotational lines, information derived from rotational spectra[Scope *Spectra of diatomic molecules* G. Herzberg, , chapter 3 + Molecular structure and spectroscopy by G Aruldhas, chapter 6. Rotation of molecules + Spectroscopy volume 2, Edited by B.P. Straughan and S. Walker, chapter 4. Infrared and Raman Spectroscopy)
4. **Vibrational spectroscopy**: Vibrational course structure, Deslandres table, Diatomic molecule as a harmonic oscillator,energy levels, eigen functions and spectrum of harmonic oscillator, Morse potential, anharmonic oscillator, vibrating rotator with & without Born Oppenheimer approximation, [Scope *Spectra of diatomic molecules* G. Herzberg, chapter 3 + Molecular structure and spectroscopy by G Aruldhas, Chapter 7. Infrared spectroscopy + Spectroscopy volume 2, Edited by B.P. Straughan and S. Walker, chapter 4. Infrared and Raman Spectroscopy)
5. **Laser Fundamentals**: Masers and lasers, methods of obtaining population inversion, Ammonia maser, Spontaneous and induced emission, Einstein's A and B coefficients, Properties of lasers, Principle & working of He-Ne, Ruby, semiconductor and color center lasers [Scope: *Physics of atoms and molecules* B. H. Bransden and C. J. Joachain + *Laser Spectroscopy, Basic Concepts and Instrumentation* by W. Demtroder, chapter 5. Lasers as Spectroscopic Light Sources]

Tutorial: Problems given in the books on related topics.

Books:

1. Introduction to Atomic Spectra H E White McGraw Hill
2. Atomic Physics by Christopher J. Foot, Oxford University Press 2005.
3. Fundamentals of Molecular Spectroscopy C.N Banwell & Elaine M. McCash. Tata McGraw Hill
4. Spectra of diatomic molecules G. Herzberg, Krieger Malbar Florida
5. Molecular structure and spectroscopy by G Aruldhas Prentice Hall of India

6. Spectroscopy volume 2, Edited by B.P. Straughan and S. Walker, London Chapman and Hall
7. Laser & Non linear Optics B B Laud. Wiley Eastern Limited.
8. Laser Spectroscopy, Basic Concepts and Instrumentation by W. Demtroder, Springer
9. Physics of atoms and molecules B. H. Bransden and C. J. Joachain Pearson Education

PHY-454 : Lab course 3 (General Physics + Nuclear Physics): Credits 2

1. Determination of h/e of electron by photocell
2. Calibration of platinum resistance thermometer as a function of temperature and to determine unknown temperature
3. Determination of temperature of a flame by sodium line reversal method.
4. Study of capacitor in A.C. circuit
5. To study random nature of radioactive disintegration by G M counter
6. Determination of range of β particles from Radium and Sr in Al
7. Inversion of matrix using Gaussian elimination method (In EXCEL)
8. Integration of mathematical equation by using Simpson's 1/3 rule with error analysis (In EXCEL)
9. Study of interference of microwaves

PHY-455: Lab course 4 (Condensed Matter Physics + Electronics): Credits 2

1. Study of band gap of semiconductor using 4 probe method
2. Determination of magnetic susceptibility by Gouy's method
3. Measurement of Hall coefficient of given semiconductor, identification of semiconductor and estimation of charge carrier concentration
4. Study the dielectric constant of solids as a function of temperature and verification of the Curie law
5. Decimal to BCD encoder using diode matrix array.
6. MOD 12 and MOD 10 ripple counters
7. Monostable multivibrator using IC- 555
8. Study of diode matrix ROM for given Boolean equations

PHY- 456 : Tutorials and Seminars : Credits 4