Revised Syllabus

For

M. Sc.

(Physics)

M.Sc. (Part I): To be implemented from Academic Year 2013-2014

M.Sc. (Part II): To be implemented from Academic Year 2014-2015

1) Title of the Course:

M.Sc. Physics

2) Preamble of the Syllabus:

Master of Science (M.Sc.) in Physics is a post graduation course of University of Pune. The credit system to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

The students pursuing this course would have to develop in depth understanding various aspects of the subject. The principles in Physics will be studied in depth. Students will have deeper understanding of laws of nature through the subjects like classical mechanics, quantum mechanics, electrodynamics, statistical physics etc. Students' ability of problem solving will be enhanced. Students can apply principles in physics to real life problems.

3) Introduction:

Salient Features of the Credit System:

1. Master's degree course in Physics would be of 100 credits, where one credit course of theory will be of one clock hour per week running for 15 weeks and one credit for practical course will consist of 10 of laboratory exercise including the revision and setting up the practical. Thus, each credit will be equivalent to 15 hours.
2. Student will have to take admission in Physics Department and complete 75 credits incorporated in the syllabus structure of Physics. The remaining 25 credits shall be chosen from courses offered by the Physics Department or other Departments of the University/College with credit system structure.
3. Except practical credits wherever applicable, students may be allowed to complete less courses per semester on the condition they complete the degree in maximum of four years. This facility will be available subject to the availability of concerned courses in a given semester and with a maximum variation of 25 credits (in case of fresh credits) per semester.
4. Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.
5. The student will be declared as failed if s/he does not pass in all credits within a total period of four years. After that such students will have to seek fresh admission as per admission rules prevailing at that time.
6. Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination will be prepared and duly notified before commencement of each semester every year.
7. Project course should not be greater than 10% of the total credits of the degree course. Project course is equivalent to 5 credits.

Instructions for the Students

The students seeking admission to M.Sc. Physics course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.
2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits / training course as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be given to the student absent for the test/s.
3. The students opting for dissertation course shall follow the rules framed for the same.

4) Eligibility:

The candidate should have a B.Sc. degree with Physics as principal subject with mathematics as subsidiary or BE/BTech of any branch

Admission: Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down by the University of Pune.
Reservation and relaxation will be as per the government rules.

5) Examination

[A] Pattern of Examination

Evaluation of Students:

1) Assessment shall consists of a) In semester continuous assessment and b)end-semester assessment. Both shall have an equal weightage of 50% marks each.
2) Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% passing in both assessments separately.
3) A student cannot register for third semester if s/he fails to complete the 50% credits of the total expected within two semesters.
4) Internal marks will not change. Student cannot repeat internal assessment. If student misses internal assessment examination, s/he will have second chance with the permission of the concerned teacher. But it will not be right of the student. It will be the discretion of the concerned teacher and internal departmental assessment committee. In case s/he wants to repeat Internal, s/he can do so only by registering for the said courses during $5^{th}/6^{th}$ semester whichever is applicable.
5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

6) Internal assessment answer scripts may be shown to the concerned student but not end semester answer script.

i. In-semester Examination: Internal assessment for each course would be continuous and dates for each tutorials/practical tests will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity

a) Theory Courses: Conducting written tests should not be encouraged. More focus should be on non-written tests. Students should be encouraged to conduct various academic activities. A teacher must select a variety of the procedures for internal assessment suggested as follows.

a) Mid-term test
b) On-line test
c) Computer based examination
d) Open book test (concerned teacher will decide the allowed books)
e) Tutorial
f) Surprise test
g) Oral
h) Assignments
i) Review of research paper
j) Seminar presentation
k) Journal / Lecture / Library notes

Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

b) Practical Courses: It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Test on practical may be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly.

The student strength of practical batch should be eight. Note that one practical session is of 3 hour duration of one practical batch.

Project Course: Project will be evaluated by In-Charge of project batch in concern with project guide. Assessment will be done weekly in the respective batch. Evaluation will be on the basis of weekly progress of project work, progress report, referencing, oral, results and documentation.

ii. End-Semester Examination: End-Semester examination for 50 marks per course would be held about two weeks after completion of teaching for the semester. Paper setting and assessment for a particular course would be the responsibility of the course In-charge, and these activities would be coordinated by the Department

Examination Committee. The Department Examination committee would undertake preparation of the result-sheets for the student

[B] Standard of Passing

Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% passing in both assessments separately.

[C] ATKT Rules

A student cannot register for third semester if s/he fails to complete the 50% credits of the total credits expected to be ordinarily completed within two semesters.

[D] Award of Class

Grades will be awarded from grade point average (GPA) of the credits.

GPA Rules:

1. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 credit hours (Science). Total credits hours means the sum of credit hours of the courses which a student has passed.
2. A seven point grade system [guided by the Government of Maharashtra Resolution No. NGO – 1298 / [4619] / UNI 4 dt. December 11, 1999 and University regulations] will be followed. The corresponding grade table is attached herewith.
3. If the GPA is higher than the indicated upper limit in the third decimal digit then the student be awarded higher final grade (e.g. a student getting GPA of 4.492 may be awarded ‘A’)
4. For Semester I, II, III examinations, only the grade points will be awarded for each subject. Final GPA along with final grade will be awarded only at the end of IV semester. There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.
5. After the declaration of result, for the improvement of Grade, the student can reappear for the examination of 30 credits worth theory courses.
6. Grade improvement programme will be implemented at the end of the academic year. A student can opt for grade improvement programme only after the declaration of final semester examination i.e. at the end of next academic year after passing M.Sc. (Physics) examination and within two years of completion of M.Sc. (Physics). A student can appear for grade improvement programme only once.

Grade and Grade Point Average			Final Grade Points	
Marks	**Obtained Grade**	**Grade Points**	**Grade Points**	**Final Grade**
100 – 75	**'O'** Outstanding	06	5.00 – 6.00	**O**
74 – 65	**'A'** Very Good	05	4.50 – 4.99	**A**
64 – 55	**'B'** Good	04	3.50 – 4.49	**B**
54 – 50	**'C'** Average	03	2.50 – 3.49	**C**
49 – 45	**'D'** Satisfactory	02	1.50 – 2.49	**D**
44 – 40	**'E'** Pass	01	0.50 – 1.49	**E**
39 -0	**'F'** Fail	00	0.00 – 0.49	**F**

Common Formula for Grade Point Average (GPA):

i) Semester Grade Point Average (SGPA):

$$SGPA = \frac{\sum_{i=1}^{p} C_i G_i}{\sum_{i=1}^{p} C_i}$$

$$SGPA = \frac{\sum Grade\ Points\ Earned \times Credits\ \ for\ each\ course}{Total\ Credits}$$

ii) Cumulative Grade Point Average (CGPA):

$$CGPA = \frac{\sum_{i=1}^{p} C_i G_i}{\sum_{i=1}^{p} C_i}$$

$$CGPA = \frac{\sum Total\ Points\ Earned \times Credits\ \ for\ each\ course}{Total\ Credits}$$

B Grade is equivalent to at least 55% of the marks as per circular No. UGC 1298/[4619]UNI-4 dated December 11,1999.
IF GPA is higher than the indicated higher limit in the three decimal digit, then student be awarded higher final grade (eg. A student getting GPA of 4.492 may be awarded 'A').

[E] External Students: There shall be no external students.

[F] Setting of Question Paper / Pattern of Question Paper

For core (compulsory) theory courses end semester question papers set by the University of Pune and centralized assessment for theory papers done as per the University instructions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

Theory examination will be of 2 hours duration for each theory course of 5 credits. There shall be 3 questions each carrying marks as shown below. The pattern of question papers shall be:

Question 1 (20 Marks)	10 compulsory sub-questions, each of 2 marks
Question 2 (20 Marks)	5 out of 7– short answer type questions
Question 3 (10 Marks)	2 out of 3 – problem type question; answerable in numerical or analytical fashion

[G] Verification / Revaluation

There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course. There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

6) Structure of Course

Basic structure/pattern (Framework) of the proposed postgraduate syllabus for the two year integrated course leading to M.Sc. (Physics) in the colleges affiliated to Pune University.

Structure of Syllabus

Proposed structure of M.Sc. (Physics) Syllabus

(For Affiliated Colleges)
Revised Syllabus implemented from June 2013
Total Credits: 100

Semester I

Course Number	Course Name
PHYUT501	Classical Mechanics (5 Credits)
PHYUT502	Electronics (5 Credits)
PHYUT503	Mathematical Methods in Physics (5 Credits)
PHYUT504	Atoms, Molecules and Lasers (5 Credits)
PHYUP505	Physics Lab I (5 Credits)

Semester II

Course Number	Course Name
PHYUT601	Electrodynamics (5 Credits)
PHYUT602	Solid State Physics (5 Credits)
PHYUT603	Experimental Techniques in Physics (5Credits)
PHYUT604	Quantum Mechanics I (5 Credits)
PHYUP605	Physics Lab II (5 Credits)

Semester III

Course Number	Course Name
PHYUT701	Statistical Mechanics in Physics (5 Credits)
PHYUT702	Material Science (5 Credits)
PHYDT703	Departmental Course I (5 Credits)
PHYDP704	Special Lab I (5 Credits)
PHYUP705	Physics Lab III (5 Credits)

Semester IV

Course Number	Course Name
PHYUT801	Nuclear Physics (5 Credits)
PHYUT802	Physics of Semiconductor Devices (5 Credits)
PHYDT803	Departmental Course II (5 Credits)
PHYDP804	Special Lab II (5 Credits)
PHYUP805	Physics Lab IV: Project (5 Credits)

List of Departmental Courses

Departmental Course I Semester III PHYDT703 (5 credits)	Departmental Course II Semester IV PHYDT803 (5credits)
Biophysics I	Biophysics II
Acoustics I	Acoustics II
Medical Physics I	Medical Physics II
Energy Studies I	Energy Studies II
Quantum Mechanics II	Theoretical Physics
Physics of Thin Films	Nanotechnology
Astrophysics and Astronomy	Atmospheric Physics and Remote Sensing
Electronic Instrumentation-I	Electronic Instrumentation-II
Communication Electronics	Microwave electronics

M. Sc. (Physics)

PHYUT501: CLASSICAL MECHANICS

Module 1: Constrained Motion and Lagrangian formulation (1 Credit)
Revision of constraints and their types. Generalized coordinates, Langrange's equations of motion, including velocity dependent potentials. properties of kinetic energy function, theorem on total energy, generalized momenta, cyclic-coordinates, integrals of motion, Jacobi integrals and energy conservation, Concept of symmetry, invariance under Galilean transformation (8L + 2T) + 5S.S.

Module 2: Variational Principle and Hamilton's formulation (1 Credit)
Variational principle, Euler's equation, applications of variational principle, shortest distance problem, brachistrochrone, Geodesics of a Sphere. Hamilton's function and Hamilton's equation of motion, configuration space, phase space and state space, Lagrangian and Hamiltonian of relativistic particles. (8L + 2T) + 5S.S.

Module 3: Canonical Transformations and Poisson Brackets (1 Credit)
Legendre transformations, Generating function, Conditions for canonical transformation and problem. Definition, Identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity, (statement only), invariance of PB under canonical transformation. (8L + 2T) + 5S.S.

Module 4: Non inertial frames of References (1 Credit)
Rotating frames of reference, inertial forces in rotating frames, Larmour precision, electromagnetic analogy of inertial forces, effects of Coriolis force, Foucault's pendulum. (8L + 2T) + 5S.S.

Module 5: Central Force (1 Credit)
Two body central force problem, stability of orbits, condition for closure, integrable power laws, Kepler's problems, orbits of artificial satellites, Virial theorem. (8L + 2T) + 5S.S.

Reference Books :

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

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PHY UTN 502: ELECTRONICS

Module 1: Applications of Operational Amplifier: 1 Credit (8L+2T, 5 SS)

1.1 OPAMP parameters (with ideal and real values) (1L)

1.2 Basic applications like inverting & non-inverting amplifier, adder, subtractor, differentiator, integrator, comparator, Schmitt trigger. (2L)

1.3 Active filters : Low pass, High pass, Band pass, Notch filters (Butterworth 1^{st} and 2^{nd} order). (3L)

1.4 Precision rectifiers : Half and full wave. (2L)

References: 1, 2

Module 2: Applications of special function ICs 1 Credit (8L+2T, 5 SS)

2.1 Study of Timer IC 555 : Block diagram, Astable and monostable multivibrator circuits. (2L)

2.2 Study of VCO IC 566 and its applications. (1L)

2.3 Study of PLL IC 565 : Block diagram, applications like frequency multiplier, FSK, FM demodulator. (2L)

2.4 Function generator using two OPAMPs with variable controls, Astable and monostable multivibrators using OPAMP, (3L)

References: 1 to 5

Module 3: Regulated power supply 1 Credit (8L+2T, 5 SS)

3.1 Concept of Voltage Regulator using discrete componenets. (1L)

3.1 Types of power supplies : series and shunt regulators,CV,CC, SMPS. (2L)

3.2 Three pin regulators. (IC 78XX/79XX, IC LM 317). (2L)

3.3 Basic low and high voltage regulator and foldback current limiting using IC 723. (2L)

3.4 Concept and applications of DC - DC converter. (1L)

References: 4, 5, 6

Module 4: Digital Logic circuits I: Combinational Logic 1 Credit (8L+2T, 5 SS)

4.1 Review of Boolean identities and its use to minimize Boolean expressions. (1L)

4.2 Minimization of Boolean expressions using Karnaugh map (upto 4 variables). (2L)

Digital Logic circuits II: Sequential Logic:

4.3 Review of synchronous, asynchronous and combinational

counters (4-bit). (3L)

4.4 Decade counter IC 7490 with applications. (1L)

4.5 Shift registers using IC 7495 : applications as SISO, SIPO, PISO and PIPO. (1L)

4.6 Up-down counter (1L)

References: 7, 8

Module 5: Data Converters 1 Credit (8L+2T, 5 SS)

5.1 Analog to digital converters: Binary weighted type, R-2R ladder type, Study of IC 0808 (3L)

5.2 Digital to analog converters : Single slope, Dual slope, Flash, Counter type, Continuous type, Simultaneous type, Successive approximation type, Study of IC 7106 (5L)

References: 7, 8, 9

- **SS: Students are required to do Self Study .**

References Books:

1) Operational Amplifiers: G. B. Clayton (5th edition)
2) OPAMPS and Linear Integrated Circuits: Ramakant Gayakwad, Prentice Hall
3) Linear Integrated Circuits: D. Roy Choudhary, Shail Jain
4) Electronic Principles: A. P. Malvino, TMH
5) Power Supplies: B. S. Sonde
6) SMPS, Inverters, Converters: Gottlieb
7) Digital Principles and Applications: Leach and Malvino
8) Digital Electronics: R. P. Jain
9) Data Converters: B. S. Sonde

M. Sc. (Physics)

PHYUT503: MATHEMATICAL METHODS IN PHYSICS

1. Module 1: Complex Analysis **1 Credit (8L, 2T), 5 SS**

Complex Analysis: Complex numbers, Complex functions (polynomials, Exponential, Trigonometric complex functions, Logarithm). Limits and continuity, differentiation, Analytical functions, Cauchy-Riemann conditions, Line integrals, Cauchy's theorem, Cauchy integral formula, Derivatives of analytical functions, Power Series, Taylor's theorem, Laurent's theorem, Calculus of residues, evaluation of real definite integrals.

References: 1-4

2. Module 2: Linear spaces and operators **1 Credit (8L, 2T), 5 SS**

Vector spaces and subspaces, Linear dependence and independence, Basis and t Dimensions, linear operators, Inverses.

References: 5-6

3. Module 3: Matrix Algebra **1 Credit (8L, 2T), 5 SS**

Matrix representation, Similarity transformations, Eigenvalues and eigenvectors, Inner product, Orthogonality, Introduction only to Gramm-Schmidt orthogonalization procedure, Self adjoint and Unitary transformations, Eigenvalues & eigenvectors of Hermitian & Unitary transformations, Diagonalization.

References: 5-6

4. Module 4: Special Function **1 Credit (8L, 2T), 5 SS**

Legendre Hermite, Laguerre function – Generating function, Recurrence relations and their differential equations, Orthogonality properties, Bessels's function of first kind, Spherical Bessel function, Associated Legendre function, Spherical harmonics.

References: 7-8

5. Module 5: Fourier series and Integral transforms **1 Credit (8L, 2T), 5 SS**

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

References: 3, 4, 7-11

L: Lectures, T: Tutorials, SS: Self study

Reference Books:

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

M. Sc. (Physics)

PHYUT504: ATOMS, MOLECULE AND LASERS

Module 1-- ATOMS **1 credit (8L + 2P + 5ss)**

Atomic structure and atomic spectra :- Revision of quantum numbers, exclusion principle, electron configuration, Hund's rule, origin of spectral lines, selection rules, one electron spectra, two electron spectra, fine structure and hyperfine structure, Zeeman effect- Normal and Anomalous , Paschen- Back effect

Ref. 1-Atricles 5.1, 5.2, 5.3, 5.4,5.6

Module 2-- MOLECULES **1 credit (8L + 2P + 5ss)**

Molecular Spectra – Rotational and vibrational spectra for diatomic molecules, Electronics spectra of diatomic molecules, vibration course structure, vibrational analysis of band system, Frank – Condon principle, Dissociation energy and dissociation products, rotational fine structure of electronic vibration transitions, electronic angular momentum in diatomic molecules.

Ref. 2-Atricles 9.1 to 9.11

Module 3-- Resonance Spectroscopy **1 credit (8L + 2P + 5ss)**

ESR- Principles of ESR, ESR spectrometer, total Hamiltonian, hyperfine structure

Ref. 2-Atricles 11.1 to 11.5

NMR – Magnetic properties of nucleus, resonance condition, NMR instrumentation, relaxation process, chemical shift, applications of NMR

Ref. 2-Atricles 10.1 to 10.4, 10.7

Module 4-- LASER **1 credit (8L + 2P + 5 SS)**

Properties and System of lasers :-Properties of laser, interaction of laser with matter – absorption, spontaneous and stimulated emission of radiation, Einstein's coefficients, absorption coefficient, optical pumping, stimulated emission cross-section, population inversion, meta stable state, gain, threshold condition, two level laser (Ammonia laser, physical

separation of excited species from those in ground state), three level system.

Articles: Ref 4: 1.1.1, 1.1.2, 1.1.3, 1.3: Ref 5 2.1, Ref 6 1.25

Module 5-- TYPES AND APPLICATIONS OF LASERS 1 credit (8L + 2P + 5 SS)

He-Ne laser and its applications, CO_2 laser and its applications, Ruby laser and its applications, Nd-YAG laser and its applications, Industrial and medical applications of lasers.

Articles: Ref 6.2.1, 6.2.2; Ref 6 2.3.1, 2.3.3, 5.2, 5.5

Reference:-

1) Fundamentals of Molecular spectroscopy. Collin N. Banwell and Elaine M. McCASH
2) Molecular structure and Spectroscopy G. Aruldhas.
3) Quantum Physics – Robert Eiesberg and Robert Resnik
4) Principles of lasers, O. Svelto, Plenum, 1982
5) Laser and non-linear optics, B. B. Laud, Wiley Eastern Ltd
6) An introduction to lasers theory and applications, M. N. Avadhanulu, S. Chand

M. Sc. (Physics)

PHYUP505: PHYSICS LAB 1

(5 Credits)

(Students have to perform Any 10 Experiments)

1. Michelson Interferometer.
2. Resistivity of Ge at various temperature by Four Probe method and determination of band gap.
3. Susceptibility, Gauy method.
4. Ionic Conductivity of NaCl.
5. Skin depth in Al using electromagnetic radiation.
6. Counting statistics, G.M. tube.
7. End point energy and Absorption coefficient using G.M.tube.
8. Conductivity of Plasma at various pressure for AC/DC source.
9. Electron Spin Resonance. (ESR)
10. Fabry-Parot Etalon.
11. Electron Diffraction.
12. Thermionic Emission.
13. Franck – Hertz Experiment.
14. Zeeman Effect.
15. 'e' by Millikan oil drop method.
16. Stefan's constant – Black body radiation.
17. Clausius – Mossottiequation using sugar solution (Determination of Polarisation.)
18. To study absorption spectra of Iodine molecule and to determine its dissociation energyusing spectrometer.
19. Comparison of resolving limit of optical instruments with human eye. (Pg.300-301,A world view of Physics by Prof. D.P. Khandelwal et al. South Asian Publishers pvt.Ltd.New Delhi, 1999)
20. Study of electromagnetic damping (Pg. 320, A world view of Physics by Prof. D.P.Khandelwal et al. South Asian Publishers pvt.Ltd.New Delhi, 1999)

Reference Books :

1. Solid State Laboratory Manual in Physics, Department of Physics, University of Pune, Pune-7. (1977)
2. Experimental Physics, Wersnop and Flint.
3. Molecular structure and Spectroscopy, G.Aruldas Prentice-hall of India Pvt. Ltd. New Delhi.
4. Solid State Physics, S.P. Pillai (3rd Edition), New age International Publisher.
5. Practical Physics, D.R. Behekar, Dr.S. T. Seman, V.M.Gokhale,P.G.Kale (Kitab Mahal Publication)
6. Introduction to experimental Nuclear Physics, R.M. Singru, Wiley Eastern private Ltd. New Delhi.

M. Sc. (Physics)

PHYUT601: Electrodynamics

Module 1: Multipole expansions and time varying fields 1 credit (8L+2T+5 S S*)

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

Ref: 1,2,3,4,10.

Module 2: Energy, force, momentum relations and electromagnetic wave equations 1 credit (8L+2T+5 S S*)

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

Ref: 1, 2, 4, 5, 6,8,10.

Module 3: Inhomogeneous wave equations 1 credit (8L+2T+5 SS*)

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

Ref: 1, 2, 4, 5,8,10.

Module 4: Radiation emission 1 credit (8L+2T+5 S S*)

Radiation from an oscillating electric dipole, radiation from a half wave antenna, radiation from a group of moving charges, radiation damping, Thomson cross-section.

Ref: 1, 4, 5, 6.

Module 5: Relativistic Mechanics and Covariance 1 credit (8L+2T+5 S S*)

Experimental basis for special theory of relativity (Michelson – Morley experiment), Lorentz transformations, Relativistic velocity addition, Minkowski's space-time diagram, Four vector potential, electromagnetic field tensor, Lorentz force on a charged particle.

Ref: 1,2,3,6,9,10

Text Book:

1. Introduction to Electrodynamics, (3rd Edition) by David J. Griffith
Publication: Prentice-Hall of India, New Delhi.

Reference Books:

2. Introduction to Electrodynamics, by A.Z.Capri and P.V.Panat Narosa Publishing House.
3. Classical electricity & Magnetism, by panofsky and Phillips, Addison Wesley.
4. Foundations of Electromagnetic theory, by Reitz & Milford, World student series Edition.
5. Classical Electrodynamics, by J.D.Jackson, 3rd Edition John Wiley.
6. Electromagnetic theory and Electrodynamics, by Satya Prakash, Kedar Nath and Co.Meerut.
7. Special theory of Relativity, by Robert Resnick.
8. Electromagnetics by B.B.Laud, Willey Eastern.
9. Matrices and Tensors in Physics, A. W. Joshi, 3rd Edition, New Age International.
10. Electrodynamics by Kumar Gupta and Singh.

***5 Additional lectures in each module are for seminars / discussions / home assignments / library work by the students.**

M.Sc. (Physics)

PHYUT602: SOLID STATE PHYSICS

Module-1: Crystal Diffraction and Lattice Vibrations of Solids

1 Credit (8L, 2T, 5SS)

Laue theory of X-ray diffraction, Geometrical structure factor, Atomic scattering factor, calculations for sc, bcc, fcc, hcp & diamond structure; Brillouin zone, Phonon, Vibrational modes of monoatomic linear lattice & diatomic lattice, Acoustic & optical modes of vibration. Lattice heat capacity, Einstein & Debye model of lattice heat capacity;Normal & Umklapp processes.

Ref.1: Ch.2, Ch. 4, Ch.5 and Ref.6: Ch.2

Module-2: Band Theory of Solids **1 Credit (8L, 2T, 5SS)**

Nearly free electron model, DC and AC electrical conductivity of metals. Bloch theorem (with proof), Kronig-Penney model, Motion of electron in 1-D according to band theory, Distinction between metals, insulators and intrinsic semiconductors, Reduced, periodic & extended zone schemes, Cyclotron resonance, Quantization of electronic orbit in a magnetic field.

Ref. 1: Ch. 7 and 9

Module-3: Diamagnetism and Paramagnetism **1 Credit (8L, 2T, 5SS)**

Classical theory of diamagnetism, Langevin theory of Paramagnetism, Quantum theory of Paramagnetism, Paramagnetic susceptibility of conduction electron, Magnetic properties of rare earth ions & iron group ions with graphical representation, Crystal field splitting, Quenching of orbital angular momentum.

Ref. 1: Ch. 14

Module-4: Ferromagnetism, Antiferromagnetism and Ferrimagnetism

1 Credit (8L, 2T, 5SS)

Ferromagnetism: Wiess theory, Curie point, Exchange integral, saturation magnetization and its temperature dependence, Saturation magnetization at absolute zero, ferromagnetic domains, Anisotropy energy, Bloch wall,

Antiferromagnetism: Neel temperature, Ferrimagnetism: Curie temperature, susceptibility of ferrimagnets.

Ref. 1: Ch 15

Module-5: Superconductivity **1 Credit (8L, 2T, 5SS)**

Occurrence of superconductivity, Meissner effect, Heat capacity, Energy gap, Microwave and IR properties, Isotope effect, Type I and II superconductors, Thermodynamics of superconductivity, London equation, London penetration depth, BCS theory, Quantization in a superconductivity ring, Qualitative discussion of Josephson superconductor tunneling.

Ref. 1: Ch.12

Note: Five (SS) additional lectures in each module are for seminars, discussions, home assignments and library work by students.

Reference Books:

1. Introduction to solid states Physics - Charles, Kittle 7th Edition
2. Introductory Solid States Physics – H. P. Myers
3. Solid States Physics - S.O. Pillai (latest edition)
4. Elementary Solid States Physics- M. Ali Omar
5. Problem in Solid State Physics – S.O. Pillai
6. Solid States Physics – A.J. Dekkar
7. Solid states Physics – Wahab
8. Solid State Physics: Neil W. Ashcroft, N. David Mermin
9. Solid States Physics – Ibach & Luth
10. Solid States Physics – C.M.Kacchawa

M. Sc. (Physics)

PHYUT603: EXPERIMENTAL TECHNIQUES IN PHYSICS

Module-1: Signal and Signal Analysis 1 Credit (8L+2 T+ 5SS)

Signals, random signals, and time series (basic), Signal analysis: Time and frequency domain analysis, spectral analysis, auto and cross correlation functions. Measurement errors and analysis, Optical Tweezers (basic principle, force detection and applications)

Module-2: Vacuum Techniques 1 Credit (8L+2 T+ 5 SS)

Vacuum Physics: Important and fields applications of vacuum, gas properties, gas flow regimes, gastransport properties, gas conductance of apertures, elbows, tubes etc. for viscous and molecular flowregimes, principles of pumping concepts (vacuum pumps), vacuum measurement, leak detection,source of gases in vacuum system, evaluation of gas load, vacuum system design.Low temperatures techniques: Refrigeration principle (including thermodynamical aspects) and lowtemperature production techniques (Throttling process)

Module-3: Radiation sources and detectors 1 Credit (8L+2 T+ 5 SS)

Sources and detectors: Techniques of production of UV/Visible, microwave, IR radiations, classification of sensors/detectors, sensor characteristics, operation principles of sensors such as electric, dielectric, acoustic, thermal, optical and mechanical phenomena and important types of sensing properties: temperature (high and low), humidity, pressure and different types of radiations (visible, UV, X-ray and □-rays)

Module-4: Morphological and Structural Charecterization 1 Credit (8L+2 T+ 5 SS)

Structural characterization (principle, instrumentation and working): Microscopy: Optical (basic optical microscopy), Electron microscopy: SEM and TEM, Probe Microscopy: STM, AFM. Diffraction techniques: XRD, Electron and Neutron diffraction. Thermal analysis: Thermo-gravimetric (TGA).

Module-5: Spectroscopic instruments **1 Credit (8L+2 T+ 5 SS)**

Spectroscopic characterization (principle, instrumentation and working): Spectroscopy: IR, FTIR, UV-VIS, X-ray Abs: XPS, Electron Spin Resonance (ESR),

SS: Additional lectures in each module are for seminars, discussions, home assignment, library work by students

Reference Books:

[1]. *Introduction to analysis and processing of signals,* Paul Lynn, Howard W. (Sams andCompany, 1983).

[2]. *Probability, Random Variables and Stochastic Process,* A. Papoulis, international student, Edition (McGraw-Hill International Book Company, 1984)

[3]. *Vacuum Physics and Techniques,* T. A. Delchar, Chapman and Hall.

[4]. *Vacuum technology,* A. Roth, (North Holland, Elsevier Science B.V. 1990)

[5]. *High vacuum techniques,* J. Yarwood, (Chapman and Hall, Londong, 1967)

[6]. *Nuclear Radiation Detectors,* S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited,Bombay)

[7]. *Experimental Principles and Methods below 1K,* O. U. Lounasmaa, (Academic Press, Londonand New York, 1974)

[8]. *Thermometry at ultra low temperatures,* W. Weyhmann in Methods of Experimental Physics,Vol. II (R. V. Coleman, Academic Press, New York and London, 1974).

[9]. *Cryophysics,* K. Mendelssohn, Interscience (London, 1960)

[10]. *Characterization of Materials,* John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth-Heinemann (1992)

[11]. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001 - Science - 664 pages).

[12]. Optical trapping and manipulation of neutral particles using lasers, *by* Arthur Ashkin. Proceeding of National Academy of Sciences May 13, (1997) vol. 94 no. 10 4853-4860.

PHYUT604: QUANTUM MECHANICS – I

Module 1: Revision and general formalism: **1 Credit** (8L + 2P + 5SS)

Inadequacy of classical Physics, wave packets and uncertainity relations. Schrodinger wave equation and probability interpretation, Simple one dimensional problems wells, barriers and harmonic oscillator (One dimension).

Postulates of quantum mechanics :

Representation of states and dynamical variables, observables, self-adjoint operators, eigen functions and eigen values, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigen values, eigen functions and expansion co-efficients, eigen values and eigen functions of momentum operator.

Module 2: Representation of States – Dirac notation **1 Credit** (8L +2P+ 5SS)

Hilbert space, Dirac's bra and ket notation, dynamical variables and linear operators, projection operators, unit operator, unitary operator, matrix representation of an operator, change of basis, unitary transformation. Eigen values and eigen functions of simple harmonic oscillator by operator method.

Module 3: Angular Momentum **1 Credit** (8L + 2P+5SS)

Eigen values and eigen functions of L2 and Lz operators, ladder operators L+ and L-, Pauli

theory of spins(Pauli's matrices) , matrix representation of J in ljm> basis. Addition of angular momenta, Computation of Clebsch-Gordon co-efficients in simple cases (J1=1/2, J2=1/2) Central forces with an example of hydrogen atom.

Module 4: Perturbation Theory **1 Credit** (8L + 2P+5SS)

Time-independent Perturbation theory: Non degenerate, degenerate, Zeeman effect, anharmonic oscillator.

Time-dependent Perturbation theory: Transition amplitude 1st and 2nd order, Fermi's golden rule, Harmonic perturbation,

Module 5: WKB and variation Methods **1 Credit** (8L + 2P+5SS)

Variational method: Basic principles and applications to particle in box, SHO, hydrogen atom,

WKB approximation : Qualitative development and condition for validity of this approx, Bohr's quantization condition, applications to tunnelling such as □-particle

Reference books :-

1) A Text-book of Quantum Mechanics by P.M.Mathews and K.Venkatesan.

2) Quantum mechanics by A. Ghatak and S. Lokanathan

3) Quantum Mechanics by L.I. Schiff

4) Modern Quantum mechanics by J. J.Sakurai

5) Quantum Physics by R. Eisberg and R.Resnick

6) Introduction to Quantum Mechanics by by David J.Griffiths

7) Introductory Quantum mechanics by Granier, Springer Publication.

8) Introductory Quantum Mechanics, Li boff, 4th Edition, Pearson Education Ltd

9) Quntum Mechanics Nouredine Zettili, , A John Wiley and Sons, Ltd., Publication

10) Shankar R. Principles of Quantum Mechanics, IInd Edition (Plenum, 1994)

Note: *5 additional lectures in each module are for seminars, discussions, home assignments, library work by students.*

M. Sc. (Physics)

PHYUP605: PHYSICS LAB II

(5 Credits)

(Any 10 Experiments)

1. Study of voltage controlled oscillator using IC-566.
2. Frequency multiplier using PLL-565(for 2 & 3 operation using counter.)
3. Fold back power supply.
4. Precision rectifier.
5. Crystal oscillator- Millar type and Digital clock.
6. Diode pump using UJT.
7. DAC (R-2R and Binary type for 4-bit).
8. Pulse train generator.
9. SMPS power supply.
10. CVCC power supply.
11. Active filter- Low pass, High pass, Band pass, and Notch Filter using OP-AMP.
12. Function generator using OP-AMP/IC –8038.
13. Study of optocoupler, MCT2E and their application.
14. Constant current source using OP-AMP.
15. Class-B push pull amplifier using Dual power supply and OP-AMP.
16. Design, built and test oscillator – Wien Bridge oscillator / phase shift oscillator using OP-AMP.
17. Inductive simulation using OP-AMP.
18. Study of multiplexer and Demultiplexer.
19. Voltage to Frequency / Frequency to voltage converter using OP-AMP.
20. Study of errors in electrical measurement and results due to loading.
21. Fourier analysis (Pg. 18, Experiments in Electronics, S.V. Subramanian, McMillan India Limited, 1982)
22. To determine the transition capacitance of a varactor diode and use it as a variable capacitor.(Pg. 28, Experiments in Electronics, S.V. Subramanian, McMillan India Limited, 1982)
23. Measurement of efficiency of a power amplifier.(IC 810)and study of its frequency response.(Pg. 118, Experiments in Electronics, S.V. Subramanian, McMillan India Limited, 1982)
24. Study of noise performance of an amplifier.(Pg. 449, Art of Electronics, Horowitz and Hill,Cambridge, University Press, Low Price Edition, 1995.)

Reference Books:

1. Signetic manual.
2. Power supplies: B.S.Sonde.
3. Digital Principles: Malvino(6th Edition, Tata McGraw Hill Publication Co. Ltd. Delhi.)
4. Operational Amplifier: G.B.Clayton.
5. OP-AMPS and Linear integrated circuits: RamakantGaikwad.
6. Data Converters: B.S. Sonde, Tata Mc-Graw Hill Pub. Co. Ltd. (1974).
7. Pulse, Digital and Switching Circuits: Miliman&Taub.
8. Electronic Integrated Circuits and Systems: Franklin, C. Fitchen(Van No strand Reinhold Company).

9. Digital Principles and applications: Leach and Malvino, Tata Mc-Graw Hill Pub.Co. Ltd. N.Delhi(5th Edition,2002).