Revised Syllabus

For

M. Sc.

(Physics)

M.Sc. (Part I) (Revised for 2013-2014 and modified with 6 courses per semester):

To be implemented from Academic Year 2014-2015

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. In a theory course, for one module, one credit is assigned. For one credit, ten lectures are assigned for actual teaching in the classroom and five additional lectures in each module are for seminars, discussions, home assignments and library work.
3. 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.
4. 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.
5. Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.
6. 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.
7. 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.
8. 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 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.

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.

4) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.
5) 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

Structure of M.Sc. (Physics) Syllabus

(For Affiliated Colleges)

Revised Syllabus to be implemented from June 2014

Total Credits: 100

Semester I

Course Number	Course Name
PHYUT501	Classical Mechanics (4 Credits)
PHYUT502	Electronics (4 Credits)
PHYUT503	Mathematical Methods in Physics (4Credits)
PHYUT504	Atoms and Molecules (4 Credits)
PHYUT505	Experimental Techniques in Physics I(4 Credits)
PHYUP506	Physics Lab I (5 Credits)

Semester II

Course Number	Course Name
PHYUT601	Electrodynamics (4 Credits)
PHYUT602	Solid State Physics (4 Credits)
PHYUT603	Quantum Mechanics I (4 Credits)
PHYUT604	Lasers (4Credits)
PHYUT605	Experimental Techniques in Physics II(4Credits)
PHYUP606	Physics Lab II (5 Credits)

Semester III

Course Number	Course Name
PHYUT701	Statistical Mechanics in Physics (4 Credits)
PHYUT702	Physics of Semiconductor Devices/Quantum Mechanics II (4 Credits)
PHYDT703	Departmental Course I (4 Credits)
PHYDT704	Departmental Course II (4 Credits)
PHYDP705	Special Lab I (4 Credits)
PHYUP706	Physics Lab III (5 Credits)

Semester IV

Course Number	Course Name
PHYUT801	Nuclear Physics (4 Credits)
PHYUT802	Material Science (4 Credits)
PHYDT803	Departmental Course III (4 Credits)
PHYDT804	Departmental Course IV (4 Credits)
PHYDP805	Special Lab II (4 Credits)
PHYUP806	Physics Lab IV: Project (5 Credits)

List of Departmental Courses

Departmental Course I Semester III PHYDT703/PHYDT704 (4 credits)	Departmental Course II Semester IV PHYDT803/PHYDT804 (4credits)
Medical physics I	Medical physics II
Acoustics I	Acoustics II
Energy Studies I	Energy Studies II
Physics of Thin Films	Physics of Nano materials
Astronomy and Astrophysics I	Astronomy and Astrophysics II
Electronic Instrumentation-I	Electronic Instrumentation-II
Communication Electronics	Microwave Physics and Applications
Biomedical Instrumentation I	Biomedical Instrumentation II
Atmospheric Physics I	Atmospheric Physics II
Nuclear Techniques I	Nuclear Techniques II
Microcontroller Based Instrumentation System – I	Microcontroller Based Instrumentation System – II

The college can start any two of the departmental courses in 3rd semester and corresponding two courses shown against the 3rd semester course in 4th semester.

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.

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.

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.

Module 4: Non inertial frames of References, Central Force (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. Two body central force problem, stability of orbits, condition for closure, integrable power laws, Kepler's problems, orbits of artificial satellites, Virial theorem.

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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PHYUT502: ELECTRONICS

Module 1: Applications of special function ICs **1 Credit**

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 2: Regulated power supply **1 Credit**

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 3: Digital Logic circuits I: Combinational Logic **1 Credit**

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 4: Data Converters **1 Credit**

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

References Books:

1) Operational Amplifiers: G. B. Clayton (5^{th} 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

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PHYUT503: MATHEMATICAL METHODS IN PHYSICS

Module 1: Linear spaces and operators **1 Credit**

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

References: 5-6

Module 2: Matrix Algebra **1 Credit**

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

Module 3: Special Function **1 Credit**

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

Module 4: Fourier series and Integral transforms **1 Credit**

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

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

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PHYUT504: ATOMS AND MOLECULES

Module 1: ATOMS **1 credit**

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**

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**

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: Crystal Diffraction and Lattice Vibrations of Solids 1 Credit

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

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) Introduction to solid states Physics - Charles, Kittle 7th Edition
5) Solid States Physics – A.J. Dekkar

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PHYUT505: EXPERIMENTAL TECHNIQUES IN PHYSICS I

Module 1: Signal and Signal Analysis 1Credit

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 Physics 1Credit

Important and fields applications of vacuum, kinetic theory of gases, impingement rate of molecules on a surface, average velocity of gas and mean free path, gas transport properties (thermal conductivity, viscosity and diffusion), various ranges of vacuum, gas conductance of a vacuum line, gas impedance of a vacuum line, pumping speed, flow of gases through apertures, elbows, tubes etc. for viscous and molecular flow regimes, pump down time, Numericals

Module 3: Pumps for High Vacuum (HV) and Ultra High Vacuum (UHV) 1Credit

Principles of pumping concept, Types of vacuum pumps: Rotary, Molecular drag, Diffusion, Cryogenic, Getter, Titanium sublimation, Sputter ion, Orbitron

Module 4: Vacuum Measurements and Low Temperature Technique 1Credit

Vacuum Gauges: Mc Leod, Thermocouple (Pirani), Penning, Hot cathode ionization (triode type), Bayard-Alpert

Leak detection, Vacuum system design

Low temperatures techniques: Refrigeration principle (including thermodynamical aspects) and low temperature production techniques (Throttling process)

References:

1. Introduction to Analysis and Processing of Signals, Paul Lynn, Howard W. (Sams and Company, 1983)
2. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.
3. Probability, Random Variables and Stochastic Process, A. Papoulis, International Student Edition (McGraw-Hill International Book Company, 1984)
4. Hand Book of Thin Film Technology, Maissel and Glange
5. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall
6. Vacuum Technology, A. Roth, (North Holland, Elsevier Science B.V. 1990)
7. High Vacuum Techniques, J. Yarwood, (Chapman and Hall, Londong, 1967)
8. Experimental Principles and Methods below 1K, O. U. Lounasmaa, (Academic Press, Londonand, New York, 1974)
9. Thermometry at Ultra Low Temperatures, W. Weyhmann

10. Methods of Experimental Physics, Vol. II (R. V. Coleman, Academic Press, New York and London, 1974)
11. Cryophysics, K. Mendelssohn, Interscience (London, 1960)
12. Optical trapping and manipulation of neutral particles usingılasers, by Arthur Ashkin, Proceeding of National Academy of Sciences May 13, (1997) (4 (10) 4853-4860.

M. Sc. (Physics)

PHYUP506: PHYSICS LABORATORY 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.

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PHYUT601: ELECTRODYNAMICS

Module 1: Multipole expansions and time varying fields **1 credit**

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**

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 **1credit**

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: Relativistic Mechanics and Covariance **1 credit**

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

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

References:

1. Introduction to Electrodynamics, (3rd Edition) by David J. Griffith Publication: Prentice-Hall of India, New Delhi.
2. Introduction to Electrodynamics, by A.Z.Capri and P.V.Panat Narosa Publishing House.
3. 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.

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PHYUT602: SOLID STATE PHYSICS

Module 1: Band Theory of Solids **1 Credit**

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 2: Diamagnetism and Paramagnetism **1 Credit**

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

Module3: Ferromagnetism, Antiferromagnetism and Ferrimagnetism **1 Credit**

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 4: Superconductivity **1 Credit**

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

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

PHYUT 603: QUANTUM MECHANICS I

Module 1: Revision and general formalism: 1 credit

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, selfadjoint operators, eigen functions and eigen values, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigen values, eigen functions and expansion coefficients, eigen values and eigen functions of momentum operator.

Module 2: Representation of States – Dirac notation **1Credit**

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 **1Credit**

Eigen values and eigen functions of L^2 and Lz operators, ladder operators L_+ and L_-, Pauli theory of spins(Pauli's matrices) , matrix representation of J in |jm> basis. Addition of angular momenta, Computation of Clebsch-Gordon coefficients in simple cases (J_1=1/2, J_2=1/2).

Module 4 : Approximation Methods **1 Credit**

Time-independent Perturbation theory: Non degenerate, Zeeman effect, Time-dependent Perturbation theory: Transition amplitude 1st and 2^{nd} order, Fermi's golden rule, Harmonic perturbation, Introduction to WKB approximation, Variational method: Basic principles and applications to particle in box, SHO.

References:

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)

M. Sc. Physics
PHYUT604: LASERS

Module 1 **1Credit**

Interaction of radiation with matter: Absorption, spontaneous and stimulated emission, population inversion, properties of laser, metastable state, gain, absorption coefficient, Einstein's coefficient, stimulated emission cross section, threshold condition. Two level laser (ammonia laser, physical separation of excited species from those in ground state).

Module 2 **1Credit**

Three and four level system and rate equations, threshold pump power, relative merits and demerits of three and four level system. g-parameters of laser cavity, stability curve, Gaussian beam and their properties. Measurements of laser power, energy, wavelength, frequency, line width.

Module 3 **1Credit**

Different types of gas lasers: He-Ne laser, nitrogen laser, CO2 laser, excimer lasers and Dye laser Solid State Lasers: Nd:YAG laser, Ruby laser, semiconductor lasers (principle and homo junction lasers),

Module 4 **1Credit**

Industrial applications: Cutting, molding, melting, welding, drilling, cladding
Medical applications: Skin Therapy, Laser eye surgery, Laser surgery,
Holography: Recording and construction.
Agricultural applications, Biological applications, Archeological applications.
Laser barcode scanners

Reference books:

1. Principles of lasers – O.Svelto – Plenum, 1982.
2. Solid state engineering Vol-I – W.Koechner Springer Verlag (1976).
3. Lasers fundamentals – W.T. Silfvast.
4. Laser and non-linear optics – B.B.Laud (2nd Edition).
5. Lasers – A.G. Sigman, Oxford University Press 1986.
6. Introduction to fiber optics – A.Ghatak, K.Thyagarajan- Cambridge University Press.
7. Laser Guidebook – J.Hecht
8. Principles of laser and their applications – Callen O'Shea, Rhodes.
9. An introduction to Laser theory and application – M.N.Avdhanulu – S.Chand Publications.
10. Optics – E.Hecht, A.RGanesan – Pears

M.Sc. Physics

PHYUT605: EXPERIMENTAL TECHNIQUES IN PHYSICS II

Module 1: Radiation Sources, Detectors and Sensors 1Credit

Sources of Electromagnetic Radiations: Different types of radiations (□-rays, X-rays, UV-VIS, IR, microwaves and nuclear) and their sources

Detectors: □-rays, X-rays, UV-VIS, IR, microwaves and nuclear detectors

Sensors: Sensor's characteristics, Classification of sensors, Operation principles of sensors such as electric, dielectric, acoustic, thermal, optical, mechanical, pressure, IR, UV, gas and humidity with examples

Module 2: Structural Characterization and Thermal Analysis 1Credit

X-ray Diffraction – Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, principle, instrumentation (with filters) and working, Techniques used for XRD – Laue's method, Rotating crystal method, Powder (Debye-Scherrer) method, Derivation of Scherrer formula for size determination

Neutron Diffraction: Principle, Instrumentation and Working

Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC); Graphical analysis affecting various factors. Numericals

Module 3: Morphological and Magnetic Characterization 1Credit

Optical Microscopy: Principle, Instrumentation and Working of optical microscope

Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM, Transmission Electron Microscope (TEM), Selected Area Electron Diffraction (SAED)

Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM)

Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop**,** SQUID Technique: Principle, Instrumentation and Working. Numericals

Module 4 : Spectroscopic Analysis 1Credit

Spectroscopic characterization (principle, instrumentation and working): Infra-Red (IR), Fourier Transform Infra-Red (FTIR), Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray Absorption (XPS), Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR). Numericals.

Reference Books:

1. Nuclear Radiation Detectors, S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited, Bombay)
2. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.
3. Instrumental Methods of Chemical Analysis, G. Chatwal and S. Anand, Himalaya Publishing House
4. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean, CBS Publishers
5. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth Heinemann (1992)
6. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001 - Science - 664 pages)

M. Sc. (Physics)

PHYUP606: PHYSICS LABORATORY II

(Any 10 Experiments) **5 Credits**

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).

M.Sc. Physics

PHYUT701: Statistical Mechanics in Physics

Module1: Statistical Description and Thermodynamics of Particles 1 Credit

Specification of the state of the system, Macroscopic and Microscopic states, Phase space, Statistical ensemble, Postulate of equal a priori probability, Probability calculations, Behaviour of density of states, Liouville's theorem (Classical)

Equilibrium conditions and constraints, Distribution of energy between systems in equilibrium, Approach to thermal equilibrium, Sharpness of the probability distribution, Dependence of the density of states on the external parameters, Equilibrium between interacting systems, Thermodynamical laws and basic statistical relations (Revision)

Module 2: Classical Statistical Mechanics: 1 Credit

Micro-canonical ensemble, System in contact with heat reservoir, Canonical ensemble, Applications of canonical ensembles (Paramagnetism, Molecule in an ideal gas, Law of atmosphere), System with specified mean energy, Calculation of mean values and fluctuations in a canonical ensemble, Connection with thermodynamics, Grand-canonical ensemble, Physical interpretation of □, Chemical potential in the equilibrium state, Mean values and fluctuations in grand canonical ensemble, Thermodynamic functions in terms of the Grand partition function

Module3:Applications of Statistical Mechanics and Quantum Distribution Functions 1 Credit

Classical partition functions and their properties, Calculations of thermodynamic quantities, Ideal monoatomic gas, Gibbs paradox, Equipartition theorem and its Simple applications. i) Mean kinetic energy of a molecule in a gas ii) Brownian motion iii) Harmonic Oscillator iv) Specific heat of solid, Maxwell velocity distribution, Related distributions and mean values

Symmetry of wave functions, Quantum distribution functions, Boltzmann limit of Boson and Fermion gases, Evaluation of the partition function, Partition function for diatomic molecules, Equation of state for an ideal gas, quantum mechanical paramagnetic susceptibility

Module 4: Ideal Bose and Fermi Systems: 1 Credit

Photon gas – i) Radiation pressure ii) Radiation density iii) Emissivity iv) Equilibrium number of photons in the cavity. Einstein derivation of Planck's law, Bose-Einstein Condensation, Specific heat, Photon gas – Einstein and Debye's model of solids

Fermi energy, Mean energy of fermions at absolute zero, Fermi energy as a function of temperature, Electronic specific heat, White – Dwarfs (without derivation)

Reference books:

1. Fundamentals of Statistical and Thermal Physics, - F.Reif, McGrawHill International Edition (1985)
2. Fundamentals of Statistical Mechanics, B.B. Laud, New Age International Publication (2003)
3. Statistical Mechanics, R.K. Pathria, Bufferworgh Heinemann (2^{nd} Edition)
4. Statistical Mechanics, K. Huang, John Willey and Sons (2^{nd} Edition)
5. Statistical Mechanics, Satya Prakash and Kedar Nath Ram, Nath Publication (2008)
6. Statistical Mechanics by Loknathan and Gambhir

M. Sc. (Physics)

PHYUT702: PHYSICS OF SEMICONDUCTOR DEVICES

Module1: Properties of Semiconductor **1 Credit**

Band structure of semiconductors, carrier concentration at thermal equilibrium for intrinsic and doped semiconductors, carrier energy distribution, application of Fermifactor to semiconductors, Density of available states Excess carriers, carrier transport phenomena. Mobility Resistivity, hall effect, recombination process. Basic equation for semiconductor device operation.

Module2: PN Junction **1 Credit**

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

Module3: Junction Transister & Field-Effect-Devices **1 Credit**

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

Module4: Metal & Metal Insulator Semiconductor Devices **1 Credit**

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

Ideal MIS diode, surface states, surface charges and space charges, Effects of metal work function.

Referance Books

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

M. Sc. Physics

PHYUT702: QUANTUM MECHANICS II

Revision and general formalism:

Time-independent Perturbation theory: Non degenerate, degenerate,

Introduction to Time-dependent Perturbation theory.

Module 1: Approximation Methods I **1 Credit**

Applications of Time-independent Perturbation theory - Stark effect, anharmonic oscillator. Time dependent Perturbation theory : Transition amplitude, 1st and 2nd order, selection rules, Fermi's golden rule, Harmonic perturbation, dipole approximation, Einstein coefficient for spontaneous emission.

Module 2: Approximation Methods II **1 Credit**

Variational method: Basic principles and application to hydrogen atom, helium atom (qualitative approach).

WKB approximation : General formalism, Bound states for potential wells - with no rigid walls, with one rigid wall, with two rigid walls.

Bohr's quantization condition, application to tunneling, field emission.

Module 3: Theory of Scattering **1 Credit**

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

The Born approximation, Lippman-Schwinger equation, applications and validity of the Born approximation.

Module 4: Symmetry in Quantum Mechanics **1 Credit**

Symmetry in Quantum Mechanics, space and time translations, discrete lattice translations, parity, time reversal, discrete symmetries. Identical particles, symmetric and antisymmetric wave functions, Slater determinants, collision of identical particles, spin angular momentum, spin functions for systems with more than one electron.

Wigner-Eckert theorem and its applications.

Schrodinger and Heisenberg picture, Heisenberg's matrix mechanics for harmonic oscillator.

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)

M.Sc. Physics
PHYUP706: Physics Laboratory III

COMPUTER LABORATORY

Expected Background: Course contents of PH-345, C' Programming and Computational Physics. (To be covered by the teacher if required)

Objective: To enable students to use numerical methods in solving problems in Physics and any other areas.

Note: (1) The theoretical background relevant to the experiments listed below should be discussed during practical sessions only.

(2) Wherever possible, the output should be presented in graphical form also.

Section I: (Any five)

(1) Legendre polynomials using the standard recurrence relation. Confirm that the method works well for Legendre functions by comparing with standard tables for special functions. (Use forward recursion.)
(2) Bessel functions of the first kind using the standard recurrence relation. Use backward recursion with

$J_{50}(x)=0$, $J_{49}(x) = 0.1 \times 10^{-30}$ and the sum rule

$J_0(x)+ 2\sum_{n=1}^{25} J_{2n}(x) = 1$

(3) To generate random numbers. Find out the value of 'π' using Monte-Carlo methods. Obtain your result correct up to five decimal positions.
(4) Interpolation: Interpolate the value of a function at a point. Use Lagrange interpolation method.
(5) Rotation of matrix: Rotate the elements of a n x n matrix in clockwise/ anticlockwise direction and display the matrices (n>=5).
(6) Inverse of a matrix: Find the inverse of a n x n matrix and display both matrices.
(7) Trapezoidal/ Simpson rule: Evaluate a given function f(x) using Trapezoidal/ Simpson rule correct up to given accuracy by successively halving the step size.
(8) Graphics: Write a program and display the Miller planes in the cubic lattice. Display the FCC,Bcc,and simple cubic lattice on the computer screen.

Section II: (Any Five)

(9) Differential Equation : Find out the motion of a charged particle in a uniform magnetic field. The equation of motion of part Type equation here.icle with charge 'q' and mass 'm' in a uniform magnetic field B is given by .

$$\frac{\vec{dr}}{dt} = \frac{q}{m}(\vec{v} \times \vec{B})$$

Where r denotes the position vector.

(10) Gauss – Elimination method : Circuit analysis using Kirchhoff's Laws. Write the relations for currents through various branches of a Whetstone's bridge. Find the current using Gauss elimination method.

(11) Different equation : Write the differential equation for charging /discharging of a capacitor C through a resistance 'R' .Solve this equation using Euler method and display your result in tabular as well as graphical form.

(12) Write a program to graphically display eigen functions and probability density curves for particle in one dimensional rigid box.

(13) Differential Equation : Write the one – dimentional time independent Schrodinger's equation. Solve. it using Runge – Kutta method for three different harmonic Oscillator potential.

(14) Fourier Analysis: perform the Fourier analysis (1) Full wave rectifier (2) Square wave

(15) Use modified Euler method to solve the differential equation

$$m\frac{d^2z}{dt^2} = mg$$

For the displacement z of a freely falling body as a function of time t, from a given height z =z0 at t=0.compare with known analytical results.Add a term due to buoyancy of air on the motion of a spherical body (say a rain drop) of radius r (No damping due to viscosity and drag is considered).Thus,

$$m\frac{d^2z}{dt^2} = (m - \frac{4}{3}\pi r\pi^3\rho)g$$

ρ is the density of air.

(16)Consider the motion of a point mass under the influence of a harmonic restoring force F=-kx. Solve m (d^2x/dt^2)=-kx for x as a function of time. The kinetic enegy of the mass=$1/2$ mv^2=$1/2\,m$ $(dx/dt)^2$ and potential energy is $1/2$ kx^2.

Such that the total energy E=T+V=constant through out the motion. Calculate x, T, V, E for various values of t starting with t=0 and time step h=dt, plot x, T, V, E as a function t and find the period of oscillation from the graph using numerical method. Compare with analytical result.

Reference Books:

1. The C programming Language: B.W.Kernighan and D.M.Ritchie.Prentice Hall of India Pvt.Ltd., (1985).
2. Schuam's series "programming in C".
3. Introductory Methods of Numaricle Analysis, S.S.Sastry, Prentice Hall of India Pvt.Ltd. (1990).

4. Computational Physics, R.C.Verma, P.K.Ahluwalia and K.C.Sharma, New Age International Publishers (1999).
5. Computational Physics,S.E.Koonin, Benjamin/Cumming Pub .Co.,(1986).
6. Computer Method for Engineering, Y.JalurIa, Allyn and Bacon Inc.,(1988).
7. An Introduction to Computational Physics, T.Pang, Cambridge Uni. Press. (1997).

M. Sc. Physics

PHYUT801: NUCLEAR PHYSICS

MODULE 1: General Properties and Concepts of Nuclei 1 Credit

Nuclear Mass & Binding Energy, Systematics of Nuclear Binding Energy, Measurement of Charge Radius- Electron Scattering Experiment, Concept of Mass Spectrograph, Nuclear spin, Magnetic Dipole Moments & Electric Quadrupole Moments of Nuclei, Radioactivity, Unit of Radioactivity, Alpha Decay: Velocity of Alpha Particles, Disintegration Energy, Range-Energy Relatiuonship, Geiger-Nuttal Law, Beta Decay: Conditions for Spontaneous Emission of β- & β+ Particles, Selectiuon Rules, Origin of Beta Spectrum-Neutrino Hypothesis, Gamma Decay: Decay Scheme of 137Cs & 60Co Nuclei, Internal Conversion, Internal Pair Creation.

MODULE 2: Radiation Detectors and Nuclear Models 1 Credit

Detectors: NaI(Tl) Scintillation Detector, Si(Li) and Ge(Li) Detectors, High Purity Germanium Detector, Bubble Chamber, Cloud Chamber, Spark Chamber, Nuclear Models: Shell Model- Square Well Potential, Harmonic Oscillator Potential, Spin-Orbit Coupling, Predictions of the Shell Model, Achievements & Failures of shell Model, Fermi Gas Model, Collective Model.

MODULE 3: Reaction Dynamics, Nuclear Reactors and Accelerators 1 Credit

Reaction Dynamics: Types of Nuclear Reactions, Conservation Laws in Nuclear Reactions, Q of Nuclear Reaction, Compound Nucleus Hypothesis, Reactors: Fission Chain Reaction, Four Factor Formula, Multiplication Factor, General Properties and Concepts of Nuclear Reactors, Reactor Materials, Types of Reactors, List of Different Types of Reactors Developed in India, Accelerators: Van de Graff, Microtron, Electron & Proton Synchrotron, Pelletron, Cyclotron.

MODULE 4: Nuclear Interactions and Particle Physics 1 Credit

Nuclear Interactions: Low Energy Neutron-Proton Scattering, Scattering Length, Spin Dependence of n-p Interaction, Proton-Proton and Neutron-Neutron Scattering at Low Energies, Particle Physics: Classification of Elementary Particles, Mass Spectra and Decays of Elementary Particles- Leptons & Hadrons, Quantum Numbers, Conservation Laws, Quarks.

Reference Books:

1. K.S.Krane, 1988, Introductory Nuclear Physics, Wiley, India.
2. B.L.Cohen, Concepts of Nuclear Physics, Tata McGraw Hill.
3. I.Kaplan, 1989, Nuclear Physics, 2nd Edition, Narosa, New Delhi.
4. S.N.Ghoshal, Atomic and Nuclear Physics, S.Chand.
5. E.Segre, Nuclei and Particles
6. D.C.Tayal, Nuclear Physics, Himalaya Publishing House.
7. R.D.Evans, The Atomic Nucleus, Tata McGraw Hill.
8. G.F.Knoll, Radiation Detection and Measurement, 3rd edition, Wiley India.
9. S.S.Kapoor and V.S.Ramamurthy, Nuclear Radiation Detectors, Wiley eastern Limited.
10. R.R.Roy, B.P.Nigam, Nuclear Physics-Theory and Experiment,Wiley eastern Limited.
11. Frauenfelder and Henley, Subatomic Physics, Prentice Hall.
12. S.Sharma, Atomic & Nuclear Physics, Pearson education 2008.

M.Sc. Physics

PHYUT802: MATERIALS SCIENCE

Module 1: Properties of Materials and Defects in Solids 1Credit

(a) Mechanical, electrical, magnetic, thermal and structural properties (in brief – 2L only)

(b) Point defects - Vacancies, interstitials, non-stoichiometry, substitution, Schottky and Frenkel defects with proofs

(c) Line defects - Edge and screw dislocations, properties of dislocations – force on dislocation, energy of dislocation, pinned dislocation (These properties with derivation), dislocation density, interaction between dislocations, motion of a dislocation (cross-slip and climb), dislocation generator (Frank Read source)

(d) Surface defects – grain boundaries with explanation of high angle, low angle, tilt and twist boundaries, stacking fault

(e) Volume defect- twin boundary

Module 2: Solid Solutions and Diffusion in Solids 1 Credit

(a) Solid solubility with few examples, Types of solid solutions – Substitutional and Interstitial, Factors governing solid solubility (Hume - Rothery rule), Atomic size and size factor in solid solutions, Vegard's law, Explanation of strain in dislocations

(b) Mechanism of Diffusion, Fick's first and second laws of diffusion, solution to Fick's second law (without proof, introduction of error function), Factors governing diffusion, Experimental determination of D, Applications of diffusion: Corrosion resistance of duralumin, Decarburization of steel, Doping of semiconductors

Module 3: Metallurgical Thermodynamics 1 Credit

Revision of laws of thermodynamics, Auxiliary thermodynamic functions, measurement of changes in enthalpy and entropy, Richard's rule, Trouton's rule, Chemical reaction equilibrium, Thermodynamic properties of solutions (mixing processes – Rault's law, activity coefficient; regular solution behavior – Henry's law), Gibb's phase rule: proof, explanation and application to single component (H_2O) and binary phase diagram

Module 4: Phase diagrams 1 Credit

Thermodynamic origin of phase diagrams, Lever rule, Type I (Cu-Ni) phase diagram, Type II (explanation only) phase diagram, Type III (Pb-Sn) phase diagram, Maxima and minima in two-phase regions, Miscibility gaps, Topology of binary phase diagrams (Explanation in short of eutectic, peritectic, Monotectic, eutectoid, peritectoid, syntactic reaction, extension rule), Experimental determination of phase diagrams

Reference books:

1. Elements of Materials Science and Engineering (5^{th} edition) - Lawrence H. Van Vlack, Addison - Wesley Publishing Co.
2. Materials Science and Engineering - V. Raghvan
3. Physical Metallurgy (PartI) R.W.Cahn and P.Hassen, North Holland Physics Publishing, New York
4. Introduction to Materials Science for Engineers (6_{th} edition) - J.F.Shaekelford and M.K.Murlidhara - Pearson Education
5. Materials Science – Kodgire and Kodgire

M.Sc. Physics

PHYDT703/PHYDT704: ACOUSTICS I

Module1: Measurement and perception of sound 1Credit

Velocity of sound in fluids; Energy density of a plane wave; Acoustic intensity; Acoustic standards and reference conditions; Specific acoustic impedance; Decibel Scales: Intensity level (IL), Sound Pressure Level (SPL); Sound Power Level (PWL); Loudness Level (LL)

Module2:Transmission phenomenon, resonators and filters 1Credit

Transmission from one fluid medium to another; reflection at the surface of a solid; significance of standing wave ratios; Helmholtz resonator; acoustic, electrical and mechanical analogues; Expansion chamber muffler

Module3: Speech hearing and community noise criteria 1Credit

Equivalent continuous sound level (L_{Aeq}); Perceived noise level (L_{EPN}); Human voice and hearing mechanism; thresholds of the ear; Audiometry; Haas effect and delay

Module4: Architectural acoustics 1Credit

Growth and decay of sound in live rooms; Sabine equation; Decay of sound in dead rooms: Eyring approach, Millington and Sette approach; Optimum reverberation time; Methods of measuring reverberation time; Sound absorption coefficients; Room modes; Room acoustics: Sound transmission class; High-loss frame walls; Floor and ceiling systems

Reference Books

1. Fundamentals of Acoustics, II or III Edn., L.E. Kinsler and A. R. Frey, Wiley Eastern, 1982
2. Acoustics, W.W. Seto, Schaum's Outline, 1978
3. Basic Acoustics, D.E. Hall, Oxford University Press
4. Technical Aspects of Sound, Richardson, Prentice Hall, 1962
5. Noise Reduction, L.L. Baranek, M.LT. Press, 1970
6. Handbook of Sound Engineers (The New Audio Cyclopedia), G.M. Ballou, Academic Press, 1998
7. Design for good Acoustics and Noise Control, J.E. Moore, University Press, 1998
8. Acoustics Sourcebook, S. Parker, McGraw Hill, 1996
9. Introduction to Acoustics, Robert D. Finch, Pearson, 2005

M.Sc. Physics

PHYDT803/PHYDT804: ACOUSTICS II

Module1: Acoustic transducers **1 Credit**

Loudspeakers: Direct-radiator loudspeaker: equivalent circuit and efficiency; effect of voice-coil parameters on acoustic output; loudspeaker cabinet; Horn loudspeaker: wave equation for horns, pressure response of loudspeakers; woofers, squawkers, tweeters; Crossover networks

Module2: Acoustic transducers **1 Credit**

Microphones: Carbon, Condenser, Moving-coil electrodynamic and Velocity-ribbon microphones; polar response characteristics; Electroacoustic Reciprocity Theorem; reciprocity calibration of microphones

Module3: Sound recording and reproducing systems **1 Credit**

Monophonic and Stereophonic sound systems; Compact disc audio; Audio file formats; Dynamic range, Volume compressors, expanders and limiters; Graphic equalizer; Dolby noise reduction

Module4: Technical acoustics and music **1 Credit**

Active noise control; Ultrasonic transducers: principle and applications; Anechoic chamber; Bioacoustics: animal sounds - synthesis and analysis; Music: pitch and timbre; Characteristics of musical notes: Vibrato, Tremolo, Portamento; Musical Instruments Digital Interface (MIDI)

Reference Books

1. Fundamentals of Acoustics, II or III Edn., L.E. Kinsler and A. R. Frey, Wiley Eastern, 1982
2. Acoustics, W.W. Seto, Schaum's Outline, 1978
3. Basic Acoustics, D.E. Hall, Oxford University Press
4. Technical Aspects of Sound, Richardson, Prentice Hall, 1962
5. Noise Reduction, L.L. Baranek, M.LT. Press, 1970
6. Handbook of Sound Engineers (The New Audio Cyclopedia), G.M. Ballou, Academic Press, 1998
7. Design for good Acoustics and Noise Control, J.E. Moore, University Press, 1998
8. Acoustics Sourcebook, S. Parker, McGraw Hill, 1996
9. Introduction to Acoustics, Robert D. Finch, Pearson, 2005

PHYDP705: SPECIAL LABORATORY I

List of experiments (Any four)

- Acoustical power output of a source
- Expansion chamber muffler
- Audiometry: Threshold of audibility
- Estimation and measurement of reverberation time
- Acoustic evaluation of a class room
- Fourier analysis of noise from a source
- Signal multiplier wave analyzer
-

PHYDP805: SPECIAL LABORATORY II

List of Experiments (Any four):

- Reciprocity calibration of a microphone
- Constant pressure frequency response of a microphone
- Crossover networks
- Loudspeaker systems
- Frequency response of a loudspeaker
- Polar response characteristics of a microphone
- Graphic equalizer

M.Sc. Physics

PHYDT703/PHYDT704: ASTRONOMY AND ASTROPHYSICS I

Module 1: ASTRONOMICAL SCALES & BASIC CONCEPTS OF POSITIONAL ASTRONOMY 1 Credit

Astronomical Distance, Mass and Time Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities, Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature, Celestial Sphere Geometry of a SphereSpherical Triangle, Astronomical Coordinate Systems, Geographical Coordinates Horizon System, Equatorial System Diurnal Motion of the Stars Conversion of Coordinates, Measurement of Time Sidereal TimeApparent Solar TimeMean Solar TimeEquation of Time, Calendar

Module 2: ASTRONOMICAL TECHNIQUES AND PHYSICAL PRINCIPLES 1 Credit

A. Basic Optical Definitions for Astronomy Magnification Light Gathering Power Resolving Power and Diffraction Limit Atmospheric WindowsOptical Telescopes Types of Reflecting TelescopesTelescope MountingsSpace TelescopesDetectors and Their Use with Telescopes Types of DetectorsDetection Limits with Telescopes, Sky charts and their importance.

B. Gravitation in Astrophysics Virial Theorem, Newton versus Einstein, Keplars laws, Systems in Thermodynamic Equilibrium, Theory of Radiative Transfer, Radiation Field Radiative Transfer Equation, Optical Depth; Solution of Radiative Transfer Equation, Local Thermodynamic Equilibrium.

Module 3: THE SUN AND STELLAR STRUCTURE: 1 Credit

A. Solar Photosphere Solar Atmosphere, Chromosphere, Corona, Solar Activity, Basics of Solar Magneto, hydrodynamics Helioseismology. Solar System: Facts and Figures Origin of the Solar System: The Nebular Model Tidal Forces and Planetary rings.

B. Hydrostatic Equilibrium of a Star, Some Insight into a Star: Virial Theorem Sources of Stellar Energy, Modes of Energy Transport, Simple Stellar Model Polytropic Stellar Model. Stellar Spectra and classification : Atomic Spectra Review, Stellar Spectra, Spectral Types and their Temperature Dependence, Black Body Approximation, H-R Diagram, Luminosity Classification.

Module 4: STAR FORMATION, NUCLEOSYNTHESIS AND STELLAR EVOLUTION: 1 Credit

Basic Composition of Interstellar Medium, Interstellar Gas, Interstellar Dust Formation of Protostar, Jeans Criterion Fragmentation of Collapsing Clouds from

Protostar to Pre-Main Sequence Hayashi Line, Cosmic Abundances, Stellar Nucleosynthesis, Evolution of Stars, Evolution on the Main Sequence, Evolution beyond the Main Sequence, Supernovae. Basic Familiarity with Compact Stars, Equation of State and Degenerate Gas of Fermions, Theory of White Dwarf, Chandrasekhar Limit, Neutron Star, Gravitational Red-shift of Neutron Star, Detection of Neutrons.

References:

1. Structure of the Universe, J.V. Narlikar
2. Astronomy- Fundamentals and frontiers , Robert Jastraw, H. Thomson (John wiley and Sons)
3. Astrophysics Vols.1 and 2. Bowers and Deeming:
4. Cox and Guili: Principles of Stellar Interiors - Vol.I and II.
5. Mihalas: Stellar Atmospheres.
6. C.R. Miczaika and W.M.Sinton: Tools of the Astronomers
7. Baidyanath Basu: Introduction to Astrophysics.
8. W.A. Hiltner (Ed): Astronomical Techniques.
9. A. Unsold : The New Cosmos (3rd Edition). Springer-Verlag 1983.
10. M. Schwarzschild: Stellar Evolution
11. S. Chandrasekhar: Stellar Structure
12. Menzel, Bhatnagar and Sen: Stellar Interiors.
13. J. Greenstein (Ed): Stellar Atmospheres.
14. The Physical Universe, F. Shu, (University Science books).
15. Bowuwer and Clemence: Methods of Celestial Mechanics.

M.Sc. Physics

PHYDT803/PHYDT804: ASTRONOMY AND ASTROPHYSICS II

Module 1: THE MILKY WAY **1 Credit**

Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way, Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms, Stars and Star Clusters of the Milky Way, Properties of and Around the Galactic Nucleus

Module 2: GALAXIES **1 Credit**

Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies
The Intrinsic Shapes of Ellipticals, de Vaucouleurs Law, Stars and Gas, Spiral and Lenticular Galaxies, Bulges, Disks, Galactic Halo, The Milky Way Galaxy
Gas and Dust in the Galaxy, Spiral Arms, Active Galaxies
'Activities' of Active Galaxies, How 'Active' are the Active Galaxies?, Classification of the Active Galaxies, Some Emission Mechanisms Related to the Study of Active Galaxies, Behavior of Active Galaxies, Quasars and Radio GalaxiesSeyferts, BL Lac Objects and Optically Violent Variables, The Nature of the Central Engine, Unified Model of the Various Active Galaxies

Module 3: ASTRONOMICAL TECHNIQUES **1 Credits**

A.Electro-magnetic spectrum. Radio Window, Radio telescopes, Interferometry, Basic parameters of an antenna. Various types of antennas. Infrared , Ultraviolet and X-ray telescopes. Solar telescopes.

B.Detectors for optical and infrared regions. Application of CCD's to stellar imaging, photometry and spectroscopy,Observing technique with a photometer, Correction for atmospheric extinction. Transformation to a standard photometric system. Astronomical spectroscopy.Spectral classification. Simple design of astronomical spectrograph. Radial velocity measurements.

C.Radio Astronomical Techniques: Design and construction of a simple radio telescope. Receiver systems and their calibration. Design and construction of a simple radio interferometer.MST Radar for Ionospheric studies.LB and VLBI Systems. Aperture Synthesis.

Module 4: LARGE SCALE STRUCTURES & THE EXPANDING UNIVERSE: 1 Credit

Cosmic Distance Ladder.An Example from Terrestrial PhysicsDistance Measurement using Cepheid VariablesHubble's Law, Distance-Velocity Relation, Clusters of Galaxies, The Virial Theorem and Dark Matter, Friedmann Equation and its Solutions, Cosmology, Cosmological models,Early Universe and Nucleosynthesis, Cosmic Background Radiation, Evolving vs. Steady State Universe

REFERENCES:

1. K.D. Abhyankar: Astrophysics: Stars and Galaxies
2. R.Bowers and T. Deeming: Astrophysics (John and Barlett. Boston)
3. L.H.Aller: Astrophysics.
4. Hynek: Astrophysics.
5. E. Ambartzumian: Theoretical Astrophysics.
6. Introduction to Cosmology, J. V. Narlikar, (Cambridge University Press).
7. Quasars & Active Galactic Nuclei, A. K. Kembhavi & J. V. Narlikar, (Cambridge Uni Press).
8. K.D.Abhyankar: Astrophysics - Stars and Galaxies. Tata McGraw Hill Publication
9. M.Sandage and J.Kristian: (Ed.) Galaxies and the Universe. University of Chicago Press.
10. C.R.Kitchin: Astrophysical Techniques.
11. Gordon Walker: Astronomical Observations - an Optical Perspective (Cambridge Uni press).
12. Henden and Kaitchuck: Astronomical Photometry.
13. W.A.Hiltner (Ed): Astronomical Techniques.
14. Kraus-‘‘Antennas”, McGraw Hill, 1950.

PHYDP707/PHYDP805: SPECIAL LABORATORY I and II

List of experiments

1. Determine the period of revolution of sun using virtual laboratory.
2. Simulation of radiation patterns of various antennas
3. To find the solar constant
4. To estimate the temperature of artificial star using photometry.
5. Measurement of solar limb darkening effect using photometer.
6. To determine the elements in sun using Fraunhofer spectra.
7. To polar align an astronomical telescope.
8. Computation of a lunar eclipse.
9. Computation of a solar eclipse.
10. Astrometry of asteroids using virtual observatory.
11. Identification of various great circles on the celestial sphere and important constellations using Norton’s Atlas.
12. To estimate the relative magnitude of a group of stars using CCD camera.
13. To study the atmospheric extinction for different colors
14. To estimate the distance of moon by parallax method
15. To study the effective temperature of stars by B.V. Photometry.
16. To estimate the night sky brightness by Photometer.
17. To study the distance to a cepheid variable.
18. To measure the polarization of day/moonlight.
19. To study the characteristics of CCD camera.
20. Plotting light curves of variable stars using virtual observations.

M. Sc. Physics

PHYDT703/PHYDT704: ATMOSPHERIC PHYSICS I

Module1: Atmospheric Thermodynamics:- **1Credit**

Atmospheric compositions, Equation of state for dry and moist air, Adiabatic process, Virtual temperature, humidity parameters, thermodynamic laws, Potential temperature, Pseudo adiabatic process, Clausius- Clapeyron equation, Thermodynamic diagrams-general considerations, Emagram, Tephigram.

MODULE-2:-Hydrostatic Equilibrium:- **1Credit**

Hydrostatic equation and geopotential, Height computation for air sounding, The homogeneous atmosphere, The isothermal atmosphere, The constant lapse rate atmosphere, The dry adiabatic atmosphere, The dry and moist adiabatic lapse rate.

MODULE-3:-Atmospheric Aerosols:- **1 Credit**

Introduction to Aerosols, Aerosol concentration and size distributions and its characteristics, sources of Aerosols, Transformation of Aerosols, Chemical composition of aerosols, Transport of aerosols, Sink of aerosols, residual time of aerosols, Geographical distribution of aerosols, Atmospheric effect of aerosols.

MODULE-4:-Cloud Physics:- **1 Credit**

Aerosols as Cloud Condensation Nuclei (CCN), Heterogeneous and homogenous Nucleation process, Curvature and solute effect, Condensation growth of cloud droplet by diffusion, collision and coalescence, Collection efficiency, Freezing nuclei, Mechanism of growth of ice particles in cloud, formation of ice, Rain making experiment, Classification of clouds and hails.

References:

1. Introduction to theoretical Meteorology-S.Hess
2 An introduction to Atmospheric Chemistry – By Prof.Peter V.Hobbs
3. Tropical meteorology Vol- I and II-G.C.Asnani
4. Weather forecasting –A.A.Ramshastry
5. Cloud physics-Rogers
6. Cloud physics-Wallace &Bob
7. Atmosphere, Weather and climate –K.Siddharth (Kisalaya Publication pvt.ltd)
8. Atmospheric Chemistry and Physics by John Seinfeld and S.N.Pandis, Wiley interscience.

PHYDP705/PHYDP805: SPECIAL LABORATORY I and II

List of Experiments: (Refer NASA SITE)

1. Use HYSPLIT Model- computation of Long-Range Transport of aerosols.

2. Use of DREAM Simulation Model to compute Aerosol concentration.

3. Measurement of Aerosol Properties using Radiometer.

4. Measurement of total Ozone using Ozonometer.

M. Sc. Physics

PHYDT803/PHYDT804: ATMOSPHERIC PHYSICS II

Module 1: Upper Atmosphere **1 Credit**

Thermal structure of Troposphere, Stratosphere and Mesosphere, Ionosphere, D, E, F regions, Radio wave propagation through Ionospheric circulation and warming, Pressure and density measurements from moving Rockets, Meteors in the mesosphere's.

Module 2: Atmospheric Ozone: **1 Credit**

Temporal and spatial variation of ozone Umkehr effect, stratospheric ozone, ozone flux from stratosphere to the troposphere, tropopsheric ozone, Chapman mechanism, ozone depletion on ozone Hole.

Module 3: Solar and Terrestrial radiations: **1 Credit**

Nature of radiations, scattering (Rayleigh and Mie), Black body radiations, Radiative transfer, Nature of solar radiations, Terrestrial radiation, optical depth, radiative equilibrium in stratosphere, short wave radiation, long wave radiation.

Module 4: Atmospheric Electricity: **1 Credit**

Elementary principle of electricity, electric field, electrostatic potential, charge separation in clouds, origin and distribution of ions, rate of ion pair production by cosmic rays as a function of height, conductivity, The lightning discharge.

References:

1. Introduction to theoretical Meteorology-S.Hess
2 An introduction to Atmospheric Chemistry – By Prof.Peter V.Hobbs
3. Tropical meteorology Vol- I and II-G.C.Asnani
4. Weather forecasting –A.A.Ramshastry
5. Cloud physics-Rogers
6. Cloud physics-Wallace &Bob
7. Atmosphere, Weather and climate –K.Siddharth (Kisalaya Publication pvt.ltd)
8. An Introduction to atmospheric physics: by Robert G. Fleagle and J.A.Businger, Academic press.
9. Atmospheric Chemistry and physics by John Seinfeld and S.N.Pandis, Wiley interscience.
10. The Upper Atmosphere, Meteorology and physics by Richard Craig, Academic press.

M.Sc. Physics

PHYDT703/PHYDT704: BIOMEDICAL INSTRUMENTATION I

Module 1: Fundamentals to Biomedical Instrumentation and patient safety **1 Credit**

1.1 Basic medical instrumentation system.
1.2 System configuration
1.3 basic characteristics of measuring system
1.4 Problems faced when measuring a human body
1.5 Essentials of biomedical instrumentation.
1.6 Electric shock hazards-Gross shock-Micro current shock
1.7 Precautions to minimize electric shock hazards

Module 2: Electrodes and physiological transducers: **1 Credit**

3.1 Electrode Theory
3.2 Biopotential Electrodes
3.3 Electrodes for ECG, EEG, EMG.
3.4 Introduction to physiological transducers
3.5 Classification of Transducer
3.6 Performance characteristic of transducer.
3.7 Displacement, position and motion transducer.
3.8 Pressure transducer
3.9 Transducer for Body temperature measurement
3.10 Biosensors

Module 3: Recording Systems and Signal Analysis: **1 Credit**

3.1 Basic recording system.
3.2 General consideration for signal conditioners
3.3 Preamplifiers, Differential, Instrumentation, Isolation amplifier.
3.4 Source of noise in low level measurement.
3.5 Biomedical signal analysis techniques
3.6 Fourier Transform, FFT and Wavelet Transform
3.7 Signal processing techniques.

Module 4: Cardiovascular System and Measurements: **1 Credit**

4.1 The Heart.
4.2 The Heart and Cardiovascular system
4.3 Blood Pressure
4.4 Heart Sounds.
4.5 Block diagram of electrocardiograph
4.6 The ECG leads
4.7 Effect of Artifacts on ECG recording
4.8Introduction to pacemakers
4.9 Types of pacemakers
4.10 Need for pacemakers
4.11Pacemaker system and its functioning

Reference Books:

1.Biomedical Instrumentation and Measurements (Second edition)
By Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer Pearson education.
2. Handbook of Biomedical Instrumentation (Second Edition) by R. S. Khandpur (Tata McGraw
Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.

PHYDP705: Special Laboratory I

List of Experiments (Any Five)

1 .Active filters for Bio-signals _ Design and Filtering
(Low pass and High pass filter)
2. Design and build a Notch filter (To reduce noise of 50 Hz).
3. ECG preamplifier-Instrumentation amplifier and testing.
4. Use of sphygmomanometers for measurement of blood pressure.
5. Concept of ECG, system and placement of electrodes
ECG signal recording with surface electrodes.
6. Design and build a Wide/ Narrow band pass filters for measurement for Bio-signals
7. To study LVDT Characteristic.
8. To study Thermistor Characteristic.
9. Measurement of physical parameter using embedded system

10.Measurement of pulse parameter using pulse oxymetry/pulse measuring instrument

M.Sc. Physics

PHYDT803/PHYDT804: BIOMEDICAL INSTRUMENTATION II

Module 1: The computer in Biomedical Instrumentation **1 Credit**

1.1 The digital computer-computer hardware-Computer Software.
1.2 Microprocessors –Types of Microprocessors
1.3 Microprocessors in Biomedical instrumentation
1.4 Microcontrollers in Biomedical instrumentation
1.5 Examples of Microcontroller Based system (data acquisition)
1.6 Interfacing the computer with medical instrumentation and other equipment.
1.7 Biomedical computer applications.

Module 2: Biomedical Recorders **1 Credit**

2.1 Introduction to nervous system,
2.2 Neuromuscular transmission, muscle potentials, receptors, Neurotransmitters
2.3 Electroencephalograph (EEG), Block diagram, Computerized Analysisof EEG.
2.2 Electromyography (EMG)
2.3 Pulse oximetry

Module 3: Ultrasonic Imaging Systems **1 Credit**

3.1 Diagnostic ultrasound,
3.2 Physics of ultrasonic waves,
3.3 Characteristics impedance, wavelength and frequency, velocity of Propagation,
3.4 Absorption of ultrasonic energy beam width, resolution,
3.5 Generation and detection of ultrasound.
3.6 Basic pulse echo apparatus
3.7 Diagnostic scanning mode A-mode, B-mode.

Module 4: Respiratory system, measurements and basic of radiology **1 Credit**

4.1 The Physiology of the respiratory system.
4.2 Tests and instrumentation of the mechanics of breathing
4.3 Respiratory Therapy Equipment
4.4 Heart lung machine
4.5 Basic definition in radiology
4.6 Generations and detection of ionizing radiation
4.7 Instrumentation for diagnostic x-rays.
4.8 Instrumentation for the medical use of radio isotopes

Reference Books:

1 .Biomedical Instrumentation and Measurements (Second edition)
By Leslie Cromwell, Fred J. Weibell, Erich A. PfeifferPearson education.
2. Handbook of Biomedical Instrumentation (Second Edition) by R. S. Khandpur (Tata McGraw
Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.

PHYDP805: Special Laboratory II

List of Experiments (Any five)

1. Recording of pulse signal using pulse oximetry/Pulse recording system.
2. Glucometer as a sensors/strain gauge, measurement of BMR, BMI and fats using fat monitor
3. Design and built data acquisition system using microprocessor/Microcontroller
4. Skin temperature using thermo sensor
5. Operation and function of all the controls of hospital X-ray machine/ C. T. Scan / Ultrasound
scanner (Visit at Hospital)
6. To study Lead I , II and III of standard bipolar Lead configuration
7. To study AVR, AVF and AVL lead of standard unipolar leads configuration
8. To study the abnormalities present in Human Cardiovascular System
9. To study of operating principles and characteristics of the D/A
10. To study Respiration rate monitor.

M. Sc. Physics

PHYDT703/PHYDT704: COMMUNICATION ELECTRONICS

Module 1: Digital Communication **1 Credit**

Fundamentals of digital communication systems.

Characteristics of data transmission system such as Band-Width requirement, speeds SNR, cross talk, echo suppressors, distortion equalizer, Digital codes, Baudot code, binary code, ASCII code (EBCDIC), hollerith code, error detection, constant ratio codes, Redundant codes, parity check codes, Communication system using modern interfacing, interconnection of Data circuit to telephone loops, Network organization.

Module 2: Broadband Communication systems: **1 Credit**

Multiplexing – FDM, TDM, Higher order digital multiplexing, Fiber Optic Communications – Principles of light transmission in a fiber, effect of Index profile on propagation , Modes of propagation, Number of modes a fiber will support, Single-mode propagation, losses in fibers. Dispersion – effect of dispersion on pulse transmission, types of dispersion, intermodal, material and waveguide, total dispersion and maximum transmission rates, Light sources for fiber optics, An Optical Receiver Circuit, Connectors and Splices – loss mechanism, types of connectors and fiber Splices, Fiber communication systems.

Module 3: Telephone and Facsimile systems: **1 Credit**

Wire telephone, telephone subscriber's loop circuit, transmission bridges, four wire terminating set, Two –wire repeaters, Four wire transmission , Public telephone network, Trunk circuits and Private telephone networks, Cellular and mobile phone systems. Facsimile transmission, reception, Transmission of facsimile telegraph, line transmission and radio transmission.

Module 4: Satellite Communication: **1 Credit**

Introduction to radar systems, fundamental radar range equation, basic pulsed radar. Satellite frequencies, orbits (geostatics, equatorial/polar, synchronous) station keeping, satellite attitude, transmission path, path loss, noise considerations, satellite system and scanning methods.

Reference Books :

1. Electronic communications – Rooddy – Coolen (PHI) electronic
2. Communication Systems – George Keneddy (TMH)
3. Telecommunication switching systems & Network – T.Vishwanathan.(PHI)
4. Mobile Cellular Tele communication System – C.Y.Lee
5. Communication Electronics – Fresnel
6. Communication Electronics – Katre

PHUDP705: List of experiments

1. Delta pulse Modulation
2. Optical communication with LED and Photo-transistor.
3. Directional characteristics of Dish antenna.
4. Digital Multiplexing
5. Study of cordless telephone
6. Study of PAM/PPM,PWM
7. Study of 3 way intercom system.

M.Sc. Physics

PHYDT803/PHYDT804: MICROWAVE PHYSICS AND APPLICATIONS

Prerequisite: Electron Motion in electric field, Magnetic field and electromagnetic field, Electric and Magnetic wave equation.

Module 1: Passive Elements **1 Credit**

Introduction to microwave it's application: transmission line theory, their equations and Solutions, reflection coefficient, standing wave ratio (SWR), admittance resonant lines.

Module 2: Impedance matching, Wave guides and wave guide components **1 Credit**

Impedance matching, single stub and double stub, rectangular wave guides, circular wave guides, TE & TM modes of propagation Q – of cavity resonator, use of Smith chart. Attenuators, filters, junctions, Tee's – magic Tee, (hybrid T), directional couplers , hybrid rings (Rat – Race), wave guide corners, bends.

Module 3: Active Elements **1 Credit**

Microwave generation problems and principles, Reflex Klystron, two cavity Klystron,
operation as amplifiers and oscillators, bunching process, Applegate diagram, Magnetron traveling wave tube amplifier, BWA Semiconductor devices ,Microwave transistor : Cutoff frequency, power gain, maximum available gain, frequency limitation. Johnson four equations, Gun diode, Tunnel diode, MOSFET,PIN diode, read diode, parametric amplifiers.

Module 4: Microwave other devices and measurements **1 Credit**

Ferrite isolators, Bolometers, TR and ATR switches,Microwave measurements : Impedance, power, frequency attenuation, dielectric constant Q measurements.

Reference Books :

1. Introduction to microwave theory and measurements : Lance PUB McGraw Hill.
2. Foundations of microwave engineering : Collins PUB McGraw Hill.
3. Microwave semiconductor devices and their circuit applications : Watson PUB McGraw Hill.
4. Microwave devices and circuits : Liao, PHL
5. Physics of semiconductor devices : S. M. Sze, Willey Eastern Ltd.
6. Microwave Electronics : V.Kulkarni, 1 Up Publication.
7. Microwave application : Sisodia, Raghuvanshi.
8. Microwave principles : Rich, Addion Wesley.

M. Sc. Physics

PHYDT703/ PHYDT704: ELECTRONIC INSTRUMENTATION I

Module 1: General Background and Measurements 1 Credit

1.1 General configuration and functional description of measuring instruments, few examples of instruments and their functional description. (Ref.1: #2.1 to 2.4). Input output configuration of measuring instruments, and methods of correction of unwanted inputs.(Ref.1: #2.5)

1.2 Qualities of measurements (Ref.9 Ch# 1) Static characteristics, Errors in measurement,

Types of errors, sources of errors (Ref.9 Ch# 1)

Dynamic characteristics: Generalised mathematical model of measurement System, order of instruments: zero, first and second order. Step, ramp and frequency response of first order instruments (Ref.1: #3.3 pp 94 to 115 & 123 to 131)

References: 1, 3,9

Module 2: Transducers: 1 Credit

2.1 Electrical transducers, resistive, strain gauge, thermistor, inductive transducers, variable reluctance, LVDT, pressure inductive, capacitive transducers, piezoelectric transducer, photoelectric, magnetoresistive sensors..Transducers for displacement, velocity, acceleration.

2.2 Fluid flow, fluid rate and velocity. Various temperature transducers : Acoustic temperature sensor, high temperature measurement using a cooled thermocouple(Ref.1),Humidity sensors, conductivity measurements, PMT, Optical pyrometry. (with at least one application of each transducer).

References: 9

Module 3: Signal conditioners and Data acquisition and conversion : 1 Credit

3.1 **Signal conditioners:** Op-amps, instrument amplifier, bridge, phase sensitive detector.

References: 9: Ch 17

3.2 **Data acquisition and conversion**

D to A and A to D converters, Data loggers, ADC digital transducer (optical transducer) Data acquisition system. ICs available: ADCs, DACs

References: 9

Module 4: Indicators, display system and recorders 1 Credit

4.1 Digital display system with LED and LCD. Printers: principle of Laser printers only

4.2. Introduction to microprocessor based instruments, with suitable examples. Stepper motor controller, and basic idea of process control.

References: 9

Reference Books:

1. Measurement systems- applications and design.4th edn E.O. Doeblin.
2.Measurement system – applications and design by E.O. Doblin ,and Manik .
3.Intrumentation, measurement and systems. Nakra and Chaudhary.
4.Electronic Instrumentation and measurement techniques by A.D.Helfrick and W. D. Cooper. (Pearson.)
5. Instrumentation, devices and systems. Rangan, Mani and Sarma Prentice Hall of India.18
6.Process controlled instrumentation by C.D.Johnson.
7.Elements of Electronic Instrumentation and measurement. 3rd edn. Joseph Carr. (Pearson).
8.Sensors and transducers. Patranabis.
9.Electronics Instrumentation. Kalsi (Tata McGraw-Hill)

PHYDP705/PHYDP805: Special Laboratory I and II

List of Experiments:

1. Temp. Characteristic of thermister / strain gauge and application. (Ref. # 1)
2. D to A converter circuit (R-2R & binary weighted using IC). For complete negative, negative to positive and positive outputs.
3. V to F, converter as basic concept of ADC.
4. Op-amp as Instrumentation amplifier.
5. Characteristics and applications of photoelectric devices, LED (photodiode, photoelectric
relay action).
6. Study of Sample and Hold Circuits
7. Study of data acquisition system
8. Study of thermocouple amplifier.
9. Application of ultrasonic pressure transducer.
10. LVDT displacement Transducer.

M. Sc. (Physics)

PHYDT803/ PHYDT804: ELECTRONIC INSTRUMENTATION II

Module 1:

1.1 INTRODUCTION TO PROCESS CONTROL 1 Credit

Introduction, Control systems, Process control block diagram, Control system Evaluation

Control system Objective Stability, Regulation, Transient Regulation, Evaluation Criteria,

Damped response, Cyclic response, Sensor time response, Process Control Drawing and symbols with their meaning.

References: 1,2

1.2 Discrete Process Control :

Introduction, definitions of discrete state process control characteristics of the systems , relay, controllers and ladder diagrams, PLC's, Interfacing with LAN, SCADA systems.

References: 1

Module 2 : Controller Principles 1 Credit

Introduction, Process Characteristics Process Load, Transient, Process Lag, Control System Parameters, Error, Variable Range, Control Parameter Range, Control Lag, Dead Time, Cycling, Controller Modes, Reverse And Direct Action, Discontinuous Controller Modes Two Position Neutral Zone (Examples) Applications, multi position controller floating control mode(eliminate single speed and multiple speed) Continuous controller modes Proportional Control Mode Integral, Control Mode, Derivative Control Mode, Composite Control , PI Control, PD Control Mode, Three Mode Controller (PID) .

References: 1

Module 3: Controllers 1 Credit

3.1Analog Controllers:

Electronic controller with design considerations: Proportional(P), Integral(I), Derivatives(D) PI, PD and PID

3.2 **Digital Control**: Introduction two position controls and multivariable alarms.

References: 1

Module 4: 1 Credit

4.1: Introduction to modeling and simulation:

Mathematical model, equivalent circuit model, Empirical Model, methodology, concept and need of simulation and its applications.

References: 2

4.2:Introduction to MATLAB/ SciLab programming:

All chapters are taken from "MATLAB an introduction and applications" , by Amos Gilat, Wiley Students Edition.

References: 3

References Books:

1: Process Control Instrumentation Technology,
Curtis D. Johnson, 7th Edition, Prentice Hall India Pvt. Ltd.
2: Computer based industrial controls
K. Kant PHI publications.
3: MATLAB an introduction and applications", by Amos Gilat, Wiley Students Edition

M.Sc. Physics

PHYDT703/ PHYDT704: ENERGY STUDIES I

Module 1: Indian Energy Scenario **1 credit**

Role of energy in economic development and social transformation, Energy and gross domestic
product (GDP), Gross National Product (GNP) and its dynamics.
Various types of energy sources: Energy sources and overall energy demand, Availability of
energy sources, Energy consumption in various sectors and its changing pattern, projected
energy demands.
Non Renewable Energy sources : Coal, Oil, Natural gas, Nuclear power, Hydro-electricity,
Renewable Energy sources: Solar ,Wind, Biomass, Tidal, Ocean wave, Ocean thermal, Geothermal and other , Depletion of energy sources and impact of exponential rise in energy
consumption on economics of India and on international relations.
Energy Security: Energy for security and security of energy, Energy consumption and its impact
on environmental climatic change.
Future Energy Option: Sustainable development, Energy crisis, Transition from carbon free
technologies, Parameters of transition, Carbon credits.

Module 2: Solar Radiation and Its Measurements **1 credit**

Importance of Solar Energy : Nature of solar radiation, Sun as a fusion rector, special distribution of extraterrestrial radiation, Estimation of extraterrestrial solar radiation, Radiation on horizontal and titled surfaces, Beam, diffuse, global radiation and their measurement.
Available solar radiation, Measurement of beam, diffuse, global radiation,
Pyranomater, Pyrhelimeter, Sunshine duration recorder Angstrom relation.
Ref. no. 8

Module 3: Basics of Heat transfer **1 credit**

Heat and Thermodynamics: Basic units, dimensions, Concept of heat, energy and work, Ideal gas flow, 1st and 2nd law of thermodynamics, Types of heat transfer.
Conductive heat transfer: Fourier's law. Stefans-Boltzman relation and IR heat transfer between gray surfaces.
Radiative heat transfer: sky radiation, radiation heat transfer coefficient
Convective heat transfer: Natural and forced convection, natural convection between parallel plates, Non-dimensional numbers, conductive heat transfer coefficient, Heat transfer due to wind.
Ref. no. 9

Module 4: Energy Storage **1 credit**

Types of energy storage systems : sensible and latent heat storage systems, Electric energy storage systems, Chemical energy storage systems, Heat exchanges, Hydrostorage, solar pond as a energy storage, Green house.
Ref.no. 11

Reference Books:

1. TEDDY Year Book, (Tata Energy Research Institute (TERI) Publication, New Delhi).
2. World Energy Resources, Charles E.Brown (Springer Publication), 2002.
3. Energy Policy for India, B.V. Desai (Welley Eastern Publication)
4. Handbooks of Solar Radiation , A.Mani (Allied Publishers), 1980.
5. Solar Energy Fundamentals and Applications, H.P. Garg and Satya Prakash, (Tata McGraw Hill), 1977.
6. Treatise on Solar energy, H.P. Garg, Volume 1,2 and 3.(John Wiley and Sons) 1982
7. Principles of Solar Engineering, F.Kreith and J.F. Kreider, McGraw Hill , 1978
8. Solar Energy Thermal Processes, J.A. Duffie and W.A. Beckman, (John Wiley and Sons)1980
9. Heat and Thermodynamics, M.W. Zemansky,(McGraw Hill Publication)
10. Principles of Solar Energy Conversion, A.W.Culp (McGraw Hill Publication)
11. Solar Energy Principles of Thermal Collection and Storage, S.P. Sukhatme, 2nd edition (
Tata McGraw Hill Publication C.Ltd.(, 1976
12. Solar Energy Utilization, G.D.Rai (Khanna Publishers) 1996
13. Solar Thermal Engineering, J.A. Duffie(Academic Press)
14. Renewable Energy Sources and Conversion Technology, N.K. Basal, M. Kleeman and
S.N. Srinivas ,(Tata Energy ReserchInstitute, New Delhi) 1996

PHYDP705 Special Laboratory I

List of Experiments:

1. Determination of Calorigic value of Wood/Cow dung.
2. Study of Optical Properties of selective coatings.
3. Study of Photovoltaic a Characteristics of Solar Cell (Variation of Intensity, Distance between Source and Solar Cell, and load)
4. Study of power versus load characteristics of Solar Power Photovoltaic Systems and Study of Series and Parallel Combination of Solar Photovoltaic panels.
5. Study of Solar Collector (Efficiency versus Δ T/I)
6. Visit to solar energy farm(Solar PV plant/Wind energy/ Thermal energy/ Hydro electric/Co generation plant).

M.Sc. Physics

PHYDT803/ PHYDT804: ENERGY STUDIES II

Module 1: Solar Photovoltaics (SPV) 1 credit

Solar Photovoltaics (SPV) Conversion : Basic principles, Types of solar cell materials, Fabrication of solar photovoltaic cells, solar cell parameters and characteristics, Modules.

Block diagram of general SPV conversion system and their characteristics, Different configurations, Application (such as street light, water pumps, Radio/TV,Small capacity power generation) Solar Photovoltaic (SPV) Systems Designing : Load estimation, selection of inverters, battery sizing, array sizing.

Ref. no. 2,15.

Module 2: Photothermal applications of Solar Energy 1 credit

Selective coatings : Ideal characteristics of selective coating for various applications, Types of selective coatings, materials and techniques for selective coatings, Effect of selective coating on the efficiency of solar collectors.

Solar Thermal Devices and Systems : Different types of collectors , Flat plate collector(Basic principle, construction, Energy balance equation of steady state, Testing, Methods to reduce losses), Solar cookers, Domestic hot water system, Solar dryers, solar pond, Solar still, Solar furnace, Solar refrigeration, Solar concentraters, systems based on use of solar concentraters.

Ref. no. 2, 6.

Module 3: Hydrogen Energy 1 credit

Hydrogen Fuel : Imortance of Hydrogen as a future fuel, Sources of Hydrogen, Fuel of vehicles.

Hydrogen production : Production of Hydrogen by various methods, Direct electrolysis of water, Direct thermal decomposition of water, Biological and biochemical methods of hydrogen production.

Hydrogen storage : Gaseous, Cryogenic and Metal hydride. Utilization of hydrogen : Fuel cell – Principle, construction and applications.

Ref.no. 2,11,12.

Module 4: Wind and Bio Energy 1 credit

Wind Energy : Introduction, Basic principle of wind energy conversion, Extraction of maximum power from wind and its dependence on various parameters.

Wind Mills : Types of wind mills, Vertical axis and Horizontal axis wind mills their performance, Merits and Demerits, Limitations of wind energy conversions.

Bio Energy : Biomass, Generation and utilization, Property of biomass, Agriculture crop and Forestry residues used as fields. Physical, Chemical and biological conversion of biomass into useful form of energy. Gasification, Biomass gasifiers and types.

Biogas : Introduction , Generation of biogas, Aerobic and anaerobic bioconversion process.
Substances used to produce biogas (Cow dung, Human and other agricultural waste, Municipal waste etc.), Digesters and their designs, Pyrolysis and gasification, Fermentation process.

Biofuels : Types of biofuels,, Production processes, Biofuel applications, Ethanol as a biofuel.
Ref. no. 2,9,14**.**

Reference Books:

1. Climatological and Solar data for India, Seshadri. (Sarita Prakashan), 1969.
2. Solar Energy Utilization, G.D.Rai, 9Khanna Publishers), 1995.
3. Energy technology, S.Rao and B.B. Parulekar (Khanna Publishers), 1995
4. Terrestrial Solar Photovoltaics, Tapan Bhattacharya, (Namsa : Publication House, New Delhi)
5. Solar Cells-operating Principles, technology and System Applications, Martin A. Green (Prentice Inc. USA).
6. Solar Thermal Engineering, J.A. Duffie (Academic Press)
7. Renewable Energy Sources and Conversion Technology, N.K. Bansal, M. Kleeman and S.N. Sreinivas 9 Tata Energy Research Institute, New Delhi), 1996.
8. Fundamentals of Solar Cells, F.A. Faherenbruch and R.H. Bube 9Academic Press).
9. Biomass Energy Systems, Venkata Ramala and S.N. Srinivas (Tata Energy Research Institute, New Delhi, New Delhi),1996.
10. Thin Film Solar Cells, K.L. Chopra and S.R.Das (Plenum Press),1983
11. Solar Hydrogen Energy Systems, T. Ohta (Pergamon Press)1979
12. Hydrogen Technology for Energy D.A. Maths (Noyes Data Corp.)1976
13. Handbook Batteries and Fuel Cell, Linden (McGraw Hill)1984
14. Wind energy Conversion Systems, L.L. Freris (Prentice Hall)1990

15. Solar PhotoVoltaics.- C.S. Solanki.

PHYDP705: Special Laboratory II

List of Experiments:

1. Study of Hot Water system.
2. Determination of heat Loss Coefficeient in Flat Plate Collector.
3. Study of Solar Dryer (Hot Air Collector)
4. Study of Solar Still.
5. Performance Evaluation of Box Type and Concentrating Type Solar Cooker
6. Visit to solar energy farm(Wind energy/ Thermal energy/ Hydro electric/ Co generation plant)

M.Sc. Physics

PHYDT703/ PHYDT704: MEDICAL PHYSICS I

Module 1: Forces acting on body and Physics of the skeleton 1 credit

Statics, Frictional forces, Dynamics, Conservation of Energy in the body, Heat losses from body, Pressure in the body. Physical properties of bone, Mechanics of joints,

Module 2: Electricity within the body 1 credit

Nervous system and neuron, Electric properties of Nerve, Electrical potential of nerve,

Nernst Equation, Bio potentials EMG, ECG, EEG, EOG, ERG, Magnetic signals from heart and Brain

Module 3: Physics of hearing 1 credit

Basic definition of Audibility, Physics of ear, Human Audibility Curve, Sensitivity of ear,

Testing of hearing. Deafness and hearing aids, Sound in medicine, Sound pollution,

Effects of sound pollution on living body, Methods to minimize sound pollution

Module 4: Physics of vision 1 credit

Optics of eye, Diffraction effects of eye, Refractive effect in eye and its correction, Contact Lenses, Color vision and chromatic aberration, Instruments used in Ophthalmology.

Reference Books:

1.Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons,Inter.Publ.
2 .Essential of Biophysics by Narayanan, New age Publication.
3. Radiation Biophysics by Edward Alphan, prentice Hall Advance Referes.
4. T.B. of Biophysics by R.N. Roy , Central Publication.
5. Medical Informatics by Smita Mishra and K. C. Mishra, ICFAI university.
6. Fundamental of Bioinformatics by Harisha. S.
7. Biomedical Engineering by S.N. Sarbadhikari, University press.
8. Principles of medical electronics &Biomedicalinstrumentation by c. Raja Rao, S. K. Guha , University press.
9. Electronics in medicine & Biomedical instrumentation by NandiniJog ,
10. Websites of the related topics

M.Sc. Physics

PHYDT803/ PHYDT804: MEDICAL PHYSICS II

Module 1: Nuclear Medicine **1 Credit**

Radioactivity, Sources of Radioactivity, Nuclear medicine imaging device rectilinear scanner, Positron emission tomography, Magnetic resonance imaging(MRI), Laser in medicine.

Module 2:.Radiation physics **1 credit**

Ionizing Radiation, Interaction of radiation with matter, Dosimetry, Radiation isotopes,
Biological effects of radiation, Radiation protection in therapy.

Module 3: X-ray in medicine **1 Credit**

Discovery and Production of X-ray, Basic components of X ray machine, Making of X-ray image, Fluoroscopy, Computer tomography (CT Scan), X-ray in diagnosis, X-ray in therapy, Hazards of X-ray.

Module 4:Biomaterials and new trends in Medical Physics **1 Credit**

Biomaterials – Introduction, Bio-ceramics, Bio-polymer, Bio-steel, Bio-chip, Blood as a Biomaterial, Introduction to Bio- Nanomaterial , Telemedicine, New trends in Medical informatics Embedded system in Hospital.
Reference books

1.Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons, Int.Publication.
2.Essential of Biophysics by Narayanan, New age Publication.
3.Radiation Biophysics by Edward Alphan, prentice Hall .
4.T.B. of Biophysics by R.N. Roy , Central Publication.
5.Biophysics by Mohan Arora , Himalaya Publication House , Mumbai(2004).
6.Opthalmology by A.K. Khurana, New age Publication.
7.Introduction to Biomedical Engineering by Enderle, Elsevier Publication
8 Websites of the related topics

PHYDP705: SPECIAL LABORATORY I

List of Experiments (Any five)

1. ECG Recording and analysis.
2. Measurement of sound intensity using SPL.
3. Audiometry and analysis.
4. Comparison of resolving limit of eye and telescope.
5. Study of ophthalmoscope, Retinoscope.
6. Visit to Hospital (for study of Instruments used in Ophthalmology).
7. Study of Snellen's chart / Tonometer
8. Speech Analysis
9. Measurement of Physical parameter(BMR,Fat,BP) and Comparison of the parameters in uncontrolled stress condition using statistical techniques.

PHYDP805: SPECIAL LABORATORY II

List of Experiments (Any five)

1. Measurement of Heart Rate, Pulse rate, respiration rate, and BP using Multipara.
2. Blood analysis, Absorption spectra of Blood using Spectrophotometer.
3. Medical Informatics using Internet.
4. Study of pacemakers Trainer Kit.
5. Visit to Hospital for study of nuclear medicine.
6. Measurement of Viscosity of blood.
7. Mechanical properties of bone.
8. ECG simulator
9. Study of UV-Visible /FTIR for characterization of Biomaterial
10. Measurement of physical parameter using embedded system

M.Sc. Physics

PHYDT703/PHYDT704: MICROCONTROLLER BASED INSTRUMENTATION SYSTEM I

Prerequisite:

General configuration and functional description of measuring instruments, few examples of Instruments and their functional description. Input output configuration of measuring instruments, and methods of correction of unwanted inputs. Errors, their classification with numerical examples, OP-Amp basics, instrument amplifier, bridge, chopped DC amplifiers, filters, sample and hold. D to A and A to D converters, a/c and dc bridges. Digital fundamentals: counters, registers, buffers, MUX & De MUX etc.

Module 1: Transducers Fundamentals : 1 Credit

Electrical transducers, resistive, strain gauge, capacitive, inductive transducers, variable reluctance, LVDT, phase sensitive detector, piezoelectric transducer, photoelectric, Pressure (mechanical) transducers, diaphragm, bellows, bourdon tube, Fluid flow (mechanical and electrical), various temperature transducers. digital transducer (optical transducer),

Module 2: INTRODUCTION TO CONTROL SYSTEMS 1 credit

Data acquisition and conversion systems : Data loggers, Data acquisition system and its example.
Introduction to control systems, Process control block diagram, Control system evaluation, objectives, stability.
Discrete Process Control :
Introduction, definitions of discrete state process control, characteristics of the systems, relay controllers and ladder diagrams with examples, PLC's
. Continuous controller : Proportional control mode
,Integral, Derivative and composite - PI, PD and PID with numerical example.

Module 3: Basic concept of embedded instrumentation: 1credit

Need and advantages of using microcontrollers in instrumentation. Basic concepts of embedded instrumentation, Features, specifications and differences, different blocks of embedded instruments, ideal microprocessor / microcontroller based instruments. Basics of processors / controllers, hardware resources comparison of 8085 and 8051 processor and microcontroller, architectural details of 8085 and 8051.

Module 4: Microprocessor/microcontroller support devices 1 credit

Memories, Latches, Shift register, RAM, NVRAMs, ROM, PROM, EAPROMS, FLASH, SRAMS, DRAMS Differences and general specifications various memory devices external memory interfacing to 8051 controller, internal memory map of 8051, details of various SRF's and BIT addressable memories, Input-Output devices: I/O mapping, I/O mapped I/O, Memory Mapped I/O, introduction to PPI 8255.

Text Books:
Instrumentation Devices and Systems. Rangan, Mani and Sarma: TATA McGraw Hills
Instrumentation: Measurement and Analysis Nakra, Chaudhari. TATA McGraw Hills
Sensors: by Patranabis
Process Control Instrumentation Technology C.D. Johnson, Pearson Publications.
OP Amps and Linear ICs Applications by Ramakant Gaikwad
Op Amps by G.B. Clayton
Reference books:
Measurement System by E.O. Doebelin: . McGraw Hills
Handbook of Transducers by H. N. Norton
Sensors: by Patranabis
Sensors: by Patranabis

PHYDP705: Special Laboratory I

1 Study of Digital IC's & Digital frequency counters. (TTL, CMOS LSI/MSI type)
2 study of LVDT and precision rectifier using OPAMPs
3 Study of Instrumentation amplifier using quad OPAMPS IC
4 Study and calibration of PT 100 temperature sensor.
5 Comparative study of various regulator ICs (78xx, 79xx, 317,337, 723) and power supplies.
6 Study of DAC 1408.
7 Study of Dual Slope ADC (7107/7106 or equivalent type), Successive Approximation type (0809 or some similar type)
OR

7 Design, build and study of 4 bit flash ADC using Op Amps and encoders.
8 Study of Photo diode/Photo transistor characteristics and its application designing a general purpose lux meter.
9 Study of characteristics of photovoltaic cell.
10 Study of digital optical rotary/linear motion transducer.
11 Study of load cell (strain gauge) for pressure/ force/displacement measurement
12 Study of sample and hold amplifier LF 398 or equivalent
13 Study of two position controller using OpAmps
14 To design build and test 4 – 20 mA current transmitter using OpAmps.
15 Study of Opto couplers
16 Study of PID controllers using OpAmps.

M.Sc. Physics

PHYDT803/PHYDT804: MICROCONTROLLER BASED INSTRUMENTATION SYSTEM II

Module 1: Microcontroller Based Instrumentation Systems 1 Credit

Addressing modes and study of instruction set of 8051, stack pointer, stack memory, and stack operations, Simple programs like code conversions, simple arithmetic manipulation programs including 16 x 16 bit operations, signed number concept, logical instructions, compare, rotate and swap instructions etc., Simple programs based on these instructions , Memory operations related programs (block copy, move, look-up table etc.)

Module 2: 8051 Timers, Interrupts and Serial Communication 1 Credit

8051 Timer programming , Interrupts and interrupts handling, generation of delays , Basics of serial of communication in 8051, 8051 connections to RS232, 8051 serial port programming in assembly language.

Use of Kiel or other suitable software package (pinnacle) for assembly language programs as a simulation and debugging tool.

Module 3: Modular Development of Embedded System I 1 Credit

Step by step development of interfacing of switches LED's rotary switches with its programming, look up table searching, I/O expansion for 8051 using serial interface, error detection programs, interfacing of different modules and peripheral devices such as ADC (0809), DAC (0808), PPI IC 8255 power down and idle mode operation of 8051, program securities.

Module 4:. Modular Development of Embedded System II 1 Credit

Detailed study of interfacing matrix key board, key de bounce problem with software and hardware techniques, Seven Segment Displays with assembly language programs for interfacing, different types of LCD display modules with their characteristics and timing consideration for interfacing to 8051, study of DS12887 RTC and its interfacing to 8051.

Text Books:

1 Process Control Instrumentation Technology (VIIIth edition or latest) C.D. Johnson, Pearson Publications.
2 Microprocessor Architecture, programming an d applications By Ramesh Gaonkar
3 The 8051 Microcontroller by K.J. Ayala
4 Atmel Microcontroller Hand book

5 The 8051 Microcontroller and embedded systems by Muhammad Ali Mazidi and Janice G Mazidi
6 Computer based industrial controls K. Kant PHI publications.

Reference Books:

1 Embedded Systems – Rajkamal
2 Programming & Customizing 8051 Micro controller – Myke Predko
3 8051 Microcontroller Programming- Haung
4 Embedded Microcomputer systems: Jonathan W Valvano – Thomson Publication
5 An Embedded Software Primer by David E. Simon. Publisher: Addison- Wesley. ISBN 0-201-61569-X. Copyright 1999.

PHYDP805: Special Laboratory II

1 Development of P, I, D control and their combination (Equivalent to 03 practical)
2 Simple programs on Handling block transfer of data, multiplication, division(8 and 16 bit by 16 bit) etc.
3 Sorting (ascending and descending) an array using assembly language programming using 8051 debugger/Kiel Pinnacle
4 Use of internal timers and counters for signal generation data communication
5 Using timers and counters of 8051 for generating PWM signals
6 Study and Use of vectored interrupt of 8051 to initiate and inhibit some operation/process
7 Interfacing stepper motor to 8051.
8 Interfacing of seven segment display and LCD display module to 8051 microcontroller.
9 Interfacing keys/matrix key board to 8051.
10 Interfacing ADC and DAC to 8051.
11 Serial data transfer to computer system using RS232/USB.
12 RTC interfacing – setting Date and Time
13 Interfacing of PPI 8255 to microcontroller

M. Sc. Physics

PHYDT703/PHYDT704: NUCLEAR TECHNIQUES I

Module 1: Interaction of radiation with matter (1 Credit)

General description of interaction processes, interactions of directly ionizing radiation (electrons, protons and ions), stopping power, linear energy transfer, range of particles, straggling, interaction of indirectly ionizing radiation (gamma radiations), attenuation coefficient, energy transfer, build up factor.

Module2: Nuclear detectors (1 Credit)

Ionization and transport phenomena in gases, cylindrical and multiwire proportional counters, Ionization chamber, Proportional counter, GM counter, general characteristics of organic and inorganic scintillators, scintillation detectors NaI-(Tl), detection efficiency for various types of radiations, scintillators, detection efficiency for various types of radiation, photomultiplier gain, semiconductor detectors, surface barrier detector, Si(Li), Gel(Li), HPGe detectors.

Module3: Pulse processing and related electronics (1 Credit)

Preamplifier, pulse shaping and pulse stretchers networks, delay lines, amplifier, Pulse height analysis and coincidence technique, Discriminators: Single channel analyzer, multichannel analyzer, pulse height spectroscopy, pulse shape discrimination, coincidence and anti- coincidence units.

Module 4: Dosimetry and radiation protection (1 Credit)

Units Rontgen, RAD, REM, RBE, BED, Gray, Sievert, kerma, Cema, energy deposit and energy imparted, absorbed dose, main aims of radiation protection, dose equivalent and quality factor, organ dose, effective dose equivalent effects and dose limits, assessment of exposure from natural man-made sources, effects of radiation on human body.

Books:

1. *Nuclear radiation detectors,* S. S. Kappor and V. S. Rmanurthy. (Wiley Eastern Limited, New Delhi,) 1986.
2. *Introduction to radiation protection dosimetry,* J. Sabol and P. S. Weng, (World Scientific), 1995.
3. *Techniques for nuclear and particle physics,* W. R. Len (Springer), 1955.
4. *Nuclear Measurement Techniques,* K. Sriram, (Affiliated East-West Press, New Delhi), 1986.

5. *Fundamentals of surface and thin film analysis,* Leonard C. Feldman and James W. Mayer, (North Holland, New York), 1988.

6. *Introduction to nuclear science and technology,* K. Sriram and Y. R. Waghamare, (A. M. Wheeler), 1991.
7. *Nuclear radiation detection,* W. J. Price, (McGraw-Hill, New York), 1964.
8. *Alphas, beta and gamma-ray spectroscopy,*. K. Siegbahn, (North Holland, Amsterdam), 1965.
09. *Introduction to experimental nuclear physics,* R. M. Singru, (John Wiley and Sons), 1974.
10. *Radioactive isotopes in biological research,* Willaim R. Hendee, (John Wiley and Sons), 1973.
11. Atomic and Nuclear physics, Satendra Sharma, Pearson Education, 2008

PHYDP705: Special Laboratory I

1. To determine resolving/dead time of a GM counter by double source method.
2. To study Compton scattering using 6.66% MeV gamma-rays.
3. To determine energy resolution of a Nal(TI) detector and show that it is independent of the gain of the amplifier.
4. To determine energy of a given gamma-ray source by calibration method.
5. To study various operations of 1024 channel analyzer and to calculate energy resolution, energy of gamma ray, area under photopeak etc.
6. To study beta-ray spectrum of Cs-137 source and to calculate binding energy of K-shell electron of Cs-137.
7. To determine and compare the linear absorption coefficient of gamma radiation for different metals.
8. To determine the efficiency of GM counter/NaI(Tl) detector for different energy gamma radiations.
9. To determine the efficiency of GM counter for beta particles.

(Any five experiments will be covered)

M. Sc. Physics

PHYDT803/PHYDT804: NUCLEAR TECHNIQUES II

Module 1: Basic parameters of radioactive disintegration process (1 Credit)

Law of radioactive disintegration, units of activity, basic concepts of half life, mean life time of nuclei. Measurement of lifetime of nuclear excited states using techniques such as conversion line shift recoil distance, delayed coincidence, activity measurement and other methods. Measurement of Beta-Beta and Beta-gamma coincidence.

Module2 : Generation and detection of neutrons (1 Credit)

Neutron sources, neutron detectors, measurement of cross-sections for nuclear reaction, thermal and fast reactors, production of radioisotopes. Reactor operation, thermal neutrons, neutron scattering and applications.

Module3: Nuclear reaction analysis (1 Credit)

Elemental analysis by neutron activation technique, proton induced X-ray emission technique, Rutherford backscattering, Resonance nuclear reaction, ERDA, channeling, ion scattering and other such methods.

Module 4: Radioisotopes and its Applications (1 Credit)

Radioistopes, Radioactive waste disposal applications of radioisotopes (industrial, agricultural) dating of archeological and other ancient object, Medical uses of radioisotopes and electron beams, radiotherapy, Carbon-14 and potassium-argon dating.

Books :

1. *Nuclear radiation detectors,* S. S. Kapoor and V. S. Ramamurthy. (Wiley Eastern Limited, New Delhi), 1986.
2. *Introduction to radiation protection dosimetry,* J. Sabol and P. S. Weng, (World Scientific), 1995.
3. *Techniques for nuclear and particle physics,* W. R. Leo. (Springer), 1995.
4. *Nuclear Measurement Techniques,* K. Sriram, (Affiliated East-West Press, New Delhi), 1986.
5. *Fundamentals of surface and thin analysis,* Leonard C. Feldman and James W. Mayer, (North Holland, New York), 1988.

6. *Introduction to nuclear science and technology,* K. Sriram and Y. R. Waghamare, (A. M. Wheeler), 1991.

7. *Nuclear radiation detection,* W. J. Price, (McGraw-Hill, New York), 1964.

8. *Alpha, beta an gamma-ray spectroscopy,* K. Siegbahn, (North Holland, Amsterdm), 1965.

9. *Introduction to experimental nuclear physics,* R. M. Singru (John Wiley and Sons), 1974.

10. *Radioactive isotopes in biological research,* William R. Hendee, (John Wiley and Sons), 1973.

11. Atomic and Nuclear physics, Satendra Sharma, Pearson Education, 2008

PHYDP805: Special Laboratory II

1. To make a short lived isotope using thermal/fast neutrons and measure its half life time.
2. To determine resolving time of a coincidence using chance coincidence technique.
3. To determine activity of a given gamma-ray source using radiation monitor.
4. Measurement of neutron flux using activation method.
5. To measure efficiency and energy resolution of a NaI(Tl)/HPGe detector
6. To study designing of a D/A converter using R-2R ladder network.
7. To design and study the different modes of scalar using IC 7490 and observe the output on CRO.

(Any five experiments will be covered)

M.Sc. Physics

PHYDT703/PHYDT704: PHYSICS OF THIN FILMS

Module 1: Introduction to thin films **1 credit**

Overview of vacuum techniques,

Comparison of thin and thick films,

Theory of growth of thin films: Nucleation, condensation, Capillarity model, Atomistic model, comparison of models, various stages of film growth.

Module 2: Deposition Techniques and Measurement of thickness **1 credit**

Physical Vapour Deposition, Chemical Vapour Deposition, Molecular Beam Epitaxy, Sputtering, Spray pyrolysis, Dip coating and Spin coating, Photolithography, Electron –beam deposition, Pulsed Laser Ablation.

Tolansky technique, Talystep (styles) method, Quartz crystal microbalance, Stress measurement by optical method, Gravimetric method.

Module 3: Properties of thin films: **1 credit**

Electrical Properties: Source of Resistivity in Metallic conductors, Influence of thickness on the resistivity of thin films, Hall Effect & Magnetoresistance in thin films, Fuch-Sondhemir theory, TCR and its effects.

Mechanical properties: Adhesion & its measurement with mechanical and nucleation methods, stress measurement by using optical method. Optical properties: Absorption and transmission.

Module 4: Applications of Thin Films: **1 credit**

Resistors, capacitors, Junction devices (Metal semiconductor junction) Solar cells, ICs, Optical coating, Thin film sensors (gas and humidity), Thin films for information storage, electro acoustics and telecommunication.

Reference books:

1. Hand book of Thin Film Technology: Maissel and Glang, (Mc Graw Hill)

2. Thin Film Phenomena: K. L. Chopra, (Mc Graw Hill)

3. Material Science of Thin Films: M. Ohring, (Academic Press)

4. Thin Film Process: J. L. Vossen and Kern, (Academic Press)

5. Vacuum Technology (2nd revised edition), A. Roth, (North Hollad)

PHYDP705: SPECIAL LABORATORY I

List of Experiments (Any five)

1. Deposition of metallic thin films by vacuum evaporation method.
2. Measurement of resistance by two probe method with variation in temperature.
3. Deposition of thin films by spray pyrolysis method and thickness measurement by gravimetric method
4. Thin film formation by Electro-chemical deposition technique.
5. Deposition of thin films by spin coating method and resistance measurement.
6. Deposition of thin film by Dip Coating method and thickness measurement.
7. Thickness measurement of thin film by Tolansky method.
8. Study of oxidation laws.
9. Development of microstructures by photolithography.

M.Sc. Physics

PHYDT803/PHYDT804: PHYSICS OF NANO MATERIALS

Module 1: Quantum Size Effects **1 credit**

Effect of reduction of dimensions, Quantum size effect.

Particle in a box, Density of states for a zero, one, two, and three dimensional box.

Surface & Interface effects, Surface energy & Surface curvature.

Sintering, Ostwald ripening and Agglomeration.

Electrostatic and Steric Stabilization.

Introduction to nano-sized materials & structures.

Module 2: Physical & Chemical Methods for the Synthesis of Nanomaterials **1 credit**

High energy Ball Milling, Melt mixing, Physical vapour deposition, cluster beam deposition, Sputter deposition, Chemical vapour deposition.

Homogeneous and Heterogeneous nucleation, Growth of nuclei controlled by diffusion & surface process.

Synthesis of nanoparticles: By Wet chemical method (colloidal route), Electrochemical Method, Langmuir-Blodgett method, Sol-gel method and Hydro thermal method.

Module 3: Special Nanomaterials **1 credit**

Fullerene, Graphene, Types and Structures of Carbon nanotubes.

Porous Silicon. Aerogels, Passivation of quantum dots by core-shell structures, Nano- composites.

Module 4: Properties & Applications of Nanomaterials **1 credit**

Mechanical, Thermal, Electrical, Optical & Magnetic Properties.

Surface Plasmon Resonance and Super-paramagnetism.

Application to Nanoelectronics, Super capacitors, Quantum Dots & Quantum well devices, (QD sensitized solar cells and dye-sensitized Solar cells), Optical Devices, Medical, Biological, Automobiles, Space, Defence, Sports & Cosmetics.

Reference Books:

1. Nanotechnology: Principles & Practices. Sulbha K. Kulkarni ,Capital Pub.
2. Nanostructures & Nanomaterials Synthesis, Properties & Applications. Guozhong Cao, Imperials college Press London.
3. Nanomaterials: Synthesis, Properties & Applications. Edited by A.S. Edelstein & R.C. Commorata. Institute of Physics Publishing, Bristol & Philadelphia.

4. Introduction to Nanotechnology. C.P. Poole Jr.& F. J.Owens, Wiley Student Ed.
5. Nano: The Essentials. T.Pradeep , McGraw Hill Education.
6. Nanotechnology: Fundamentals and applications by Manasi Karkare, I.K. International Pvt. Ltd, New Delhi (2008).
7. Properties of semiconductor nanocrystals by S. V. Gaporenko (Cambridge Press), 1997.

PHYDP805: SPECIAL LABORATORY II

List of Experiments:

1. Synthesis of metallic nanoparticles by wet chemical method.
2. Synthesis of metal oxide nanoparticles by electrochemical method.
3. Preparation of porous silicon using electrochemical etching method
4. Study of optical absorption of nanoparticles (UV-visible spectroscopy) and determination of particle size.
5. Determination of particle size of nanoparticles from X-ray diffraction.
6. Study of photoluminescence of nanoparticles.
7. Synthesis of metal oxide nanoparticles by Hydro-thermal method.