Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College" Affiliated to

KBC North Maharashtra University, Jalgaon

KNOWLEDGE IS POWER

ESTD. 1945

SYLLABUS

Physics

M.Sc.-II

(Semester – III & IV)

Under Choice Based Credit System (CBCS)

[w. e. f. Academic Year: 2020-21]

Course Structure: M.Sc. – II (Physics)

Duration: The duration of M.Sc. (Physics) degree program shall be of two years.

Term / Semester	Course Module	Subject Code	Title of Paper	Credit	Hours per Week
III	DSC	PHY-301	Atomic and molecular physics	4	4
	DSC	PHY-302	Quantum mechanics - II	4	4
	DSC	PHY-303	Special laboratory III	4	8
	DSC	PHY-304	Project-I	4	8
	SEC	PHY-305	Computational methods and programming using 'C' language	4	4
	DSE	PHY-306	Material synthesis methods	4	4
IV	DSC	PHY-401	Nuclear physics	4	4
	DSC	PHY-402	Laser and it's applications	4	4
	DSC	PHY-403	Special laboratory IV	4	8
	DSC	PHY-404	Project-II	4	8
	GE	PHY-405	Solar power plant – design and installation	4	4
	DSE	PHY-406	Characterization of materials	4	4

DSC: Discipline Specific Elective Core Course; **SEC**: Skill Enhancement Course;
DSE: Discipline Specific Elective (DSE) Course; **GE**: Generic Elective Course
PHY-YSC : Physics (Y-year; S-Semester; C-Course number)

Examination pattern for M.Sc.

Nature	Marks
External Marks	60
Internal Marks	40
Total Marks	100

M.Sc. (Physics): Semester-III

PHY-301: Atomic and Molecular Physics

Total Hours: 60 **Credits: 04**

Course objectives:

1. To understand the basic theories of atomic, molecular spectra.
2. To understand principle working and application of NMR, ESR and LASER.

Course outcomes:

Students will be able to…

1. Understand the basic theories of atomic and molecular spectra.
2. Understand the basic technique and use of Raman spectroscopy

Unit I: ATOMIC SPECTRA: [18 h]

Quantum states of an electron in an atom, Electron spin, Spectrum of hydrogen, Helium and alkali atom., Relativistic corrections for energy levels of hydrogen atom, Lande interval rule, inverted terms, Hund's rule, Zeeman effect, Paschen Back effect in complex spectra , Stark effect of hydrogen in weak and strong field, Hyperfine structure: Introduction, origin of hyperfine structure, hyperfine structure of two or more valence electrons, width of spectral line, LS and JJ coupling.

Unit II: MOLECULAR SPECTRA : [14 h]

Classification of molecular spectra, Types of molecules, Pure rotational spectra, relative intensities of spectral line, rotational spectra of rigid and non-rigid molecule through microwave spectroscopy, Determination of moment of intertia and bond length from rotational spectra. Harmonic oscillator, Unharmonic oscillator, rotational-vibrational spectrum(diatomic vibrating rotator).

Unit III: ELECTRONIC SPECTRA, RAMAN SPECTRA: [12 h]

Electronic Spectra: Electronic spectra of diatomic molecule, Born Oppenheimer approximation, Vibrational coarse structure of electronic band, Franck- Condon principle, selection rule, dissociation and pre dissociation. Raman Spectra: Raman effect, experimental arrangement of Raman Spectrometer, Quantum theory of Raman Spectra, Raman spectroscopy in the structure determination of simple molecule.

Unit IV: ESR , NMR: [08 h]

ESR-Electron spin resonance, ESR spectrometer and its application. NMR- Nuclear spin magnetic moment, interaction of nuclear magnet with external field, NMR spectrometer, chemical shift and its application.

Unit V: LASER: [08 h]

Spontaneous & Stimulated emission, Einstein A & B coefficient, optical pumping, population invertion, rate equation, mode of resonator and coherence length.

References:

1. White H.E. 1934 Introduction to Atomic Spectra McGraw-Hill book company, inc., , 457
2. Bransden B. H. and Joachain G. J. 2003Physics of atoms and molecules, Pearson Education, 2nd edition,
3. Herzberg Gerhard. 1950Spectra of diatomic molecules. Van Nostrand, vol 1, ediation 2, , ISBN 0442033850, 9780442033859
4. Banwell C. B. 1995. Fundamental of Molecular Spectroscopy. 4th ed., , McGraw-Hill
5. Jeanne L. 1999 McHale. Molecular Spectroscopy, Prentice Hall, ISBN 0132290634, 9780132290630.
6. Bemath P. F. 2005 Spectra of atom and molecule, edition 2, Oxford University Press, , ISBN 0195346459, 9780195346459 -
7. Rajkumar, Keadar Nath Ram Nath (1997). Atomic and Molecular Spectra, New Delhi.
8. Akitt J. W., 1992 NMR and chemistry, edition 3, Springer Netherlands, , ISBN 0412372606, 9780412372605
9. Demtroder Wolfgang, 1997 Laser Spectroscopy: Basic Concepts and Instrumentation Springer Berlin Heidelberg, ISBN 354057171X, 9783540571711.

M.Sc. (Physics): Semester-III

PHY-302: Quantum Mechanics-II

Total Hours: 60 **Credits: 04**

Course objective:

This course is designed for students to gain knowledge about the approximate methods for solving the Schrödinger equation (perturbation theory, variational method, WKB method)

Course outcomes:

student will be able to ….

1. Competent to take up research in frontier areas like quantum information, quantum computation, quantum entanglement, quantum fields and quantum gravity.
2. Apply the variational method, time-independent perturbation theory, time-dependent perturbation theory and WKB method to solve simple problems

Unit I: Approximation Methods for Stationary States: [25 h]

Introduction, Time-Independent Perturbation Theory, Nondegenerate Perturbation Theory, Degenerate Perturbation Theory, Fine Structure and the Anomalous Zeeman Effect, The Variational Method, The Wentzel–Kramers–Brillouin Method, General Formalism, Bound States for Potential Wells with No Rigid Walls, Bound States for Potential Wells with One Rigid Wall, Bound States for Potential Wells with Two Rigid Walls, Tunneling through a Potential Barrier

Unit II: Time-Dependent Perturbation Theory: [20 h]

Introduction, The Pictures of Quantum Mechanics, The Schrödinger Picture, The Heisenberg Picture, The Interaction Picture, Time-Dependent Perturbation Theory, Transition Probability, Transition Probability for a Constant Perturbation, Transition Probability for a Harmonic Perturbation, Adiabatic and Sudden Approximations, Adiabatic Approximation, Sudden Approximation, Interaction of Atoms with Radiation, Classical Treatment of the Incident Radiation, Quantization of the Electromagnetic Field, Transition Rates for Absorption and Emission of Radiation, Transition Rates within the Dipole Approximation, The Electric Dipole Selection Rules, Spontaneous Emission

Unit III: Scattering theory: [15 h]

Scattering and Cross Section, Connecting the Angles in the Lab and CM frames, Connecting the Lab and CM Cross Sections, Scattering Amplitude of Spinless Particles, Scattering Amplitude and Differential Cross Section, Scattering Amplitude, The Born Approximation, The First Born Approximation, Validity of the First Born Approximation, Partial Wave Analysis, Partial Wave Analysis for Elastic Scattering, Partial Wave Analysis for Inelastic Scattering, Scattering of Identical Particles

References:

1. Sakurai J. J. Modern Quantum Mechanics, edition 2, Addison Wesley 2011, ISBN 0805382917, 9780805382914.
2. Schiff L. I.. Quantum Mechanics, NY, McGraw-Hill, 1968.
3. Gasiorowicz S. Quantum Physics, Wiley International Edition, copyright 2003 ISBN 0-47142945-7.
4. Griffiths D. J. Introduction to Quantum Mechanics, Pearson Prentice Hall, 2005 ISBN 0131118927, 9780131118928.

5. Nouredine Zettili. Quantum Mechanics Concepts and Applications Jacksonville State University, Jacksonville, USA, Second Edition, Wiley 2009, ISBN 978-0-470-02678-6.
6. Landau L.D. and Lifshitz E.M. Quantum Mechanics Non-Relativistic Theory, Elsevier, 1981, Edition 3, ISBN 0080503489, 9780080503486.
7. Cohen-Tannaudji C., Diuand B. Laloe F.. Quantum Mechanics : Vols. I & II , John Wiley ISBN: 978-0-471-16435-7.
8. Gottfried K.and Mow Yan T. Quantum Mechanics: Fundamentals, Springer Science & Business Media, 2003, ISBN-0387955763, 9780387955766.
9. Pauling L. and Wilson E. B.. Introduction to Quantum Mechanics, McGraw Hill book company New York, 1935.
10. Crasemann B. and Powel J.D.. Quantum Mechanics, Addison-Wesley Pub. Co. [1961].
11. Messiah A.P. Quantum Mechanics -Vol. I & II, Dover French North Holland 1961.
12. Dirac P. A. M.. The Principles of Quantum Mechanics, Clarendon Press, Oxford edition 4, 1981.
13. Levine I. Quantum Chemistry, Allyn and Bacon 1970 .
14. Townsend J. A Modern Approach to Quantum Mechanics, University Science Books, 2000, ISBN 1891389130.
15. Bowman G.E.. Essential Quantum Mechanics, Oxford University Press 2008 ISBN 0199228922, 9780199228928.
16. Bellac M. Le. Quantum Physics, Cambridge University Press 2006 ISBN 0521852773, 9780521852777.

M.Sc. (Physics): Semester-III

PHY-303: Special laboratory III

Total Hours: 120 **Credits: 04**

Course objectives:

1. To develop an awareness of the importance of accurate experimentation in the understanding of natural phenomena.
2. To develops students understanding and thinking for engineering and developing new materials as well as synthesis techniques for understanding physics and its applications.

3. To develop the students practical and technical skills required for physics experimentation.
4. It gives deeper knowledge of fundamentals of material processing and its growth that develops students skill.
5. Other Experiments include study of basic theory related to solid state physics, it will help to understand the basic theories governing the different properties of solids.
6. It gives deeper understanding of material properties such as magnetic, electric, piezoelectric, optics, photo conduction etc.
7. To develop an awareness of the value and the power of computer based techniques for experimentation, analysis and presentation and a familiarity in their exploitation.

Course outcomes:

Student will be able to

1. Aware of various material synthesis techniques.
2. Understand material synthesis and growth process.
3. Understand drawbacks and advantages of different material synthesis techniques.
4. Understand to do proper selection of material synthesis process and its application for developing new material properties through modification in its morphological as well as chemical structure.
5. Understand the various theories of different classes of solids showing varying properties like magnetism, polarization, conductivity, thermal conductivity. piezoelectricity etc.
6. Apply logics for writing programmes for solving mathematical problems.

Note: Students should perform total 12 experiments from the section-A , section-B and section-C. 04 experiments from each section are compulsory.

Section-A: Material Synthesis Method (Any 4)

1. Synthesis of semiconductor nanoparticles by chemical method.
2. Synthesis of metal nanoparticles.
3. Synthesis of porous silicon.
4. Deposition of metallic thin films by vacuum evaporation method.
5. Pattern generation by Photolithography.

6. Synthesis of thin film by chemical bath deposition (CBD) method.
7. Deposition of thin film by using SILAR method.
8. Deposition of thin film by using spin coating method.
9. Deposition of thin film using spray pyrolysis method.
10. Synthesis of nanoparticles using plant extract (Green synthesis method).

Section-B: Other experiments (Any 4)

1. The Franck-Hertz experiment
2. Study of hysteresis of hard and soft ferrites.
3. To record and analyze the spectral response of a given photo conducting sample.
4. Skin depth of electromagnetic radiation in Al.
5. Determination of resonance frequency of piezoelectric element
6. Determination of Curie temperature of a given sample.
7. Determination of thermoelectric EMF of copper iron thermocouple.
8. Dependence of hall coefficient on temperature.
9. Determination of thermal conductivity using Lee's Disc apparatus.
10. Determination of susceptibility by using Guoy's method.
11. Determination of susceptibility by using Quink's method.
12. Study of Fourier analysis.

Section-C: Computational Methods & 'C' Language programming (Any 4)

1. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Bisection method.
2. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Newton Raphson method.
3. Draw a flowchart and write a program to find the root of the equation f(x)=0 by False position method.
4. Draw a flowchart and write a program to integrate the given function using Trapezoidal rule.
5. Draw a flowchart and write a program to integrate the given function using Simpson's 1/3 rule.
6. Draw a flowchart and write a program to integrate the given function using Simpson's 3/8 rule.

7. Draw a flowchart and write a program for fitting of a polynomial of degree n using Lagrange's Interpolation formula.
8. Draw a flowchart and write a program to solve given set of simultaneous equations using Gauss Elimination method.
9. Draw a flowchart and write a program to solve given differential equation using Euler's simple method.
10. Draw a flowchart and write a program to solve given differential equation using Runge kutta method.
11. Draw a flowchart and write a program for finding the inverse of a given matrix/transpose of a matrix.
12. Write a menu driven program to create, list, modify and calculate the student record details. Assume the file structure: Register No., Subject 1 mark, Subject 2 mark and Subject 3 mark.

References:

1. Kulkarni S.K., 2015 Nanotechnology: Principles and Practice, Capital Publishing Company.
2. Charles P. Poole Jr., Frank J.Owens. Introduction to Nanotechnology, John Wiley & Sons, 30-May-2003 - Technology & Engineering.
3. Kernighan B.W.& Ritchie D.M. . The 'C' Programming Language, Prentice Hall India Pvt. Ltd.
6. John Mathews. Numerical methods for Mathematics, Science and Engineering, Prentice Hall India Pvt Ltd.
7. Rajaraman V.. Computer Oriented Numerical Methods, Prentice Hall India Pvt Ltd.
8. Ramkumar. Programming in ANSIC, Tata Mc Graw Hill.

M.Sc. (Physics) : Semester-III

PHY-304: Project-I

Total Hours: 120 **Credits: 04**

Course objectives:

1. To develop technical skills to perform experiments in details.
2. To encourage research and development activities.

3. To develop an awareness of the importance of accurate experimentation in the understanding of natural phenomena.
4. To develops students understanding and thinking for developing techniques for understanding physics and its applications.
5. To develop strong student skills in research, analysis and interpretation of complex information.

Course outcomes:

Student will be able to ….

1. Aware of various techniques to perform physics experiments in detail.
2. Successfully carry out advanced tasks and projects, both independently and in collaboration with others, and also across disciplines.

Activities:

1. To display the list of 'project titles' on notice board.
2. To organize a meeting of project supervisors' and students for discussion about projects.
3. To finalize the project titles so as to match student's particular interest.
4. Survey of the Literature.
5. To set the experiment/to start Preliminary Experimental work.
6. Internal examination.

The guide should regularly monitor the progress of the project work.

ASSESSMENT OF PROJECT TERM WORK (FIRST TERM):

Student should submit a Progress Report on the work done by him/her during the First Phase of the project including following points;

1. Project Selection,
2. Literature Search Strategy,
3. Literature Review,
4. Project Planning.

The student will have to give a seminar on the above topics.

M.Sc. (Physics) : Semester-III

PHY-305: Computational Methods and Programming Using 'C' Language

Total Hours: 60 **Credits: 04**

Course objectives:

1. To learn the advance of "C" programming language
2. Development of programming skill to write advance "C" programs
3. To learn and develop C language programs for various numerical methods.

Course outcomes:

Students would be able

1. To write C language programs using structure, pointers and file handling features.
2. To develop C language programs for various numerical methods.

Course Contents:

Note: For the topics of numerical methods, students are expected to write programs using 'C' language as well as perform numerical calculations using electronic calculators and mathematical tables.

Unit I: [14 h]

a) **Review of C language for preparing and running 'C' programs.**

b) **Pointers:** The concepts of pointers, The address operator, pointer arithmetic, pointers as function parameters, pointers and arrays, Dynamic storage allocation.

Unit II: [06 h]

a) **Structures and Unions:** Declaration and period operator, structure initialization, structure and arrays, structure and functions, structure and pointers, structure within structure, Unions, Rules to use unions.

b) **File handling:** Opening and closing a data file, creating a data file, processing a data file.

Unit III: [24 h]

a) Iterative methods to obtain roots of equations: The method of successive Bisection, False position method, Newton-Raphson method. Derivation of formula and advantages, as well as limitations of these methods over each other.

b) Interpolation: Definition of Interpolation and extrapolation, finite differences, Interpolation with equally spaced and unevenly spaced points. Lagranges interpolation, curve fitting, polynomial least squares and cubic spline fitting.

c) Numerical Integration: Derivation and application of Trapezoidal, Simpson 1/3 and Simpson's 3/8 th rule.

Unit IV: [16 h]

a) Solution of simultaneous linear equations: Gauss elimination method, pivotal condensation, Gauss Seidal method.

b) Solution of first order differential equation: Eulers method, Runge-Kutta methods.

References:

1. Kernighan B.W. & Ritchie D.M. The 'C' Programming Language, Prentice Hall, Englewood cliffs, 2edn (1988).
2. Yashwant Kanetkar. Let us 'C', BPB Publications 2004, 3 edn ISBN, 8176569402, 9788176569408.
3. Gottfried B.S. Schaum's outline of theory and problems of programming with 'C', Tata McGraw Hill Publishing Co. Ltd 2002.
4. E.Balagurusamy. Programming in ANSI C, Tata McGraw Hill Publishing Co.Ltd., IInd Edition ISBN 0070534772, 9780070534773.
5. J. Jayasri. The C language Trainer with C graphics and C++, New Age International Pvt. Ltd. New Delhi, 1993.
6. Mullish Cooper. The spirt of 'C', Jaico Publishing Co.New Delhi 1998.
7. Ramkumar. Programming in ANSI C, Tata McGraw Hill ISBN 0074623532, 9780074623534.
8. Sastry S.S. Introductory methods of Numerical Analysis, 5edn PHL learning PVT ltd 2012 ISBN 8120345924, 9788120345928.
9. Goel and Mittal. Numerical Analysis, Pragati Prakashan,Merrut 2016, ISBN 978-93-5006-912-7.
10. Steven C. Chapra, Raymond P.Canale. Numerical methods for engineers with programming and software applications, McGraw Hill 1998.
11. Jain M.K., Iyengar S.R.K., Jain R.K.. Numerical Methods problems and solutions, Wiley Eastern Ltd 2007.

12. John Mathews. Numerical methods for Mathematics, Science and Engineering, Prentice Hall India Pvt Ltd.
13. Willam Press, Teukolsky. . Numerical Receips in C, Cambridge University Press
14. Rajaraman V.. Computer Oriented Numerical Methods, Prentice Hall India Pvt Ltd.

M.Sc. (Physics): Semester-III

PHY-306: Material Synthesis Methods

Total Hours: 60 **Credits: 04**

Course objectives:

1. It develops the students practical and technical skills required for physics experimentation.
2. It develops the students through high quality of education/study which enables them to succeed in career in which an understanding of physics is relevant.
3. It develops students understanding and thinking for engineering and developing new materials as well as synthesis techniques for understanding physics and its applications.
4. It gives deeper knowledge of fundamentals of material processing and its growth that develops students skill and qualities of adoptability, innovation and dynamism.

Course outcomes:

Student will be able to…

1. Understand material synthesis and growth process.
2. Synthesis new materials and develop new synthesis techniques in laboratories.
3. Understand to do proper selection of material synthesis process and its application for developing new material properties through modification in its morphological as well as chemical structure.
4. Develop a Practical Skill and Scientific understanding of material synthesis.

Unit I: Nucleation and growth of thin films: [06 h]

Condensation, Langmuir-Frankel theory of condensation. Theories of nucleation: Capillarity model, Atomistic model, various stages of growth**.**

Unit II: **Mechanical methods:** [12 h]

Introduction, High Energy Ball Milling, Melt Mixing, Spray- techniques, Spin techniques, Screen printing (Doctor blade method).

Electro Processes: Electroplating, Electroless plating, Electrolytic anodization.

Unit III: Physical methods: [18 h]

Thermal evaporation: Resistance heating, Flash evaporation, R.F. heating, Electron beam (e-beam) heating, Molecular Beam Epitaxy(MBE).

Sputtering: Cathodic sputtering- Sputtering process, glow discharge sputtering pressure, Deposit distribution, current and voltage dependence, cathode, contamination problem, Deposition control, Sputtering variants, Low pressures sputtering: Magnetic field, Assisted(triode)sputtering, R.F. sputtering, Ion-beam sputtering. Reactive sputtering.

Chemical vapour deposition Techniques : Principle, chemical reactions used: Pyrolysis (Thermal decomposition), Hydrogen reduction, Halide disproportionation, Transfer reactions, polymerization, Types of CVD : Atmospheric-pressure CVD (APCVD), Low-pressure CVD (LPCVD), Metalorgainc CVD (MOCVD), Photo-enhanced CVD (PHCVD), Laser-induced CVD (PCVD), Electron-enhanced CVD.

Unit IV: Chemical methods: [14 h]

Introduction, Synthesis of materials using colloidal route, chemical bath deposition, SILAR, Spray Pyrolysis, Langmuir-Blodgett (LB) Method, Microemulsions, Sol-Gel Method, Hydrothermal Synthesis, Sonochemical Synthesis, Microwave Synthesis, flux method.

Unit V: Biological methods: [10 h]

Introduction, Synthesis Using Microorganisms, Synthesis Using Plant Extract, Use of Proteins, Templates Like DNA, S-Layers etc, Synthesis of Nanoparticles using DNA.

References:

1. Chopra K.L (1969). Thin Film Phenomenan, McGraw Hill.
2. Maissel L.I., Glang R. (1970). Hand book of Thin Film Technology McGraw Hill.
3. Vossen J.L., Kern W. (1978). Thin Film Processes: Academic Press.
4. Goswami A. 1996 Thin Film Fundamentals, New Age International Publishers.
5. Gary Hodes. 2003 Chemical Solution Deposition of Semiconductors Films, Weizmann Institute of Science, Rehorot, Iszael.New York-Basar.

6. Ohring M. (1992). The materials science of Thin Films, Academic Press.
7. Kulkarni S. K.. Nanotechnology:Principles and Practice, Capital Publishing Company.
8. Dieter Vollath. 2008 Nanomaterials: An Introduction to Synthesis, Properties and Applications.
9. Wegendristel A, Wang Y. (1994). An Introduction to Physics and Technology of Thin Films, World Scientific.
10. Krishna Seshan. Handbook of thin-film deposition processes and techniques, intel corporation Santa Clara, California, Noyes publications

M.Sc. (Physics): Semester-IV

PHY-401: Nuclear Physics

Total Hours: 60 **Credits: 04**

Course objectives:

1. This is a basic course in Physics which deals with the phenomena taking place in the nuclear domain. Students will be given an insight into the dimensions of a nucleus.
2. The aim of this course is to tell them about the stability of nucleus and various other properties.
3. To learn various types of radiations and their interaction with matter.
4. To learn about various types of nuclear reactions and their energetics.
5. Learn various methods to extract energy from nuclei in real life.

Course outcomes:

Student will be able to ….

1. Determine the charge, mass of any nucleus by using various spectrograph.
2. To understand the size of nucleus and all its properties.
3. To understand interaction of various types of radiation with matter which they observe in their daily life.
4. Understand various methods of accelerating various types of particles to perform scattering experiments.
5. Understand the detecting methods and instruments for different types of charged and neutral particles

UNIT 1: General properties of nuclei, Radioactive decay and Radiation detectors: [15 h]

Nuclear mass, mass defect, binding energy, nuclear radius, angular momentum, magnetic dipole moment and electric quadrupole moment. Basic theory of Alpha, Beta and Gamma-Rays decay. Radioactivity and units of radiation. Interactions of charged particles and gamma-rays with matter. Basic working principle of radiation detectors with details of proportional counter, NaI(Tl) and semiconductor detectors.

UNIT 2: Nature of Nuclear Interactions and Nuclear Reactions: [15 h]

Nature and properties of nuclear force. Deuteron problem, Electromagnetic, weak and hadronic interactions. Low energy n-p and n-n scattering, Phase shift and scattering cross section. Q-value and threshold energy of nuclear reactions. Neutron and charged particle induced nuclear reactions, cross section of a nuclear reaction. Compound nucleus formation, nuclear fission and fusion reactions.

UNIT 3: Nuclear Models and Nuclear Reactors: [15 h]

Liquid drop model and Empirical mass formula. Shell Model with details of Magic numbers, Nuclear Energy levels and their applications. Collective Model. Nuclear fission and fusion reactions. Fissile and fissionable nuclei. Classification of nuclear reactors and electric power delivered Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

UNIT 4: Elementary Particle Physics: [15 h]

Classification of elementary particles, their masses, spin parity, and life-time. Additive quantum numbers such as strangeness, isospin, baryon number,hyper charge,etc. Classification of quarks, their masses and spins. Quark contents of particles. C.T.P invariances. Parity non conservation in weak interactions, etc. Gell-Mann-Nishijima formula.

References:

1. Kenneth S. Krane (2008). Introductory nuclear Physics, Wiley India Pvt. Ltd.
2. Bernard L. Cohen (1998). Concepts of nuclear physics, Tata Mcgraw Hill.
3. Dunlap R.A. (2004). Introduction to the physics of nuclei & particles, Thomson Asia.
4. Griffith D.\ 1987 Introduction to Elementary Particles, John Wiley & Sons
5. Halzen F., Martin A.D.. 2008 Quarks and Leptons, Wiley India, New Delhi
6. Heyde K. (2004). Basic ideas and concepts in Nuclear Physics - An Introductory Approach, IOP- Institute of Physics Publishing.

7. Knoll G.F. (2000). Radiation detection and measurement, John Wiley & Sons.
8. Blatt J.M., Weisskopf V.F. (1991). Theoretical Nuclear Physics, Dover Pub.Inc.

M.Sc. (Physics): Semester-IV

PHY-402: Laser and it's Applications

Total Hours: 60 **Credits: 04**

Course objectives:

1. To learn the fundamental concepts and characteristics of Laser.
2. To develop experimental knowledge of various types of atomic/molecular spectra.
3. To learn the basic techniques of experimental spectroscopy.

Course outcomes:

On completion of the course, students will be able to…

1. Know the theoretical and experimental background of atomic as well as molecular spectra.
2. Understand various types of Lasers, their working and applications.
3. Understand basic components of spectroscopic instruments and their functions.
4. Know about measurements of atomic/molecular spectra using spectrometers.

Unit I: Introduction to Lasers and its characteristics: [14 h]

Ordinary light and Lasers, Brief history of Lasers, Energy levels, Population inversion, Population density, Boltzmann distribution, Transition Lifetimes, Allowed and Forbidden Transitions, Stimulated Absorption, Spontaneous Emission and Stimulated Emission, Einstein's Coefficients, Einstein's relations. Directionality, Monochromaticity, Coherence, Brightness

Unit II: Laser Action: [12 h]

Condition for large stimulated emission, Population inversion Condition for light amplification, Gain coefficient Active medium, Metastable states Pumping schemes: three level and four level

Unit III: Laser Oscillator: [08 h]

Optical feedback, round trip gain, threshold gain, critical population inversion, Optical resonator, condition for steady state oscillations, cavity resonance frequencies.

Unit IV: Laser Output: [06 h]

Line shape broadening, Lifetime broadening, Collision broadening, Doppler broadening

Unit V: Types of Lasers: [12 h]

Solid State Lasers – Ruby Laser, Diode Laser Gas Lasers – HeNe Laser, CO_2 Laser, Liquid Lasers: Tunable dye laser

Unit VI: Applications of Lasers: [08 h]

Industrial applications – welding, cutting, drilling: Nuclear Science applications – laser isotope separation, laser fusion, Defense - range finder

Medical applications - eye surgery

Optical applications - holography, supermarket scanners, compact discs

References:

1. Avadhanulu M. N. An introduction to Lasers – theory and applications, S. Chand and Co. New Delhi 2001, ISBN 9788121920711
2. Sirohi R. S. Experiments with HeNe Laser, 2 edn 1995.
3. Anuradha De. Optical fibre and Laser – Principle and applications, New Age International Publishers, Second edition. 2009, ISBN 10: 8122421393 ISBN 13: 9788122421392.

M.Sc. (Physics): Semester-IV

PHY-403: Special laboratory IV

Total Hours: 120 **Credits: 04**

Course objectives:

1. To develops the students practical and technical skills required for physics experimentation.
2. It develops students logical thinking, skill for collecting, Analysis and extracting relevant information from experimental outcomes.
3. To give basic understanding regarding basic concepts LASER and it applications.
4. It develops deeper understanding of phenomenon related to optics such as diffraction, interference, polarization and properties and application of LASER.
5. It develops students skill for handling sophisticated and sensitive instrumentation.

6. The aim of the practical’s based on Solar Photovoltaics system is to enable students to develop insights into components of the system as well as design, working and installation of such system.

Course outcomes:

1. Student will able to understand and differentiate the Characterization techniques.
2. Student will able to Characterize and to do Analysis of Materials.
3. Student will understand to do proper selection of particular techniques and its application for data analysis and testing of synthesis material.
4. Practical Skill and Instrument working as well as handling knowledge will help students in their future research carrier and higher studies.
5. The students will understand the fundamental process of advanced material characterization techniques.
6. Students will understand the concept of LASER and its applications as well as fundamental concepts related to optics.
7. Student will understand the concept of solar photovoltaic system.
8. The students will know in details different parts of systems with their required specifications as well as working of SPV system.
9. The students will also know different aspects related to designing and the installation of the system.
10. Students will understand the basic concept of energy conversion and able to differentiate different generation of solar cells and their photovoltaic conversion efficiency.

Note: Students should perform total 12 experiments from the section-A , section-B and section-C. 04 experiments from each section are compulsory.

Section-A: Laser and its application (Any 4)

1. To determine diameter of a given wire by diffraction.
2. Verification of Brewster’s law of polarization using He-Ne laser
3. To determine the wavelength of a LASER source using an engraved scale as a reflecting diffraction grating.
4. Study of magneto-optic rotation and magneto-optic modulation.
5. Measurement of reflectivity and transferability of thin film by using He-Ne laser.
6. To verify Heisenberg uncertainty principle using He-Ne laser source.

7. Determination of bandwidth of a given optical fiber.

Section-B: Solar photovoltaic system (Any 4)

1. Study of power vs. load characteristics of solar P.V. systems and study of series and parallel combination of solar P.V. panels.
2. Estimation and measurement of solar energy availability.
3. Estimating the effect of sun tracking on energy generation by SPV module.
4. To determine effect of shading, tilt, temperature and radiation on SPV module performance.
5. Efficiency measurement of standalone SPV system.
6. Dark and illuminated IV characteristics of solar cells.
7. Work out power flow calculations of standalone SPV system of DC/AC load with battery.
8. Measurement of external quantum efficiency of solar cell.

Section-C: Characterization of materials (Any 4)

1. Optical absorption of nanoparticles (observation of Blueshift with size of particles).
2. To analyse the photoluminescence spectrum of a given sample.
3. To analyse the Raman Spectrum of a sample.
4. X-ray diffraction studies of nanoparticles (effect of temperature).
5. Determination of crystal structure of given material by X-ray diffract meter.
6. Determination of grain size of a given sample by Scherer method.
7. Determination of direct and indirect band gap of a given materials by UV-visible spectroscopy.
8. Determination of inter atomic bond length in a diatomic molecule by studying rotational vibrational IR spectra.
9. Study of Beer Lamberts Law in absorption spectroscopy using IR spectroscopy.
10. Stress measurement of transparent conducting oxides (Newton's ring method).
11. Determination of refractive index of a transparent film by Abe's method.
12. Determination of Electrical conductivity measurements in thick films.
13. Determine the thickness of thick film by gravimetric method.

References:

1. Sukhatne S. P. Solar Energy Conversion, Tata McGraw-Hill Education, 1996,

2. Satya Prakash (2012). Laser Systems and Applications, Pragati Prkashan, IInd Ed.
3. Avadhanulu M. N. (2008). An introduction to Lasers - Theory and Applications, S. Chand & CO New Delhi.
4. Cullity B.D. Elements of X-ray diffraction, Addision-Wesely PublishingCo., USA
5. Banwell C.N. Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publ. Delhi.
6. Elton N. Kaufman. Characterization of Materials, Volume1, &2, Wiley-Interscience.
7. Chattopadhyay K.K. and Banerjee A.N. Introduction to Nanoscience and Nanotechnology, PHI Pvt. Ltd., New Delhi- 110001
8. Nan Yao, Zhong Lin Wang Kluwer. Handbook of Microscopy for Nanotechnology: Academic Publishers.

M.Sc. (Physics): Semester-IV

PHY-404: Project-II

Total Hours: 120 **Credits: 04**

Course objectives:

1. To develop technical skills to perform experiments in details.
2. To encourage research and development activities.
3. To develop an awareness of the importance of accurate experimentation in the understanding of natural phenomena.
4. To develops students understanding and thinking for developing techniques for understanding physics and its applications.
5. To develop strong student skills in research, analysis and interpretation of complex information.

Course outcomes:

On the completion of this course student will be able to ….

1. Aware of various techniques to perform physics experiments in detail.
2. Successfully carry out advanced tasks and projects, both independently and in collaboration with others, and also across disciplines.

Activities:

1. To complete the experimental work.

2. To carry out the measurements.
3. To characterize the samples.
4. To obtain the results.
5. To draw the conclusions.
6. To write the project report.
7. To appear for internal examination
8. To appear for external examination

Project Report:

1. Students have to write a 'project report'.
2. A report should be a concise account of project work containing full descriptions of the aims, method and outcomes.

Assessment Criteria of the project:

The following criteria are to be used in assessing the project work:

(i) The conduct of project work:

The following questions are considered in assessing how well students have carried out the project work.

1. How difficult was the project?
2. How well did the student understand the scientific principles behind the project?
3. How well did the student plan the project work?
4. How much effort was put into the project?
5. Was an interim report presented on time?
6. Was the student's project logbooks adequate?
7. How much initiative and/or originality did the student contribute to the project.
8. How well did the student cope with problems that arose during the course of project?
9. Did a project reach a stage of completion where meaningful results were obtained and definite conclusions could be drawn?

(ii) The Project Report:

1. How well did the report set out the background?
2. How well did the report describe the underlying them?
3. Was the report a reasonable length?
4. How well was the report structured?

5. How understandable was the written content?
6. How well did the report describe the execution of the project?
7. Did the report have an adequate summary or conclusions?

(iii) Oral Examination:

1. Did the student adequately describe what he/she had done in their project?
2. Did the student have a clear interpretation of his/her results?
3. What was the clarity and overall standard of the presentation?
4. How well was the talk/presentation structured?
5. Did the student cover all the relevant material in a reasonable time?

M. Sc (Physics): Semester-IV

PHY-405: Solar Power Plant: Design and Installation

Total Hours: 60 **Credits: 04**

Course objectives:

1. To learn the basic concepts of nonconventional solar power plant.
2. To design and install the on-grid and off-grid solar power plant of various capacities.
3. To achieve excellent standards of quality education by keeping pace with rapidly changing technologies and create technical manpower of global standards with capabilities of accepting new challenges.

Course outcomes:

After successfully completion of course, students will be able to …

1. Design and install a solar power plant of different capacities.
2. To start a small scale business on installation and maintenance of solar power plants

Unit I: The need of solar power: [10 h]

Basics need of solar power and generation system, Types of Solar power system: Grid connected solar Power Plant, Grid interactive solar power plant, Net Metering Solar Power Plant, Off-Grid / Hybrid solar power plant, Schemes of solar power plant.

Unit II: Selection of PV module technology: [10 h]

Introduction, Crystalline technology and Thin film technology: Mechanical equipment and its functioning, Comparison between PV module technologies, Comparison between solar power plant energy output.

Unit III: Plant Installation: Site survey and shadow analysis [15 h]

Site survey, Design and evaluation of various parameters, tools involved in installation of system, PV module structure inter-row spacing calculation, Pitch analysis, Selection of PV module tilt angle, Near shading object calculation, Type of solar radiation, Sun path Diagram, Defining the Position of the Sun, Solar Altitude, Geometric Effects, Oriented Solar Modules.

Unit IV: Selection and Sizing of Inverters (Grid Connection and Off Grid) : [15 h]

Types of solar inverter, Selection of inverter, Sizing of solar inverter for roof top and grid plants, Selection and sizing of string and central inverter, power conditioning unit (PCU), AC/DC overloading calculation and losses, Protection necessity of solar inverter, Types of Protection: Passive and active protection, Anti-islanding protection, Mounting arrangement of string inverter, Grid-Connected Inverters vs. Stand-Alone Inverters.

Unit V: Costing Of Solar Power Plant and Smart Grid/Net Metering: [10 h]

Introduction, Life Cycle Costing, Determining Costs Associated with the Whole PV System, Valuing a PV System, Smart Grid, Smart Meters.

References:

1. https://www.advanceelectricaldesign.com/Syllabus-solar-power-plant-design.
2. Geoph Stapleton, Susan Neill. Grid connected solar electric system:ISBN-13: 978-1849713443/ ISBN-10: 1849713448
3. Suneel Deambi. Photovolataic system Design: Procedure, Tools & Applications, CRC Press 2016.
4. Angale Reinders, Pierre Verlinden, Wilfried Van Sark, Alexandere Freundlich. Photovoltaic Solar Energy from fundamentals to Applications:2017 ISBN: 978-1-118-92746-5
5. Allen Freeman. Off-Grid Solar Living: Total Solar Conversion for your home on a Budget: Streets Of Dream Press; 1 edition, 2017.

M. Sc (Physics): Semester-IV

PHY- 406: Characterization of Materials

Total Hours: 60 **Credits: 04**

Course objectives:

1. It develops the students practical and technical skills required for physics experimentation.
2. It develops the students through high quality of education/study which enables them to succeed in career in which an understanding of physics is relevant.
3. It develops students' logical thinking, skill for collecting, Analysis and extracting relevant information from experimental outcomes.

Course outcomes:

1. Student will able to understand and differentiate the Characterization techniques.
2. Student will able to Characterize and to do Analysis of Materials.
3. Student will understand to do proper selection of particular techniques and its application for data analysis and testing of synthesis material.
4. Practical Skill and Instrument working as well as handling knowledge will help students in their future research carrier and higher studies.

Unit I: Characterization Techniques: [06 h]

Importance of materials characterization, Classification of characterization techniques, Destructive and non-destructive techniques, Electromagnetic spectrum, Properties of electromagnetic radiation.

Unit II: Spectroscopy: [15 h]

Optical (Ultraviolet-Visible-Near Infra-Red) Absorption Spectrometer, UV-Vis-NIR Spectrometer, Infra Red Spectroscopy, Dispersive Infra-Red Spectrometer, Fourier Transform Infra Red Spectrometer, Raman Spectroscopy, Luminescence X-Ray and Ultra Violet Photoelectron Spectroscopies (XPS or ESCA and UPS), Auger Electron Spectroscopy.

Unit III: Diffraction techniques: [14 h]

X-Ray Diffraction (XRD), Atomic Scattering Factor, Bragg's Law of Diffraction, Diffraction from Different Types of Samples, Crystal Structure Factor, Diffraction from Nanoparticles, Structure determination, Particle size determination, X-ray Diffractometer. Applications of X ray diffraction measurements.

Unit IV: Microscopes : [15 h]

Principle, Construction and working : Optical Microscopes, Confocal Microscope, Electron Microscopes , Scanning Electron Microscope , Transmission Electron Microscope (TEM), Scanning Probe Microscopes (SPM), Scanning Tunnelling Microscope , Atomic Force Microscope , Scanning Near-Field Optical Microscope (SNOM) .

Unit V: Material properties analysis: [10 h]

Electrical Properties: Electrical conductivity of films, two probe, Van-der Pauw and Four probe methods, Hall measurements, Magnetic Measurements: Vibrating Sample Magnetometer (VSM).

References:

1. Cullity B.D.. Elements of X-ray diffraction, Addision- Wesely Publishing Co.,USA.
2. Holt D.B., .Joy D.C, SEM micro characterization of semiconductors, Academic Press, New Delhi.
3. Banwell C.N. Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publ. Delhi.
4. Willard H.H., Merritt L. L., Dean John A, Settle F.A.. Instrumental methods of Analysis, CBS Publishers and Distributors, Seventh Edition, New Delhi
5. Chattopadhyay K. K., Banerjee A. N. Introduction to Nanoscience and Nanotechnology, PHI Pvt. Ltd., New Delhi
6. Elton N. Kaufman. Characterization of Materials, Volume1, &2, Wiley-Inter science
7. Nan Yao, Ahong Lin Wang, Kluwer. Handbook of Microscopy for Nanotechnology, Academic Publishers.
8. Kulkarni S. K. Nanotechnology: Principles and Practice, Capital Publishing Company.