HAVERI UNIVERSITY, HAVERI.

P.G. DEPARTMENT OF STUDIES IN PHYSICS

Syllabus for M.Sc. Course in PHYSICS

Under Choice Based Credit System (CBCS)

The Course Details:

The Department offers M.Sc. Program in Physics. The M.Sc. Program is a two-year Course, spread over four semesters, each of which is sixteen weeks duration. The Course comprises Compulsory and Specialization Courses and Open Elective Courses (OECs). A student admitted to the course leading to a M.Sc. degree should necessarily study the compulsory and specialization courses in Physics, offered in the Department as well as the Open Elective Courses in different subject(s), offered by other Departments. The student has the freedom to choose two courses during the study under prescribed OECs.

There are 6 compulsory and 8 specialization theory courses, 7 practical courses and one project. Out of these, 10 theory courses and 4 practical courses are common to all the students studying in I and II Semesters. The remaining 4 theory courses, 3 practical courses and the project are specialization-based courses offered in the III and IV semesters. Specialization courses are offered in the following subjects:

(1) Atomic & Molecular Physics,(2) Condensed Matter Physics,(3) Electronics &Communications and (4) Nuclear & Particle Physics.

There are two Open Elective Courses (under OEC), one in II Semester and one in III Semester, offered by the Department of Physics for the students of other science Departments.The student shall opt for open elective course (OEC) at the time of admission.

Credits:

The credits for each theory (compulsory, specialization and elective) courses and practical (compulsory and specialization) courses shall be 4.The M.Sc. Course in Physics carries the following number of credits.

Semester	I	II	III	IV	Total	No. of Credits
Core Paper	4	3	3	4	14	56

Practical	2	2	2	1	7	28
Open Elective	---	1	1	---	2	8
Project Work	---	---	---	1	1	6
Total	6	6	6	6	24	98

The student has to score 98 credits successfully for M. Sc. Degree in Physics.The students are allotted the specializations in the third semester on the bases of their order of preference and merit-cum roster system.

1. M. Sc. Degree Course:

1.1 Duration of the Course: The M.Sc. degree course is of two years duration spread over four semesters each of sixteen weeks duration.

1.2 Eligibility for Admission: B.Sc. graduates of this University or of any other University recognized as equivalent there-to with Physics and Mathematics as optional subjects are eligible. The candidate should have obtained at least 45% of marks in optional subjects as well as in aggregate. Relaxation in respect of SC/ST/Cat-I etc. will be applicable as per prevailing rules of the University.

1.3 Intake: Total intake to the M.Sc. course in Physics under the jurisdiction of Haveri University is_____. The intake for the course at the Department of Physics, Haveri University, Haveri is ____. The Haveri University reserves the right to vary intake as deemed necessary including admission rules, fee structures and roster as per notification from time to time.

2. **Attendance:** Every student must have at least **75%** attendance in each of the courses (theory and practical) in each semester**.** Shortage of attendance will be dealt with as per the University rules from time to time.

3. Medium of Instruction: The medium of instruction shall be English.

4. Scheme of Instructions:

4.1 In each semester there will be FOUR Theory Courses and TWO Practical Courses.

4.2 Each theory course is of FOUR hours of lectures per week. Each practical course is of FOUR contact hours per week. These include seminars, tutorials and discussion classes. Internal Assessment (IA) shall be conducted during the semesters. Each theory and practical course shall carry **100** marks, out of which **25** marks are for internal assessment (IA). The components of IA for **25** marks are as follows: Attendance-**3** marks, two written tests/seminars/assignments-**22** marks. Total maximum marks are 600 per I, II and III Semesters and 650 marks in IV Semester with total marks for the entire course is 2450.

4.3Project: Every student has to compulsorily take a Project course in IV semester. The Project may be a theoretical or an experimental work in the respective specialization subject. More than one student may be required to work on an assigned project. Project course carries **150** marks, of which **25**marks for **IA,50** marks for viva-voce examination with presentation of the work and **75** marks for the evaluation of dissertation at the semester-end examination.

5. Scheme of Evaluation: Evaluation of each of the courses will have two components: the first being internalassessment (IA) and the second being the semester-end examinations.For theory and practical courses having a credit award of **4**, the total maximum marks shallbe **100**. Out of the total of **100,25** marks shall be earmarked for the **IA** and the remaining **75**marks for the semester-end examination.For the project, carrying **6** credits, the total maximum marks shall be **150**. Out of **150**, **25**marks shall be earmarked for the IA and the remaining **125** marks is shared between viva-vocecarrying **50** marks and evaluation of dissertation carrying **75** marks for the semester-endexamination.

5.1 Examination: Examinations will be conducted at the end of each semester as per the Universityregulations governing PG Courses.The semester-end examination in each theory course will have a question paper for 3 hoursduration and will carry a maximum of 75 marks. The IA test will be conducted during thesemester. Mode of conducting the tests may involve a common time-table for all thecourses in that semester.Each practical course will have an examinationof four hours duration and willcarry a maximum of **75** marks in the semester-end exam. A two-hour duration practical IA for **25**marks is conducted at the end of the semester.

Project: A project dissertation should be submitted by each student at the end of IV semester to become eligible for the examination. The evaluation of the project dissertation carries a maximum of **75** marks. The viva-voce examination carries a maximum of **50** marks and will be in the form of presentation by the student. During this examination, one external examiner and one project supervisor or along with internal examiner will be involved in the evaluation. IA for **25** maximum marks is conducted during the mid-semester, either through a test or a seminar. In the case of seminar, an internal examiner along with the project supervisor will be involved in the evaluation.

5.2 Question Paper Pattern: Each theory Course paper is organized into I, II, III and IV Units. A question paper comprises two questions as internal choice from each of these four

Units, giving a total of eight questions and, a ninth question has four sub-questions drawn from each of the Units with an option to answer any three. The four sub questions may be in the form of a problem / short answer question / question for explanation of a concept. Each question carries **15** marks, giving a total of **75** marks for the question paper. Below is the summary of the Scheme:

5.3 Distribution of Marks:

a) Theory Course:

	Max Marks
Semester-end Examination	75
Internal assessment (IA)	25
Total:	100

b) Practical Course:

	Max Marks
Semester-end Examination	75 (Practical – 60, Journal – 5, and Viva-Voce – 10)
Internal assessment (IA)	25
Total:	100

c) Project:

	Max Marks
Semester-end Examination	125 (Dissertation-75, Viva-Voce-50)
Internal assessment (IA)	25
Total:	150

6. Maximum Period for Completion of the M. Sc. Degree Programme:

There shall be carry-over from I to IV semester. The maximum number of years required by a student to complete the degree is as specified by the University from time to time.

7. Rules and Award of Degree:

7.1 The Minimum passing percentage in each course shall be 40% (semester-end exam and IA put together). Further, the candidate shall obtain at least 40% of the marks in the semester-end exam and 50% in aggregate when all Courses of four semesters are put together. There shall be no separate minimum for IA.

7.2Award of Degree: Students after successfully completing all the Courses prescribed for all the four semesters by scoring minimum of 50% in aggregate will become eligible for the award of M. Sc. Degree in Physics.

7.3 Results: Marks and Grading: Results of candidates are declared based on the marks obtained and grades earned and classesare awarded as per the University rules.

8. Co-Curricular and Extra Curricular activities:

8.1 Co-Curricular Activities: Seminars, tutorials, mentoring programmes, problem solving sessions, discussion classes will be conductedperiodically. However, these activities do not carry any marks or credits.

8.2 Computer Laboratory Facilities: Students are provided with computer facilities for their curricular as well as for their co-curricularstudies and internet browsing.

8.3 Library Facilities: The Department has a library with research journals and text/reference books. Students areallowed to borrow on regular basis.

8.4 Students Counseling: Students will be assigned to teachers for counseling regarding their academic and othermatters.

8.5 Epsilon Club: A students council called ε (epsilon) club exist in the Department for the all-round developmentof the students. Lectures by students, staff and special lectures by eminent scientists arearranged under the auspices of this club.

Extra-Curricular activities such as sports, literary and cultural activities are also conducted under the auspices of this club.

8.6 Special Encouragement: Students interested in research activities are encouraged by providing them with an opportunity to work in the research laboratories and USIC under the guidance of the faculty members.

Teaching and Evaluation Scheme

M.Sc. Course in Physics Choice Based Credit System (CBCS) (2018 Scheme)						**Maximum Marks**		
Sem. No	**Course Code**	**Title of the Paper**	**Credits**	**Teaching Hrs/week**	**Duration of Exam (hours) for Theory/Practical**	**Semester End Exam**	**IA**	**Total**
Compulsory Courses								
I	**PG85T 101**	Mathematical Methods in Physical Sciences	4	4	3	75	25	100
	PG85T 102	Classical Mechanics	4	4	3	75	25	100
	PG85T 103	Basics of Electronics & Communications	4	4	3	75	25	100
	PG85T 104	Basic Condensed Matter Physics	4	4	3	75	25	100
	PG85P 105	Practical – I: Electronics & Communication and Condensed Matter Physics (General)	4	4	4	75	25	100

	PG85P 106	Practical – II: Atomic & Molecular and Nuclear & Particle Physics (General)	4	4	4	75	25	100
II	**PG85T 201**	Quantum Mechanics – I	4	4	3	75	25	100
	PG85T 202	Basic Atomic & Molecular Physics	4	4	3	75	25	100
	PG85T 203	Basic Nuclear & Particle Physics	4	4	3	75	25	100
	PG85T 204	Open Elective Course-I: Modern Physics	4	4	3	75	25	100
	PG85P 205	Practical – III: Electronics & Communication and Condensed Matter Physics (General)	4	4	4	75	25	100
	PG85P 206	Practical – IV: Atomic & Molecular and Nuclear & Particle Physics (General)	4	4	4	75	25	100
Compulsory Courses								
III	**PG85T 301**	Quantum Mechanics – II	4	4	3	75	25	100
	Specialization Courses							
	PG85T 302A	Atomic and Diatomic Molecular Spectra	4	4	3	75	25	100
	PG85T 302C	Electron Transport and Lattice Dynamics						
	PG85T 302E	Transmission Lines, Waveguides and Satellite Communication						
	PG85T 302N	Nuclear Properties and Elementary Particles						
	PG85T 303A	Spectroscopy Instrumentation Techniques	4	4	3	75	25	100
	PG85T 303C	Magnetism and Dielectrics						
	PG85T 303E	Electronic Instrumentation, Signals and Systems						
	PG85T 303N	Nuclear Detectors, Accelerators and Neutron Physics						
	PG85T 304O	Open Elective Course – II: A)Instrumental Methods **OR** B)Physics of Nanomaterials	4	4	3	75	25	100
	PG85P 305A	Atomic & Molecular Physics Practical – I	4	4	4	75	25	100

	PG85P 305C	Condensed Matter Physics Practical – I						
	PG85P 305E	Electronics & Communications Practical – I						
	PG85P 305N	Nuclear & Particle Physics Practical – I						
	PG85P 306A	Atomic & Molecular Physics Practical – II	4	4	4	75	25	100
	PG85P 306C	Condensed Matter Physics Practical – II						
	PG85P 306E	Electronics & Communications Practical – II						
	PG85P 306N	Nuclear & Particle Physics Practical – II						
Compulsory Courses								
IV	**PG85T 401**	Classical Electrodynamics	4	4	3	75	25	100
	PG85T 402	Statistical and Thermal Physics	4	4	3	75	25	100
		Specialization Courses						
	PG85T 403A	Molecular Spectra & Structure of Polyatomic Molecules	4	4	3	75	25	100
	PG85T 403C	Semiconductors and Devices						
	PG85T 403E	Microprocessor and Microcontroller						
	PG85T 403N	Nuclear Models, Nuclear Reactions and Weak Interactions						
	PG85T 404A	Lasers, Nonlinear Optical Effects and Laser Spectroscopy	4	4	3	75	25	100
	PG85T 404C	Superconductivity and Advanced Materials						
	PG85T 404E	Analog and Digital Modulation						
	PG85T 404N	Nuclear Reactors and Nuclear Decays						
	PG85P 405A	Atomic & Molecular Physics Practical– III	4	4	4	75	25	100
	PG85P 405C	Condensed Matter Physics Practical– III						
	PG85P 405E	Electronics & Communications Practical – III						
	PG85P 405N	Nuclear & Particle Physics Practical– III						
	PG85PJ 406A	Project in Atomic & Molecular Physics	6	6	4	75 + 50	25	150
	PG85PJ 406C	Project in Condensed Matter Physics						

	PG85PJ 406E	Project in Electronics & Communications						
	PG85PJ 406N	Project in Nuclear & Particle Physics						

Total No. of Credits: 98 **Total No. of Maximum Marks, 2450**

9. M.Sc. Physics Degree Programme Outcomes:

The **M.Sc. Degree Programme** is designed to offer advanced knowledge of physics subjects, in part as a continuation of B.Sc.programmes and with a view to provide an in-depth understanding. The subjects include core Courses like Mathematical Physics, Classical Physics, Quantum Mechanics, Electrodynamics, Statistical Physics, basic Atomic & Molecular Physics, Condensed Matter Physics, Electronics and Nuclear & Particle Physics. Specialization-specific papers include Atomic & Molecular Physics, Condensed Matter Physics, Electronics and Nuclear & Particle Physics. The students will learn these topics at the advanced level both with respect to a combined analysis of mathematical and physical aspects, their application to a variety of theoretical and practical problems. These learning outcomes would benefit students in their diverse job and research careers.

The Department offers post graduate program M.Sc. in Physics to provide the students with a sound knowledge of the principles of Physics which form a thorough basis for careers in Physics and related fields. It also aims to enable students to develop insights into the techniques used in current fields and allow an in-depth experience of a particular specialized subject. In addition, the M.Sc. Program is meant to develop professional skills in students that play a meaningful role in industrial and academic life and give students the experience of teamwork and a chance to develop presentation skills.

9.1 Outcome Based Education: Outcome-Based Education (OBE) is a student-centric teaching and learning methodology in which the course delivery and assessments are planned to achieve the stated objectives and outcomes. It focuses on measuring student performance i.e., outcomes at different levels.

9.2 Course Objectives: The entire M.Sc. course is aimed to impart an in-depth knowledge and understanding in Physics and Science in general through various courses like classical mechanics, quantum mechanics, mathematical physics etc. It also aims to develop creative thinking and problem-solving capability.

9.3 Programme Outcomes (POs): M.Sc. Physics Program outcomes are expected to bealigned closely with attributes. The program consists of theory, practical and project work. After successful completion of the program, the students

- Will acquire advanced knowledge in the core subjects of Physics as well as in the Interdisciplinary Courses
- Will learn techniques of analysis involving physical, mathematical and data aspects and thereby get trained in applying skill sets to solving complex problems
- Will be exposed to advanced level of training in experimental physics involving planning, execution, measurements and data analysis
- Will be trained at the research level in project dissertation work involving systematic methodologies, scientific literature study and interpretation
- Will be exposed to techniques of seminar, talks, etc. presentation skills.

9.4 Program Specific Outcomes (PSOs): After completion of M.Sc. Physics program, the students will be able to

- Acquire an in-depth understanding and knowledge of the core areas of Physics encompassing mathematical physics, classical mechanics, quantum mechanics, electrodynamics, and statistical mechanics for explicating physical phenomena covering wide length and time scales.
- Develop hands-on skills for carrying out elementary as well as advanced experiments through acquired knowledge in physics
- Attain abilities of critical thinking, problem mapping & solving using fundamental principles of Physics, systematic analysis & interpretation of results, and unambiguous oral & writing/presentation skills.
- Sustain an intellectual curiosity and know how to continue to learn not only areas that are relevant to Physics, but also that are important to society
- Perform minor research projects so as to familiarize with the research works and enhance pedagogical and scientific writing skills through modern methods.
- Enhance National/International competency, kindle entrepreneurial skills and become socially and environmentally responsible citizens.

- Course specific outcomes describe the significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Three to four course outcomes are specified for each course based on its weightage.

SEMESTER – I

PG85T 101: Mathematical Methods in Physical Sciences

Teaching hours per week: 4
No. of credits: 4

Unit I

Special functions: Beta and gamma functions. Solution of differential equation using power series-Frobenius method.

Legendre functions: Legendre polynomials, Rodrigue's formula; generating function and recursion relations; Orthogonality and normalization; associated Legendre function, special harmonics.

Bessel functions: Bessel functions of the first kind, recursion relations and orthogonality.

Hermite functions: Hermite polynomials, generating function, recursion relations; Orthogonality.

Laguerre functions: Laguerre and associated Laguerre polynomials, recursion relations; Orthogonality.Applications of special functions to problems in physics.

12 Hours

Unit II

Matrices: Orthogonal, Hermitian, and unitary matrices; eigenvectors and eigenvalues, diagonalization of matrices, Matrix representation of linear operators, eigenvalues and eigenvectors of operators, simultaneous eigen vectors and commutativity, applications to physical problems

Tensors: Types of tensors, contravariant and covariant tensors, symmetric and antisymmetrictensors, Tensor algebra: equality, addition and subtraction, tensor multiplication, outer product;contraction of indices, inner product, quotient theorem, Kronecker delta, metric tensor, Christoffel symbols. Tensors in physics problems.

12 Hours

Unit III

Group Theory: Groups, subgroups and classes; homomorphism and isomorphism, group representation, reducibleand irreducible representation, Schur's Lemmas, orthogonality theorem, character of arepresentation, character tables, decomposing a reducible representation into irreduciblerepresentations, construction of representations, lie groups, rotation groups SO(2) and SO(3).Problems

12 Hours

Unit IV

Monte Carlo methods: Introduction, definitions, Illustration of the use of Monte Carlo Methods, Examples on Particles in a Box and Radioactive Decay, Probability Distribution Functions, Multivariable Expectation Values, The Central Limit Theorem, Definition of Correlation Functions and Standard Deviation, Random Numbers and properties, Improved Monte Carlo Integration, Change of Variables, Importance of Sampling, Acceptance Rejection Method, Monte Carlo Integration of Multidimensional Integrals, Brute Force Integration, Importance of Sampling, Classes for Random Number Generators. Metropolis algorithm and detailed balance, Ising model. examples and problems.

12 Hours

Course Outcomes:

At the end of Mathematical Methods in Physical Sciences course, the students will be able to

- Interpret the various special mathematical functions to understand the physical consequences.
- Discuss and interpret the matrices for solving the physical problems.
- Apply the group theory for knowing the physical properties of the matter.
- Describe the mathematical techniques for the statistical interpretation of the physical sciences.

Text Books

1. Mathematical Methods for Physicists (4th edition): George Arfken& Hans J. Weber, Academic Press, San Diego (1995).
2. Mathematical Methods in Physical Sciences (2nd edition): Mary L. Boas, John Wiley & Sons, New York (1983).
3. Mathematical Physics: P. K. Chattopadhyay, Wiley Eastern Ltd., New Delhi (1990).
4. Introduction to Mathematical Physics: Charlie Harper, Prentice Hall of India Pvt. Ltd., New Delhi (1995).
5. Matrices and Tensors in Physics (3rd edition): A.W. Joshi, New Age International (P) Ltd. Publishers, New Delhi (2000).

6. Elements of Group Theory for Physicists (3rd Ed): A.W.Joshi, Wiley Eastern Ltd (1982).
7. Monte Carlo Methods, 2nd Edition, M.H. Kalos, P.A. Whitlock, Wiley VCH

Reference Books

1. Mathematical Methods for Physics and Engineering: K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge Univ. Press Cambridge (1998).
2. Advanced Mathematics in Physics and Engineering: Arthur Bronwell, Mc Graw Hill Book Company, New York (1953).
3. Group theory and its Applications to Physical Problems: M.Hammermesh, Addison Wesley, Mass (1962).
4. Schaum's Outline Series: Programming with FORTRAN: Seymour Lipschutz& Arthur Poe, McGraw Hill company, Singapore (1982).
5. Schaum's Outline Series: Vector Analysis and Introduction to Tensor Analysis: M.R. Speigel, McGraw Hill Company, Singapore (1983).
6. Mathematical Physics A. K. Ghatak, I. C. Gayal& S. J. Chua, Trinity Publications, 2017.
7. Computational Physics. J. M. Thijssen, Cambridge - 2007.
8. Understanding Molecular Simulations, D. Frenkel and B. Smith, Academic press, 2002.
9. Steven E Koonin and D C Meredith, Computational Physics [FortranVersion], Westview Press (1990)
10. Press, M. et al. – Numerical Recipes, Cambridge University Press, or Foundation Book, India (1998).

PG85T 102: Classical Mechanics

Teaching hours per week: 4
No. of credits: 4

Unit I

Lagrangian Mechanics: Generalized coordinates, constraints, Lagrange equation, Hamilton'sprinciple, Derivation of Lagrange's equation from Hamilton's Principle. Symmetry and conservation laws: momentum conservation, cyclic coordinates, angular momentum conservation and conservation of energy.

Motion in central force field: Equivalent one body problem, motion in central force field, Equation of orbit. Elliptic orbits, hyperbolic orbits and parabolic orbits. Elastic scattering in central force field, Rutherford scattering. Problems

12 Hours

Unit II

Motion of Rigid body: Fixed and moving coordinate systems. Coriolis force, Coriolis force acting on falling body Euler theorem. Euler angle, angular momentum and kinetic energy of a rigid body. Inertia tensor, Euler's equations of motion. Torque free motion. Motion of symmetric top – Nutational motion, Problems.

12 Hours

Unit III

Hamiltonian Mechanics and Brackets: Legendre transformation and Hamilton equations of motion: conservation theorem and physical significance of Hamiltonian. Derivation of

Hamilton's equation from a variation principle: principle of least action.Lagrange and Poisson brackets, Equation of motion in Poisson bracket notation.
Hamilton Jacobi Theory: Hamilton Jacobi equation of motion for Hamilton's principle and characteristic functions, Harmonic oscillator problem as example of Hamilton Jacobi method. Problems

12 Hours

Unit IV

Rocket Dynamics: Introduction equation of motion for variable mass – performance of single stage rocket; exhaustvelocity, structure factor and mass ratio. Exhaust speed parameter, effect of gravity; expression forheight attained by second stage rocket, performance of second-stage rocket optimization of multistage rocket, Launch site selection. problems

12 Hours

Course Outcomes:

After successful completion of the course on Classical Mechanics, the student will be able to

- Demonstrate a basic and advanced knowledge of Lagrangian and Hamilton's principles and solve related problems.
- Demonstrate the concept of motion of a particle under central force, concepts of different orbits and apply advanced methods to deal with the central force problems.
- Understand the kinematics and dynamics of rigid body in detail and ideas regarding Euler's equations of motion and techniques for solving problems of rigid body mechanics.
- Learn the details of fixed and moving co-ordinate systems, Coriolis force acting onfalling body, torque free motion and motion of symmetric top.
- Understand the Hamiltonian formalism in solving physics problems and understand Poissonbracket method in tackling physical problems.
- Use Hamilton-Jacobi theory for finding the solutions of various classical systems.
- Understand the fundamentals of rocket propulsion, including thrust equation, specific impulse of a rocket engine.
- Understand the effect of gravity on rocket, equation for burnout velocity, rocket staging and optimization of multistage rocket.

Text Books

1. Classical Mechanics: H.Goldstein, Narosa Publishing Pvt. Ltd. (1998).

2. Introduction to Classical Mechanics: R. G. Takwale& P. S. Puranik. Tata McGraw Hill, New Delhi (1997).

Reference Books

1. Classical Mechanics: H.Goldstein, C.Poole&J.Safko. Third Edition. Pearson Education Asia (2002).
2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, New Delhi (1991).
3. Classical Dynamics of Particles and Systems: J. B. Marion, Academic Press (1964).
4. Classical Mechanics of Particles and Rigid Bodies: Kiran. C. Gupta, New Age International (1998).
5. Classical Mechanics: Dr. J. C. Upadhyaya, Himalaya Publishing House, Revised Edition (2009).
6. Classical mechanics: K. Sankara Rao, P. H. E Learning Private Limited (2008)

PG85T 103: Basics of Electronics & Communications

Teaching hours per week: 4
No. of credits: 4

Unit I

Operational amplifier: Introduction to Op Amp, Basic op amp circuit, 741 IC Op-Amp, open loop op-amp configurations – inverting, non-inverting and differential amplifiers, feedback configurations, voltage follower, non-inverting amplifier, inverting amplifier, Op-Amp parameters,input output voltages, common mode rejection ratio, slew rate and frequency limitations. Summing, difference, scaling and averaging amplifier. DC and AC Voltmeter, instrumentation amplifier, Integrator and differentiator, Differentiator and Integrator design and performance, Precision half wave and full wave rectifier, Clipper and Clamping circuits, Peak detector, Sample and hold Circuit.

12 Hours

Unit II

Op-amp applications and specialized ICs: Active filters – types, All pass phase shifting circuits, first and second order active low and high pass filter. Band pass filter, band stop filter. Oscillators – basic principles, phase shift oscillator, Wein bridge oscillator, triangular and rectangular wave generator. Comparators and converters – basic comparator, zero crossing detector, Inverting and non-inverting Schmitt trigger, Astable and monostable multivibrator. Precision voltage regulator (fixed and adjustable). IC 565 Phase locked loop, characteristics, Frequency multiplier, AM and FM demodulator.

12 Hours

Unit III

Optical fiber communications: Introduction, optical fiber wave guide, ray theory transmission total internal reflection, acceptance angle, numerical aperture, skew rays, Electromagnetic mode theory, Modes in planar guide, Phase and group velocity, Types of fibers, step index fiber, graded index fiber, single mode fiber, mode field diameter and spot size, effective refractive index, photonic bandgap fibers. Intrinsic and extrinsic absorption losses, Rayleigh scattering, fiber bend loss, material dispersion and scattering effects. Preparation of optical fibers, liquid phase (melting) techniques, Plasma activated chemical vapor deposition. Structure and characteristics of multimode step index fibers, graded index fibers, single mode fibers and plastic clad fibers, optical fiber connectors, fiber alignment and joint loss, fiber splices. Light sources for OFC, LED and laser diodes, detectors p-n, p-i-n and avalanche photodiodes.

12 Hours

Unit IV

Digital Electronics: Boolean operations and expressions, Boolean analysis of logic gates, simplification of Boolean expression. Karnaugh map: two, three and four variable maps.

Digital logic gates: AND, OR, NAND and NOR gates, AND-OR and NAND-NOR implementation of Boolean Expressions. Logic gate operation with pulse waveforms.

Combinational Logic circuits: Adder, parallel binary adder, subtractor, parity generators and checkers, comparators, decoders, BCD to seven segment decoder, encoders, code conversion, multiplexers, demultiplexers.

Sequential circuits: Latches, flip flops, SR, D, JK, Master Slave JK,T flip flops, counters, synchronous and asynchronous counters, ripple counters, mod n counters, mod 3, mod 5 and mod 10 counters, registers, shift registers, timing sequences, memory units, random access memory (RAM).

12 Hours

Course Outcomes:

At the end of this course, the students will be able to

- Understand the basic principles of working of operational amplifiers and design op-amp based circuits such as amplifier,integrator,differentiator, full wave and half wave rectifiers.Understand the design of various electronic circuits.
- Gain knowledge of designing additional op-amp based filter circuits and oscillators,comparators,frequency multipliers,basics of modulation and demodulation.
- Appreciate the importance and working of Optical FibreCommunication system,its design and applications which help the student to appreciate the current advances in communication system.
- Gain knowledge of working of various Gates and logic circuits,sequential circuits which form the elements of Digital circuits.
- Will be able to implement the above practically with the help of Numerical problems solving.

Text Books

1. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op Amps and linear Integrated Circuits: R. Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 10th Edition: Thomas L Floyd, Pearson Education (2003).
5. Optical Fiber Communication Principles & Practice, John M. Senior, Prentice Hall International Ltd, London (1992).

Reference Books

1. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
2. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
3. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt.Ltd New Delhi (2000).
4. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).

PG85T 104: Basic Condensed Matter Physics

Teaching hours per week: 4

No. of credits: 4

Unit I

Crystal structure: Lattice translational vectors and lattices, basis and crystal structure, primitive and non-primitive cells, fundamental types of lattices, Miller indices. Symmetry elements, point groups and space groups. Examples of simple crystal structures.

Crystal diffraction and reciprocal lattice: Bragg law, reciprocal lattice vectors, diffraction conditions, Laue equations, Brillouin zones. Atomic form factor, structure factor and its calculations in simple cases. Experimental methods of X-ray diffraction, details of powder X ray diffraction of crystal structure determination.

12 Hours

Unit II

Crystal binding: Crystals of inert gases: Van der Waals London interaction, repulsive interaction, cohesive energy, compressibility and bulk modulus.

Ionic Crystals: Madelung energy, Born Mayer Model, evaluation of Madelung constant for an infinite line of ions. The nature of binding in covalent, metal and hydrogen bonded crystals.

Lattice vibrations and thermal properties: Elastic waves, density of states of a continuous medium, Theories of specific heat: Classical, Einstein and Debye models. Vibration of one dimensional monatomic and diatomic lattices, properties of lattice waves, phonons. Lattice thermal conductivity.

12 Hours

Unit III

Free electron model of metals: Free electron gas and formulation of free electron theory of metals, electrical conductivity and origin of collision time, electrical conductivity versus temperature, Mattheissen's rule. Heat capacity of free electrons, Fermi Dirac distribution, the concept of Fermi surface, the effect of Fermi surface on electrical conductivity. Thermal conductivity: Wiedemann Franz law.

Energy bands in solids: Origin and magnitude of energy gap. Bloch functions. Kronig Penney model (qualitative). Number of states in a band. Distinction between metals, insulators and semiconductors. Velocity of the Bloch electron, electron dynamics in an electric field, concept ofhole, dynamic effective mass of electrons and holes.

12 Hours

Unit IV

Semiconductors: Intrinsic and extrinsic semiconductors. Intrinsic and extrinsic carrier concentrations, position of Fermi level, electrical conductivity and mobility and their temperature dependence. Hall effect in semiconductor.

Superconductivity: Experimental survey, qualitative ideas about BCS theory, high temperaturesuperconductors and their applications.

Magnetic properties: Classification of magnetic materials, quantum theory of paramagnetism Curie law; Weiss' molecular field theory of ferromagnetism, Curie-Weiss law.**Defects in solids:** Types of imperfections, Schottky and Frenkel defects and their concentrations.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- The formation of crystalline state in solids along with the basic definitions associated with geometrical arrangement of atom in crystal can be understood.
- The atomic arrangement in real crystals can be studied experimentally by using X-ray diffraction by introducing the concept of reciprocal lattice.
- The crystal binding of solids through chemical bonding is an important topic to understand the strength and physical properties of materials that can be achieved by this course.
- The behavior of materials in terms of interaction of atoms and electrons in subject to applied external fields/force can be understood.

Text Books

1. Introduction to Solid State Physics: C.Kittel. Wiley Eastern Ltd., Bangalore (1976).

2. Elementary Solid-State Physics: M.A. Omar.Addison Wesley Pvt.Ltd. NewDelhi (1993)
3. Solid State Physics: A.J. Dekker, Macmillan India Ltd., Bangalore, (2000).
4. Solid State Physics: F.W.Ashcroft& N.D. Mermin. Saunders College Publishing, New York (1976).

Reference Books

1. Introduction to Solids: L.V. Azaroff. McGraw Hill inc, New york (1960).
2. Solid State and Semiconductor Physics: J.P.McKelvey. Harper and Row, Newyork (1966).
3. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009).

PG85P 105: Practical – I: Electronics & Communication and Condensed Matter Physics (General)

Contact hours per week: 4
Number of credits: 4

1. Op-Amp 741 as an adder, subtractor, differentiator and integrator.
2. Wien bridge oscillator using Op-Amp 741.
3. Triangular wave generator using op-amp 741.
4. Low pass, high –pass and band pass active filters using Op Amp 741.
5. Simplification of Boolean expressions and implementation using 2 input NAND gate IC7400.
6. Fortran Programming using Fortran 77.
7. Analysis of X ray diffraction pattern.
8. Thermistor characteristics
9. Determination of energy gap of semiconductor by resistivity measurement (4 probe method).

10. Developing of X ray pattern for a given substance using x ray diffractometer and determination interplanar spacing.
11. Structure factor calculation of simple crystal structures.

(New experiments may be added)

Course Outcomes:

The specific outcomes of this course are as under:

- It helps to solve the crystal structure of given X-ray patters and hence to estimate the lattice and lattice parameters.
- The experiment gives an idea to measure the energy gap of a given semiconductor through the temperature dependent resistivity measurement.
- It clears the concept of structure factor and its significance.
- Design and learn implementing the operational amplifier IC 741 based amplifier, adder, subtractor, differentiator, integrator circuits
- Design and learn implementing op-amp 741 based circuits in generation of sinusoidal and triangular waveforms and characterize them
- Design and learn implementing op-amp based low-pass, high-pass and band-pass filter circuits.
- Learn simplification of Boolean expressions using NAND gates
- Learn using FORTRAN programming for solving E&C related problems

Reference Books

1. Microelectronics Circuits: Adel S. Sedra and Kenneth C.Smith, Oxford University Press (1991).
2. Electronic devices and circuits: R.Boylstead and Nashalsky: PHI publications (1999).
3. Electronics Principles: A.P. Malvino, TMH Publications (1984).
4. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
5. Op-Amps and Linear Integrated Circuits: R. Gayakwad, PHI publications, New Delhi (2000).
6. Elementary Solid State Physics: M.A.Omar, Addison WisleyPub.Ltd. New Delhi (1993).
7. X ray Diffraction: B.D. Cullity, Addison Wisley Ltd. New York (1972).
8. Introduction to Solid State Physics: C. Kittel, Wiley Eastern Ltd. Bangalore (1976).

9. Laboratory Manuals

PG85P 106: Practical – II: Atomic & Molecular Physics and Nuclear & Particle Physics (General)

Contact hours per week: 4
Number of credits: 4

1. Study of Interference and Diffraction by means of He-Ne laser.
2. Determination of ionization potentials in atoms by the Franck-Hertz experiment.
3. Study of Zeeman Effect: Determination of e/m for an electron.
4. Study of dispersion of a Grating Spectrograph.
5. Spectroscopy Assignments in Computer Lab.
6. Study of the performance of G.M. Counter and Proportional counter.
7. Study of the performance of Scintillation detector and scintillation spectrometers.
8. Study of the random nature of radioactive decay.
9. Study of the absorption of beta particles.

(New experiments may be added)

Course Outcomes:

After successful completion of the course on practicals, a student will be able to:

- Understand the fundamentals of various physical phenomena and physical concepts.
- Understand the interference and diffraction by means of He-Ne laser.
- Determine the ionization potentials in atoms by the Franck-Hertz experiment.
- Understand the impact of electric and magnetic fields on electron and determine e/m of electronusing Zeeman Effect.
- Understand the dispersion of a Grating Spectrograph.
- Write the Fortran program, compile and execution to solve the spectroscopyproblems.
- Understand the performance and characteristicsof Geiger-Muller counter for estimating the random nature of radioactive decayand attenuationof beta particles.
- Understand theperformance and characteristics of NaI(Tl) scintillation gamma rayspectrometers.

Reference Books

1. Advanced Practical physics: (9th Edition) B.C.Worsnop& H.T. Flint Methuen & Co. Ltd. London (1951).
2. Instrumental Methods of Analysis : (6th Edition) H.H. Willard, L.L.Merrit, J.A. Dean & F.A. Settle, J.K. Jain for CBS Publishers (1986).
3. Optics (2nd Edition) A.K. Gathak Tata Mc Graw Hill Pub. Comp.Ltd New Delhi (1977).
4. Experimental Spectroscopy (3rd ed): Ralph A.Sawyer, Dover Pub, N.Y. (1950).
5. Lab Manuals/Books/Charts.
6. Experiments in Modern Physics: A.C. Melissions academic press (NY)(1966).
7. Experiments in Nuclear Science, ORTEC Applications Note. ORTEC,(1971) (Available in Nuclear Physics Laboratory).
8. Practical Nucleonics: F.J.Pearson., and R.R. Dsborne, E7 F.N. Spon Ltd(1960).
9. The Atomic Nucleus: R.D. Evans, Tata McGraw Hill Pub.comp.Ltd(1960).
10. Nuclear Radiation Detectors:S.S.Kapoor& V.S. Ramamurthy, Wiley Eastern Ltd(1986).
11. Experimental Nucleonics: E. Bleuler and G.J. Goldsmith, Rinehart & Co. Inc. (NY). (1958).

SEMESTER – II

PG85T 201: Quantum Mechanics – I

Teaching hours per week: 4
No. of credits: 4

Unit I

Basic Principles: Hermitian operators, observables; Eigenfunctions, eigenvalues and orthonormalization of eigenfunctions, completeness. State functions as probability amplitude andthe principle of superposition. Momentum, Hamiltonian and energy operators, Schrodingerequation. Probability density and probability current density, expectation value, Ehrenfest'stheorem; basic postulates of quantum mechanics.

Simple Applications: Eigenvalues and eigenfunctions of free particle, particle in infinite square well and of simple harmonic oscillator by polynomial method, barrier transmission: leakage of free particle through a thick rectangular potential barrier and transmission and reflection coefficients.

12 Hours

Unit II

Hydrogen atom: Particle in spherically symmetric potential, Reduction of two body problem to a single particle problem. Center of mass and relative motions; eigenvalues and eigenfunctions.Hydrogen like atom, eigenvalues of energy and eigenfunctions.

Angular momentum: The expression for the three Cartesian components and the square of theangular momentum, their commutation relations, expression for the operators in polar coordinates, eigenvalues and eigenfunctions in terms of polar coordinates; eigenvalues and eigenfunctions of the square and z component of angular momentum.

12 Hours

Unit III

Time Independent Perturbation Theory: Eigenvalue of energy and eigenfunction in the first order approximation (the case of a system with non-degenerate energy levels). Application to anharmonic oscillator and to the ground state of Helium atom.

Time Dependent Perturbation Theory: Concept of the theory, transition from one discrete level to the other, to a continuum states: Fermi's Golden rule. The harmonic perturbation, resonance transitions. Semi classical theory of Einstein's A & B coefficients. Interaction of radiations with a system of atoms, transition dipole moment, selection rules.

12 Hours

Unit IV

Elastic Scattering: Differential and total cross section, phase analysis. Significance of the partial waves and phase shifts, S wave scattering from a square well potential. The Born approximation, derivation of the expression for differential scattering cross section, condition for validity of the approximation: application to square well potential and screened coulomb potential.

12 Hours

Course Outcomes:

At the end of the course students will learn:

- Basic postulates of Quantum mechanics, Ehrenfest's theorem and simple applications of Quantum Mechanics.
- Reduction of two body problem to single particle problem. Centre of mass and relative motions, eigen values and eigen functions.
- Theory of time-independent perturbation theory (the case of a system with non-degenerate energy levels) its applications.
- Theory of time-dependent perturbation theory its concept and its applications.
- Scattering theory: Differential and total cross-section. Born approximation and its derivation of the expression for different cross-section.

Text Books

1. Quantum Mechanics – Theory & Applications (3rd Ed): A.K. Ghatak& S. Loknathan, MacMillan India Ltd. 91984).

2. A Text of Quantum Mechanics: P.M. Mathews &K. Venkatesan, Tata McGraw Hill, New Delhi (1982).
3. Quantum Mechanics (2nd ed): G. Aruldhas, Prentice Hall India Pvt.Ltd. New Delhi (2009).
4. Quantum Physics (3rd ed): S. Gasiorowicz, Wiley India (P) Ltd., New Delhi (2007).

Reference Books

1. Introduction to Quantum Mechanics: L. Pauling & E. Bright Wilson, McGraw Hill, N.Y.(1935).
2. Quantum Mechanics(3rd ed): L.I. Schiff, McGraw Hill, N.Y.(1968).
3. Quantum Mechanics: E. Merzbacher, 2nd ed., Wiley, N.Y.(1970).
4. Quantum Mechanics (2nd Ed): V.K. Thankappan, new Age International (P) Ltd.(1993).

PG85T 202: Basic Atomic & Molecular Physics

Teaching hours per week: 4
No. of credits: 4

Unit I

Atomic spectra and structure: Overview of the salient features of optical spectra due to alkalis, Boron group and IIA and IIB group of elements (as in Periodic Table). Spin orbit interaction due to single valence electron atoms and its doublet spectra. Vector model for two valence electron atoms: Determination of spectral terms (singlets, doublets, triplets, etc.); derivation of interaction energies in LS and jj couplingschemes; the Lande interval rule; singlet and triplet splitting. Normal and anomalous Zeeman Effect of singlets and doublet states(qualitative). Stark effect in hydrogen (qualitative).

12 Hours

Unit II

Laser Physics: Laser principles: Einstein coefficients, optical pumping, population inversion, the threshold condition– the Schawlow Townes condition for laser oscillations. Three level and four level laser systems. The Ruby laser and He Ne Laser: energy level diagrams, excitation mechanism, construction and working. Shape and width of spectral lines: mechanisms; Natural, Doppler, Collision/pressure and Stark broadenings. Laser cooling: basic concepts, trapping techniques of neutral atoms, the Bose Einstein condensation. Atom lasers: basic ideas with illustrations.

12 Hours

Unit III

Diatomic rotational spectra and structure: General features of observed spectra of typical diatomic molecules in Far IR (microwave) and due toRaman scattering; empirical series for the observed wave numbers in both IR and Raman spectra.Diatomic molecule as rigid and non rigid rotator models: energy levels, eigenfunctions, selectionrules, IR spectra and correlation with empirical series and illustrations. Raman scattering and spectradue to the rigid and non rigid rotator: energy levels, eigenfunctions, selection rules, spectra andcorrelation with empirical series and illustrations.

12 Hours

Unit IV

Diatomic vibrational spectra and structure: General features of observed spectra of typical diatomic molecules in Near IR and due to Ramanscattering; empirical series for the observed wave numbers in both IR and Raman spectra. Diatomicmolecule as Harmonic and Anharmonic oscillator models: energy levels, eigenfunctions, selectionrules, IR spectra and correlation with empirical series and illustrations. Raman scattering and spectradue to Harmonic and Anharmonic oscillator models: energy levels, eigenfunctions, selection rules,spectra and correlation with empirical series and illustrations. The vibrating rotator model: energylevels, selection rules, IR and Raman spectra, IR fine structure spectrum of a rotation vibration bandand correlation with empirical series.

12 Hours

Course Outcomes:

At the end of the course students will learn:

- How to interpret optical spectra using theoretical models & achieve agreement with experiment.
- How typical lasers work, their use in advanced frontier areas.
- How to interpret microwave and mid IR spectra due to diatomic molecules, their relevance in chemical sciences, astrophysics & planetary science.

Text Books

1. Introduction to Atomic Spectra: H.E. White, McGraw – Hill, Tokyo (1934) [Free soft copy available on Net].
2. Atomic Spectra: H.G.Kuhn, Longmans, Green &Co.Ltd, London & Harlow (1962) [Free soft copy available on Net].

3. Molecular Spectra & Molecular Structure(Vol I; 2nd ed): G.Herzberg, D. Van Nostrand Inc. N.Y. (1950) [Free soft copy available on Net].
4. Spectroscopy (Vol. 3) :S. Walker & B. P. Strauhghan, Chapman & Hall, London (1976)
5. Fundamentals of Molecular Spectroscopy: C. N. Banwell and E.M. McCash, Tata Mc Graw-Hill Co., (4th revd Ed; 9th reprint, 2000)
6. Lasers and Non-Linear Optics: B. B. Laud, Wiley Eastern Ltd., New Delhi (1991).
7. Laser Fundamentals: William T. Silfvast, Cambridge Univ Press, 1999.

Reference Books

1. Fundamentals of Spectroscopy (2nd ed): B. Narayan, Allied Publishers Ltd., New Delhi (1999).
2. Physics of Atoms and Molecules – 2nd Ed., Bransden B.H. and Joachain C.J., Pearson Education, India (2006).
3. Modern Spectroscopy (4th Ed): J.M. Hollas, John Wiley & Sons Ltd. UK 2004[Free soft copy available on Net]
4. Laser Electronics: Joseph T. Verdeyen, Prentice-Hall of India Pvt. Ltd. New Delhi (1989).
5. Lasers: Theory & Applications: K. Thyagarajan& A. Ghatak, MacMillan India, New Delhi (1981).

PG85T 203: Basic Nuclear & Particle Physics

Teaching hours per week: 4
No. of credits: 4

Unit I

Basic Properties: Binding Energy and separation energy. Radius of nucleus by scattering of high energy neutrons, by X rays from muonoic atom and by high energy electron scattering method.

Nuclear spin and magnetic moment: Spin and magnetic moment of odd A nucleus. Experimental determination of magnetic moment by Rabi's atomic beam method.

Nuclear quadrupole moment: Electric quadrupole moment of nucleus (Prolate and Oblate).

Nuclear models: Liquid drop model, stability against beta decay, stability against spontaneous fission, Fermi gas model, Fermi energy and kinetic energy, nuclear shell model and magic numbers.

12 Hours

Unit II

Alpha decay: Gamow's theory of alpha decay, quantum mechanical tunneling, relation between mean life and decay energy. Hindrance factor.

Beta decay: Energetics of beta decay, continuous beta ray spectrum, neutrino hypothesis, Fermi's theory of beta decay (derivation), Fermi Kurie plot, non-conservation of parity in beta decay
Gamma decay: Gamma transitions in nuclei and classifications. Internal conversion(qualitative)
Detectors: Gas filled detector, proportional counter, NaI(Tl) scintillation gamma ray spectrometer, semiconductor detector for detection of X ray and gamma radiation.

12 Hours

Unit III
Nuclear Reaction: Types of nuclear reactions. conservation laws, laboratory and center of masssystems. Q value of a nuclear reaction and relation between Q value and energy of outgoing particle, threshold energy. Compound nucleus model and its experimental verification. Briet Wigner formula (qualitative).
Reactor Physics: Condition for controlled chain reaction, four factor formula, thermal reactor, fast breeder reactor.
Elementary particles: Fundamental interactions and their general features, conservation laws,classification of elementary particles as leptons, mesons and baryons. Quark model (Qualitative).

12 Hours

Unit IV
Interactions of gamma rays and charged particles with matter: Photoelectric effect, Compton effect and pair production, Mass attenuation co efficient of gamma rays. Mossbauer effect; Resonance scattering of gamma rays, experimental technique, simple applications. Energy loss of heavy charged particles; ionization, radiation processes, Bethe Bloch formula, applications. Energy loss of fast electrons; ionization, excitation and radiation process(Bremsstrahlung).
Application of Nuclear Physics: Trace elemental analysis and alpha decay applications, applications of radioisotopes in cancer treatment, agriculture and industry.

12 Hours

Course Outcomes:

After successful completion of this course the students will be able to:

- Describe the basic propertiesof nucleus, its structure and different models that explain the static and dynamical properties of a nucleus.
- Understand the phenomenon of radioactive decays of alpha and beta particles and gamma rays, their detailed formalismand outcomes.
- Acquire knowledge about various type of radiation detectors used in nuclear physics experiments, unique properties of different detectors and their applications.
- Differentiate between different types of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions.
- Learn aboutconditionsof controlled chain reaction in different nuclear reactors.

Know about different elementary particles their classifications and quark model to understand the fundamental forces of nature and classification.

- Understand the stopping power of different energetic chargedparticles in a medium and mechanisms of interaction of gamma photon with matter.
- Understand the trace elemental analysis and applications ofradioisotopes in cancer treatment, agriculture and industry.

Text Books

1. Nuclei and Particles: E. Segre –The Benjamin Publishing, Pvt Ltd (1977).
2. Introductory Nuclear Physics: K.S. Krane John Wiley & Sons (1987).
3. Atomic and Nuclear Physics: Vol. II S.N.Goshal S. Chand and Company (1996).
4. Nuclear Physics: D.C.Tayal Himalaya Publishing House(2009)
5. Nuclear and Particle Physics: S.L.Kakani, ShubhraKakani Vira Books(2008)
6. Environmental radioactivity: Eisenbud M, Academic Press (1987)

Reference Books

1. The Atomic Nucleus: R.D. Evans – Tata McGraw Hill New Delhi (1992).
2. Physics of Nuclei and Particles: Marmer and E.Sheldon,Vol.II Academic press (1970).
3. Physics of Nuclear Reactors: S.Garag, F.Ahmed and L.S. Kothari. – Tata McGraw Hill New Delhi (1986).
4. Introductory Nuclear Physics: Samuel Wong Prentice Hall (1996).
5. Fundamentals of Nuclear Physics:N.A.Jelly Cambridge University Press (1990).
6. Introduction to Nuclear Physics: Harald A. Enge Addison –Wiseley (1996).
7. Introduction to Nuclear and Particle Physics: V.K.Mittal, R.C. Verma, S.C. Gupta PHI Learning Limited (2009)
8. Radiation detectors: Kapoor S S and Ramamurthy V S Wiley Eastern (1986)

PG85T 204: Open Elective Course – I: Modern Physics

Teaching hours per week: 4

No. of credits: 4

Unit I

Blackbody Radiation: Nature of Blackbody spectrum; classical radiation laws and their limitations; Planck's radiation law and quantum hypothesis. Simple examples/problems.
The Photoelectric Effect: Apparatus used to study the Photoelectric Effect; laws of Photoelectric Effect; Einstein Photoelectric Equation. Simple examples.
X-Rays: Nature and production of X rays; the Bragg law; Bragg X ray crystal spectrometer.
The Compton Effect: X ray Compton scattering from an electron; experimental set up for Compton scattering. Simple problems.

12 Hours

Unit II

Atomic Structure: Hydrogen spectrum; the Bohr model; experimental measurement of the Rydberg constant; Franck Hertz experiment.
Matter Waves: The de Broglie wavelength and its relation with the Bohr model; Davisson Germer experiment. Heisenberg Uncertainty principle: Momentum position and Energy time relations. Simple examples.
Quantum Physics: Idea of wave function and probability. One dimensional Schrödinger wave equation: Its application to the particle in a box and Hydrogen atom; energies and wave functions.
Vector Model: Space quantization: Orbital angular moment and magnetic moment; Spin angular moment and magnetic moment; Stern Gerlach experiment. States of Hydrogen in terms of n, l, ml. The normal Zeeman Effect; experimental set up for Zeeman effect. Simple problems.

12 Hours

Unit III

Statistical Physics: Distinguishability and Indistinguishability; Maxwell Boltzmann distribution for gas molecules; V_{rms}; Equipartition theorem. Quantum statistics: F D and B E distributions.
Molecular Structure: Bonding mechanisms: Ionic bonds; Covalent bonds; the Hydrogen bond; Van der Waals bonds. Molecular vibration and rotation spectra. Molecular orbitals: Hydrogen molecular ion and molecule; bonding in complex molecules.
Solid State Physics: Ionic solids; covalent solids; metallic solids; molecular crystals; amorphoussolids. Classical models of electrical and heat conductivities in solids; Ohm's Law; Wiedemann Franz law; the quantum view point.
Lasers: Absorption, Spontaneous and Stimulated emissions; Population inversion; laser action;typical gas (He Ne/CO_2) characteristics.

12 Hours

Unit IV

Magnetism; Magnetic moment; Magnetization. Magnetic materials: Diamagnetic, paramagnetic and ferromagnetic materials. Superconductivity phenomenon.
Nuclear Structure: Nuclear properties: Charge, Mass, Size and Structure; Nuclear spin and magnetic moment; Nuclear Magnetic Resonance (NMR) phenomenon. Binding energy and nuclear forces. The liquid drop model. Radioactivity: Decay constant, Half-life.
Nuclear Fission / Fusion: Fission – Basic process; a simple model; a typical nuclear reactor. Fusion: basic process; stellar energy.
Relativity: The Michelson Morley experiment. Postulates of Special theory of Relativity; Time dilation; Length contraction; Simultaneity of events; $E = mc^2$.

12 Hours

Course Outcomes:

After successful completion of this course a student will be able to:

- Learn nature of black body spectrum, classical radiation laws and their limitations; Laws of photoelectric effect and Einstein photoelectric equation and Compton effect.
- Understand the atomic structure, matter waves, Quantum Physics and its applications.
- Acquire knowledge about nuclear structure and molecular structure, quantum statistics, F-D and B-E distributions. Laser action and its characteristics.
- Acquire knowledge about nuclear fission/fusion nuclear reactor stellar energy and their applications.

Text Books

1. Modern Physics (2nd Ed) Serway, Moses and Moyer, Saunders College Pub, 1997.
2. Fundamentals of Physics extended with Modern Physics (4th Ed) Halliday, Resnick and Walker, John Wiley, 1993.

PG85P 205: Practical – III: Electronics & Communication and Condensed Matter Physics (General)

Contact hours per week: 4

No. of credits: 4

1. Study of triggered SR, JK and D-flip-flops.
2. Ripple counter and Shift Register using JK flip-flop.
3. Regulated power supply using 78xx integrated circuits.
4. R 2R ladder network D/A converter
5. Fortran Programming using Fortran 77.
6. Hall Effect and Hall mobility in semiconductors.
7. Determination of energy gap by reverse saturation current of pn-junction.
8. Computer programming using Fortran 77.

9. Developing of X-ray pattern for a cubic lattice using X-ray diffractometer and indexing of the pattern.

(New experiments may be added)

Course Outcomes:

The specific outcomes of this course are as under:

- Students learn to measure the Hall effect which in turn helps to measure the basic parameters such as carrier density, sign of carriers and mobility of charge carriers in a semiconductor.
- It helps to explore the temperature dependent properties of a diode estimate the energy gap of a semiconductor.
- The indexing of cubic patterns and calculation of lattice parameters is possible.

Reference Books

1. Microelectronics Circuits: Adel S.Sedra and Kenneth C.Smith, Oxford University, Press (1991).
2. Electronic devices and circuits: R. Boylstead and Nashalsky : PHI publications (1999).
3. Electronic Principles: A.P. Malvino, TMH Publications (1984).
4. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
5. Op Amps and Linear Integrated Circuits: R. Gayakwad, PHI publications, New Delhi (2000).
6. Elementary Solid State Physics: M.A. Omar, Addison Wesley Pub. Ltd. New Delhi (1993).
7. X ray Diffraction: B.D. Cullity, Addison Wesley, Ltd. New York (1972).
8. Introduction to Solid State Physics: C. Kittel, Wiley Eastern Ltd. Bangalore (1976).
9. Laboratory Manuals.

PG85P 206: Practical – IV: Atomic & Molecular Physics and Nuclear & Particle Physics (General)

Contact hours per week: 4
No. of credits: 4

1. Study of Elliptically Polarized Light
2. Study of Beer's law
3. Study of Dispersion of a Glass Prism Spectrograph.
4. Stefan's constant of Radiation: High resistance by leakage method
5. Study of gamma ray spectrum obtained in Nal (TI) detector spectrometer.
6. Study of attenuation of gamma rays in matter.
7. computer programming using Fortran 77

(New experiments may be added)

Course Outcomes:

After successful completion of the course on practicals, the students will be able to:

- Demonstrate the production and analysis of elliptically polarized light.
- Understand the Beer's Law to measure the fraction of the incident light transmitted through a solution.
- Understand the dispersion spectra of radiations usingglass prism spectrograph.
- Acquire practical knowledge on calibrating Nal(TI)gamma ray spectrometer and to determine the energy of a given gamma ray sourceand calculate the energy resolution.
- Able to determine theattenuation of gamma rays in matter using Nal(TI) gamma ray spectrometer.
- Understand the semi-empirical mass formula to calculate the binding energy of any nucleus using Fortran 77 computer programming.

Reference Books

1. Advanced Practical Physics: (9th Edition) B. C Worsnop& H.T. Flint, Methuen & Co. Ltd. onion (1951)
2. Instrumental Methods of Analysis: (6th Edition) H. H. Willard, L. L. Merit, J. A. Dean & F. A. Settle, J. K. Jain for CBS Publishers (1986)
3. Optics: (2nd Edition) A. K. Gathak Tata Mc Graw Hill Pub. Comp. Ltd New Delhi (1977)
4. Lab Manuals / Books / Charts.
5. Experiments in Modern Physics: A C. Melissions, Academic press (N.Y.) (1966).
6. Experiments in Nuclear Science ORTEC Application Note ORTEC, (1971) (Available in Nuclear Physics Laboratory)
7. Practical Nucleonics: F.J. Pearson., and R.R. Osborne, E & F.N. Spon Ltd., London (1960)
8. The Atomic Nucleus: R.D. Evans Tata Mc Graw Hill Pub. Comp. Ltd., (1960)
9. Nuclear Radiation Detectors: S.S. Kapoor and V.S. Ramamurthy, Wiley Eastern Limited (1986)
10. Experimental Nucleonics: E Bleuler and G.J. Goldsmith, Rinehart & Co, Inc. (NY) (1958)

SEMESTER – III

PG85T 301: Quantum Mechanics – II

Teaching hours per week: 4
No. of credits: 4

Unit I

Linear Vector Algebra: Linear Vectors space, Orthonormality, linear independence. Operators. Eigenvalues, eigenvectors; Hermitian, Unitary and Projection operators. Bra and Ket notation forvectors. The elements of Representation Theory. Idea of Measurements, Observables and generalized uncertainty relation. Coordinate and momentum representations. Quantum PoissonBracket.

Quantum Dynamics: Schrödinger and Heisenberg pictures; Interaction picture; the Heisenberg equation of motion. Linear harmonic oscillator problem by matrix method.

12 Hours

Unit II

Angular Momentum: Introduction, angular momentum operator and its representation, Eigen values and eigen functions of L^2, commutation relations, Angular momentum and rotations. Bra and Ket representation, Eigen values, ladder operators, Eigenvectors of $J^2$and J_z. Angular momentum matrices for j=1/2 and j=1. Pauli wavefunction and equation, Theory of addition of two angular momenta, Clebsch Gordan coefficients, allowed values of j, singlet and triplet states (qualitative).

12 Hours

Unit III

Approximation Methods: First order stationary perturbation theory for a degenerate case; thesecular equation; applications: particle in a infinitely deep potential well subject to perturbingpotential and, Stark effect in hydrogen atom; Second order perturbation theory and its applicationto a linear harmonic oscillator subject to a potential. W.K.B. approximation: Connection formulas; application to a potential well and alpha decay. The Variation method and its application to the ground state of hydrogen atom and helium atom.

12 Hours

Unit IV

Relativistic Quantum Mechanics: Klein–Gordon equation. Dirac's relativistic equation for a free particle: commutation relations and matrices for α and β; free particle solutions; probability charge and current densities; positive and negative energy states; the spin of the Dirac particle, Zitterbewegung. Dirac equation in electromagnetic potentials and magnetic moment. Dirac equation for a central field; the hydrogen atom: energy levels and fine structure (without derivation).

12 Hours

Course Outcomes:

At the end of the Course students will learn:

- How to formulate the foundational aspects of quantum mechanics in the formalism of linear vector algebra.
- How to use different approximate methods for solving higher problems.
- How the different aspects of angular momentum can be used in theoretical models to understand variety of physical problems.
- How the synthesis of two fundamental theories – theory of relativity & quantum mechanics – leads to enhanced understanding of new major results in agreement with experiment.

Text Books

1. Quantum Mechanics (2nd Edition) : L. I. Schiff, McGraw – Hill Co, New York (1955)
2. Quantum Mechanics (Vol. I) : A. Messiah, North Holland Pub Co, Amsterdam (1962)
3. Quantum Mechanics – Theory and Applications (3rd Edition): A. Ghatak and S. Lokanathan, MacMillan India Ltd. New Delhi (1984)
4. A Text book of quantum Mechanics: P. M. Mathews and K. Venkateshan, Tata Mc Graw -Hill, New Delhi (1987).

Reference Books

1. The Principles of Quantum Mechanics (4th Edition) : P.A.M. Dirac, Oxford Univ Press, New York (1958)
2. Quantum Mechanics (1st Edition): V. K. Thankappan, New Age Intl. Pvt. Ltd., New Delhi (1985)
3. Quantum Mechanics : E. Merzbacher., John Wiley, New York (1970)
4. Modern Quantum Mechanics : J. J. Sakurai, Addison Wesley, Massachusetts (1994)
5. Applied Quantum Mechanics: A.F.J Levi, Cambridge Univ Press, 2003.

PG85T 302A: Atomic and Diatomic Molecular Spectra

Teaching hours per week: 4

No. of credits: 4

Unit I

One electron atoms: Fine structure and Hyperfine structure Fine structure: of hydrogenic atoms (quantum mechanical treatment): energy shifts due to relativistic and spin orbit corrections, fine structure splitting (hydrogen atom), fine structure and intensities of spectral lines. The Lamb shift.

Hyperfine structure and isotope shifts: magnetic dipole hyperfine structure; energy shift, hyperfine structure multiplet, hyperfine transitions in hydrogen, isotope shift.

12 Hours

Unit II

Interaction of One electron Atoms with External Electric and Magnetic fields: (Quantum mechanical treatment) The Stark effect-first order correction to energy and eigen states:splitting of the degenerate level of hydrogen; the Zeeman effect: Normal Zeeman effect-magneticinteraction energy, selection rules, Lorentz triplet, polarization states; the Paschen-Back effect(qualititative); anomalous Zeeman effect magnetic interaction energy, selection rules, splitting oflevels in hydrogen atom.

12 Hours

Unit III

Elementary discussion of electronic states: Electronic energy and Total energy, Born-Oppenheimer approximation. Symmetry properties of electronic eigen functions. Vibrational structure of electronic bands; Progressions and Sequences, isotope effect, Deslandres' table; Intensity distribution in the vibrational structure of electronic bands; the Franck-Condon principle (absorption), Dissociation energy. MO theoretical treatment of H_2^+ and H_2 electronic states and correlation of states.

12 Hours

Unit IV

Finer details about electronic states and electronic transitions: Coupling of Rotation and Electronic Motion:Coupling of rotation and electronic motion in diatomicmolecules. Hund's coupling cases, Spin uncoupling, Lambda doubling, symmetry properties ofrotational levels of Σ and Π electronic states.Types of allowed electronic transitions; selection rules, Rotational structure of bands due to Σ–Σ, Π–Σ, Σ–Π and Π–Π transitions of singlet multiplicity, P,Q,R branches; the Fortrat diagram; combination relations; evaluation of rotational constants.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- Students will learn application of theoretical models to the interpretation of atomic spectra in agreement with experiment.
- Electronic structure of atoms under the influence of electric & magnetic fields.
- Application of theoretical models to the interpretation of diatomic molecularstates, electronic, vibrational & rotation spectra in agreement with experiment.
- Relevance of these spectra in understanding atmosphere, comets, stars and inter-galactic matter

Text Books

1. Physics of Atoms and Molecules(2nd ed): Bransden B.H. and JoachainC.J.,Pearson Education, India (2006)
2. Atoms &Molecules : Mitchel Weissbluth, Academic Press, N. Y. (1982)
3. Molecular Spectra & Molecular Structure(Vol I): G.Herzberg, D. Van Nostrand CoPrinceton, N.J. (1945)
4. Spectroscopy (Vol. 3):S. Walker & B. P. Strauhghan, Chapman & Hall, Lon (1976)

Reference Books

1. Introduction to Atomic Spectra : H.E. White, McGraw – Hill, Tokyo (1934)
2. Quantum Chemistry : Ira Levine, Prentice – Hall of India, New Delhi (1991)
3. Fundamentals of Spectroscopy (2nd ed): B. Narayan, Allied Publishers Ltd., NewDelhi, (1999).
4. Modern Spectroscopy (4th Ed): J.M. Hollas, John Wiley & Sons Ltd. UK 2004.

PG85T 302C: Electron Transport and Lattice Dynamics

Teaching hours per week: 4

No. of credits: 4

Unit I

Periodic Structures: Reciprocal lattice and its properties, periodic potential and Bloch theorem,reduction to Brillouin zone, Born von Karman boundary conditions. Counting of states.**Electron States:** Nearly free electron model, discontinuity at zone boundary, energy gap and Bragg reflection. Tight binding method, band width and effective mass in linear lattice and cubic lattices. APW and k.p. methods of band structure calculations.

12 Hours

Unit II

Fermi surface Studies: Extended, reduced and periodic zone schemes. Construction of Fermisurface in square lattice, Harrison construction, slope of bands at zone boundary, electron orbits,hole orbits and open orbits. Experimental methods: Electron dynamics in a magnetic field, cyclotron frequency and mass, cyclotron resonance. Quantization of orbits in a magnetic field, Landau quantization, degeneracy of Landau levels, quantization of area of orbits in k – space, de Hass-van Alphen effect, external orbits.

12 Hours

Unit III

Electrical Transport in Metals and Semiconductors: Boltzmann equation, relaxation time approximation, electrical conductivity, thermal conductivity, thermoelectric effects Calculation of relaxation time, scattering by impurities and lattice vibrations, Mattheisen's rule, temperature dependence of resistivity, residual resistance.

12 Hours

Unit IV

Quantization of lattice vibrations and phonons: Potential and kinetic energies in terms of generalized coordinates and momenta, Hamilton's equations of motion, quantization of normal modes.**Elastic properties of solids:** Stress and strain tensors, elastic constants and Hooke's law, strain energy, reduction of elastic constants from symmetry, isotropy for cubic crystals, technical moduli and elastic constants. Propagation of long wavelength vibrations. Experimental determination of elastic constants by ultrasonic interference method.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- The effect of periodic structure a lattice on the electron energy states can be learnt.
- The concept of Fermi surface is important in the understanding the properties of crystalline materials. They can be thoroughly understood by studying this course.
- The quantization of lattice vibrations that leads to formation of quantum particle that is phonon can be understood.
- The course helps to apply the Boltzmann transport equation to understand the charge transport mechanism in metals and semiconductors.

Text Books

1. Principles of Theory of Solids: J. M. Ziman, Cambridge University Press, (1972).
2. Introduction to Solid State Physics : C. Kittel, Wiley Eastern Ltd, Bangalore (1976).
3. Lattice Dynamics: A. K. Ghatak and L. S. Kothari, Addison Wesley, Reading (1971).
4. Solid State Physics: J. D. Patterson and B.C. Bailey, Springer Verlag, Berlin (2007)

References Books

1. Physics of Solids: F. C. Brown, Benjamin Inc. Amsterdam (1967).
2. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)
3. Solid State Physics: N. W. Aschroft and A. D. Mermin, Saunders College Publishing New York (1976)

PG85T 302E: Transmission Lines, Waveguides and Satellite Communication

Teaching hours per week: 4

No. of credits: 4

Unit I

Transmission lines: Line parameters, inductance and capacitance of open wire and coaxial line, line of cascaded sections, transmission line general solution, physical significance of the equations, the infinite line, wavelength, velocity of propagation, wave form distortion, distortion less line, telephone cable, induction loading of telephone cable, reflection of line not terminated with characteristic impedance, open and short circuited lines, insertion losses.

12 Hours

Unit II

Lines at RF: Parameters of open wire line at high frequencies, parameter of co axial cable at high frequencies, constants of lines of zero dissipation, voltage and current on dissipation less lines, standing wave ratio, impedance of open and short circuit lines, the ¼ wave line, ½ wave line, impedance matching of ½ wave line, single stub matching, Circle diagram for the dissipationless line and its applications.

12 Hours

Unit III

Waveguides: Solutions of wave equations in rectangular and cylindrical coordinates, TE and TM modes in rectangular and cylindrical wave guides, characteristics of rectangular and circular wave guides.

Antennas: Hertzian dipole, Current and voltage distributions Resonant antennas, radiation patterns, and length calculations, Non-resonant antennas, Antenna gain and effective radiated power, Radiation measurement and field intensity, Antenna resistance, Bandwidth, beam width, and polarization, Ungrounded antennas, Grounded antennas, Grounding systems, Effects of antenna height, loop antennas, phased arrays, antenna as aperture, different types of apertures, Principles of pattern multiplication, phased arrays, Yagi Uda antenna, helical antenna.

12 Hours

Unit IV

Satellite communication: Introduction, Kepler's laws, orbits, geostationary orbit. Power systems, attitude control, satellite station keeping, antenna look angles, limits of visibility, frequency plans and polarization, transponders, up link and down link power budget calculations, digital carrier transmission, multiple access methods, fixed and mobile satellite service, earth stations, INSAT.

12 Hours

Course Outcomes:

At the end of this course, the students will be able to

- Learn transmission of electrical energy from one point to another and will be able to analyze the working of different types of transmission lines and also clear understanding of working of wired telephone communication system.
- Working of transmission lines at higher frequencies such as Radio Frequencies which helps student to appreciate the use of transmission lines in video/picture transmission.
- Get a comprehensive picture of signal transmission, analyzing various waveguides as well as antennas.

- Gain knowledge of how satellites communicate with ground stations and help in appreciating various applications.
- Will be able to implement the above practically with the help of Numerical problems solving.

Text Books

1. Networks, Lines and Fields: J. D. Ryder, Prentice Hall India Pvt., Ltd., New Delhi (1995)
2. Electronic communications, 4th edition: Dennis Roddy and John Coolen, Prentice – Hall of India Pvt. Ltd. New Delhi (1997)
3. Electronic Communication systems – 4th edition: George Kennedy and Bernard Davis, Tata McGraw – Hill Publishing Company Ltd., New Delhi (1999).
4. Satellite communication – 3rd edition, Dennis Roddy, McGraw – Hill Publishing Company Ltd., New Delhi (2001)

References Books

1. Communications Systems: Simon Haykin, Wiley Eastern Ltd., New Delhi
2. Radio Engineering: G. K. Mittal, Khanna Publishers, Delhi (1998)
3. Modern Communication Systems – Principles and Applications : Leon W. Couch II, Prentice Hall of India Pvt. Ltd. New Delhi (1998)

PG85T 302N: Nuclear Properties and Elementary Particles

Teaching hours per week: 4
No. of credits: 4

Unit I

Basic Properties: Scattering of high energy electrons by nucleus; Expression for Mott Scattering, differential cross section, form factor, charge distribution in nuclei. Scattering of high energy electrons by nucleons; Expression for Rosenbluth formula, electric andmagnetic form factors of protons, the magnetic form factor of neutron, their distribution in nucleon.

Electric quadrupole moment: Expression for axial quadrupole moment, quadrupole moment of spheroidal nucleus. Quadruple moment due to single nucleon is a state J.

Magnetic dipole moment: Nuclear g factor for neutron and proton, expression for g factor for anucleon in a state J in special cases for odd proton and odd neutron on extreme single particle model, Schmidt limits.

12 Hours

Unit II

Nuclear forces: Characteristics of nuclear forces, deuteron problem, basic properties, ground state of deuteron for square well potential, relation between the range and depth of potential. Non-existence of excited states, basic properties of non central force, deuteron in mixture of S and D states using magnetic moment. Range of tensor interaction using quadrupole moment, saturation of nuclear forces.

12 Hours

Unit III

Nucleon-Nucleon Scattering: n-p scattering, partial wave analysis, scattering of neutron by hydrogen molecules: ortho and para hydrogen, spin dependence of nuclear force, effective range theory for n-p scattering. Qualitative features of p p scattering, effect of Coulomb and nuclear scattering. High energy n-p and p-p scattering (qualitative). Meson theory of nuclear force: Yukawa and pseudo scalar theory, one pion exchange potential.

12 Hours

Unit IV

Elementary Particles: Pion-nucleon scattering and its resonances. Strange particles:associatedProduction-strangeness quantum number, Gell–Mann and Nishijima formula, Kaons, lamda, sigma, omega hyperons. Symmetry classification of elementary particles: SU(3) symmetry and eight-fold way, Gell-Mann Okubo formula, Weight diagram, discovery of Ω^- particle.

Quark Model: fundamental representation of SU(3) and quarks, experimental support for quarkmodel, quark structure of mesons and baryons, color quark and gluons, quark dynamics, charm,beauty and truth quarks, grand unification theory.

12 Hours

Course Outcomes:

After completing this course, the students will be able to:

- Learn the scattering phenomenon using high energy electrons on nucleus to understand the electric andmagnetic form factors of protons, and magnetic form factor of neutron.
- Understand electric quadrupole moment due to single nucleon is a state J and magnetic dipole moment for odd proton and odd neutron using extreme single particlemodel.
- Know and learn about the theory of deuteron, explore its ground state properties of and applications withsquare well potential.

- Know the range of tensor interaction using quadrupole moment to understand the saturation ofnuclear forces.
- Understand the neutron-proton scattering and concept of scattering length and its effective range theory along with spin dependence of nuclear force.
- Learn the effect of Coulomb and nuclear scattering, and Meson theory of nuclear force.
- Understand the symmetry classification of elementary particles and apply the Gell-MannNishijima and Gell-Mann-Okubo formula to solve numericalproblems.
- Learn the basics of strong interactions and quark structures, experimental support for quarkmodel and quark dynamics.

Text Books

1. Introductory Nuclear Physics: Kenneth S. Krane, John Wiley and sons (1988)
2. Subatomic Physics: Nuclei and Particles (Volume II) : Luc Valentin North Holland (1981)
3. Physics of Nuclei and Particles: P. Marmier and E. Sheldon Academic press (1970)
4. Introduction to Particle Physics: M. P. Khanna Prentice Hall of India (1990)
5. Nuclear Physics: R. R. Roy and B.P. Nigam, Wiley Eastern (2014)

Reference Books

1. Subatomic Physics (Second Edition) : Hans Frauenfelder and E. M. Henley, Prentice Hall (1991)
2. Introduction Nuclear Physics : Herald. A. Enge., Addison Wesley (1983)
3. Introductory Nuclear Physics : Samuel S. M. Wong, Prentice – Hall (1996)
4. Atomic Nucleus : R. D. Evans, Tata Mc Graw –Hill (1982)
5. Theoretical Nuclear Physics Volume I : Nuclear structure : AmosdeShalit and Herman Feshbach, John Wiley (1974)
6. Nuclear and particle Physics : W. Burcham and M. Jobes, Addisionwesley (1998)
7. Theoretical Nuclear Physics : J. M. Blatt and V. F. Weisskoff, Wiley (1962)
8. Introduction to quantum electrodynamics and particle physics: Deep Chadra Joshi,
9. Modern Atomic and Nuclear Physics: A.B. Gupta Books and Allied (2009)
10. Nuclear Physics: S. N. Ghoshal, S Chand & Company (2014)
11. Nuclear Physics: D. C. Tayal, Himalaya Publishing House (5th ed.) (2013)
12. Introduction to Elementary Particles: D. Griffiths, John Wiley (1987)

PG85T 303A: Spectroscopy Instrumentation Techniques

Teaching hours per week: 4
No. of credits: 4

Unit I

Components of Optical Instruments: Sources of radiation for UV-Visible and IR regions; types of prism and grating monochromators;Radiation detector types Photon (photovoltaic, vacuum phototube, PMT); Multichannel typesPhotodiode arrays, CID, CCD; Thermal detectors Thermocouples, Bolometer, Pyrroelectric types.Principles of FT optical measurements.

Atomic Spectroscopy

Atomic Absorption Spectrometry: Sources of flames; Instrumentation: Single and Double beaminstruments. Sampling techniques. Simple applications.
Atomic Emission Spectrometry: Sources; Typical spectrometers; sampling techniques. Arc and sparksources; instrumentation.

12 Hours

Unit II
Luminescence Spectroscopy
UV Visible Absorption Spectrometry: The Beer's law and its limitations. Instrumentation: sources; single and double beam spectrometers; Solvent effects; Bathochromic and Hypsochromic shifts; Assignment of and transitions.
Fluorescence Spectrometry: Theory of Fluorescence and Phosphorescence (with energy leveldiagram); Transition types; quantum efficiency (yield). Instruments: Fluorometers and Spectrofluorometers; lifetime measurements, Radiative and Natural lifetime, Decay curves. Applications.

12 Hours

Unit III
Vibrational Spectroscopy
Infrared Spectrometry: Molecular vibrations and Group frequencies. IR sources; transducers.Instruments: Dispersive and FT based spectrometers; sample handling. Interpretation of spectrastructure correlations.
Raman Spectrometry: Origin of Raman scattering (qualitative);comparison of vibrational Raman and infrared spectra; activity and intensity of Raman bands; depolarization ratio. Instrumentation; sources; dispersive and FT-based Raman spectrometers; sample handling. Simple applications.

12 Hours

Unit IV
NMR Spectroscopy
Proton NMR Spectrometry: Theory of NMR: Interaction between nuclear spin and magnetic moment; resonance condition; population of energy levels. Relaxation processes: spin lattice and spin-spin relaxations (qualitative). The chemical shift and its correlation with molecular structure. Typical NMR spectrometers (cw/FT); sample handling. Simple applications of 1H.NMR.
Photoelectron Spectroscopy
Photoelectron spectroscopy: Types UPS and XPS. Experimental method for UPS and XPS. Ionization processes and Koopmans' theorem. Interpretation of UP and XP spectra with applications.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- Students will learn the principles of eight analytical techniques for the analysis of atomic and molecular samples.
- How to select an analytical technique for a given application.
- How to apply the basic knowledge to characterize atomic & molecular samples.

- How to acquire the desired knowledge of analytical techniques to work in laboratories of multi-disciplinary subjects.
- How to cultivate the spirit of entrepreneurship in the field of instrumentation.

Text Books

1. Instrumental Methods of Analysis: H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
2. Principles of Instrumental Analysis (5th Ed): D. A. Skoog, F. J. Holler & T. A. Nieman, Harcourt Asia Pvt. Ltd. (1998)
3. Fundamentals of Molecular Spectroscopy: C. N. Banwell and E.M. McCash, Tata McGraw-Hill Co., (4th revd Ed; 9th reprint, 2000).

Reference Books

1. Raman Spectroscopy: D. A. Long, McGraw Hill Intl. Co. (1977)
2. Modern Spectroscopy (4th Ed): J.M. Hollas, John Wiley & Sons Ltd, UK (2004) [Free soft copy available on Net].

PG85T 303C:Magnetism & Dielectrics

Teaching hours per week: 4
No. of credits: 4

Unit I

Ferromagnetism: Review of Weiss theory of ferromagnetism, its successes and failures, Heisenberg exchange interaction, exchange integral, exchange energy, spin waves (one dimensional case only), quantization of spin waves and magnons, density of modes, thermal excitation of magnons and Bloch $T^{3/2}$ law, specific heat using spin wave theory. Origin of ferromagnetic domains, hysteresis curve, magnetocrystalline anisotropy energy, Bloch wall formation.

Antiferromagnetism: Characteristic property of antiferromagnetic substance, Neutron diffraction experiment. Two sub lattice model molecular field theory of antiferromagnetism, Neel temperature, Susceptibility below and above Neel temperature.

Ferrimagnetism: Ferrimagnetic order, ferrites, Curie temperature and susceptibility of ferrimagnets.

12 Hours

Unit II

Magnetic Resonance: Basic principles of paramagnetic resonance, spin spin and spin–latticerelaxation, susceptibility in a.c. magnetic field power absorption, equations of Bloch, steady statesolutions, determination of g factor, line width and spin –lattice relaxation time, electron paramagnetic resonance and nuclear magnetic resonance. Effect of crystal field on energy levels of magnetic ions (qualitative). Spin Hamiltonian, zero field splitting.

Novel Magnetic Materials and Devices: Magneto optic effect: Kerr and Faraday. The basic concepts of Giant Magnetoresistance (GMR) and Colossal Magnetoresistance (CMR), applications to memory storage, actuators and sensors.

12 Hours

Unit III

Dielectrics: Review of basic formulae, dielectric constant and polarizability, local field, ClausiusMossotti relation, polarization catastrophe. Sources of polarizability, Dipolar polarizability: dipolar dispersion, Debye's equations, dielectric loss, dipolar polarization in solids, dielectric relaxation. Ionic polarizability. Electronic polarizability: classical treatment, quantum theory, interband transitions in solids.

12 Hours

Unit IV

Ferroelectrics: General properties of ferroelectrics, classification and properties of representative ferroelectric crystals, dipole theory of ferroelectricity, dielectric constant near Curie temperature, microscopic source of ferroelectricity, Lyddane –Sachs Teller relation and its implications, thermodynamics of ferroelectric phase transition, ferrroelectric domains, piezoelectricity and its applications.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- The classification of magnetic materials and Weiss molecular field theory of ferromagnetism can be understood.
- It clears the concept of formation of magnons at very low temperature in a ferromagnetic material and their behavior through Bloch $T^{3/2}$ law will be evident.

- Other class of magnetic materials like anti-ferromagnetic and ferromagnetic can be understood.
- The significance of dielectric materials and their associated phenomena such as dipolar polarizability, ferroelectrics and piezoelectric can be learn.

Text Books

1. The Physical Principles of Magnetism : A. H. Morrish, John Wiley & sons, New York (1965)
2. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
3. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
4. Elementary Solid State Physics : M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000).
5. Elements of Solid State Physics, Second Edition, J.P. Srivastava, Eastern Economy Edition, PHI Learning Private Limited, New Delhi (2009).

Reference Books

1. Introduction to Magnetic Resonance: A. Carrington and A. D. Mclachlan, Harper & Row, New York, (1967).
2. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)

PG85T 303E: Electronic Instrumentation, Signals and Systems

Teaching hours per week: 4
No. of credits: 4

Unit I

Basic concepts of measurements & instruments: Static characteristics of instruments, accuracy & precision, sensitivity, reproducibility, errors, Transducers, classification & selection criteria, principles of piezoelectric, photoelectric, thermoelectric transducers, resistance temperature transducers (RTD), Thermistor, strain gauge, load cells, LVDT. Digital voltmeter, digital multimeter, Q meter, Electronic LCR meter, Frequency & time interval counters.

12 Hours

Unit II

Biomedical Instrumentation: Role of technology in medicine, Developments in biomedical instrumentation, physiological systems of the body, sources of biomedical signals, basic medicalinstrumentation system, performance requirements of medical instrumentation systems, intelligent medical instrumentation systems, consumer and portable medical equipment, implantable medical devices, micro-electro mechanical systems (MEMS), wireless connectivity in medical instruments, electrocardiograph(ECG), vector cardiograph (VCG), phonocardiograph (PCG), digital stethoscope, electroencephalograph (EEG), electromyography, magnetic resonance imaging (MRI),real-time ultrasonic imaging systems. pace makers, defibrillators.

12 Hours

Unit III

Continuous time signals: Classification of signals, continuous time signals, discrete time signals, standard test signals, operations on signals. Definition of a system, classification of system, examples of systems. Classification of system, Continuous time systems defined by an input/output differential equation, system modeling, zero input response zero state response and causality, unit impulse response, convolution, convolution integral and properties, system stability. Discrete time systems, difference equation, initial conditions and iterative solution, zero input response, unit impulse response, zero state response, discrete time convolution, properties of convolution sum, convolution examples, system stability, numerical convolutions.

12 Hours

Unit IV

Transform domain representation of signals: Fourier series representation of periodic signals, exponential form of the Fourier series, aperiodic signal representation, Fourier transform, transforms of some useful functions, properties, generalized Fourier transform. Computations of output response via the Fourier transform, analysis of ideal filters, amplitude modulation, angle modulation. Discrete time Fourier transform, discrete Fourier transform, system analysis via the DTFT and DFT.

12 Hours

Course Outcomes:

At the end of this course, the students will be able to-

- Get a clear picture of various transducer based electronic instruments used for measuring various physical quantities such as light, pressure, temperature, humidity, etc.
- Obtain a detailed knowledge of role of technology in medicine,biomedical signals and medical instrumentation system such as ECG, EEG, EMG, MRI, etc.

- Learn classification of signals and systems and various mathematical techniques employed to study and analyze these.
- A detailed knowledge about conversion of signals from frequency domain to time domain and vice-versa, detailed mathematical background for resolving signals in both domains.
- Will be able to implement the above practically with the help of Numerical problems solving.

Text Books

1. Electronic Measurements and Measuring techniques: A. D. Helfrick and W.D. Cooper
2. Electrical and Electronic measurements and techniques: A. K. Shawney The educational and Technical Publications, New Delhi (1985)
3. Biomedical digital signal procession: William J. Tompkins, Prentice hall of India Pvt. Ltd. (2000)
4. Electronic Signals and Systems: Paul A. Lynn, English Language Book Society Macmillan (1986)

Reference Books

1. Communication systems: Simon Haykin, Wiley eastern Ltd. New Delhi (1983)
2. Modern Communication Systems – Principles and Applications: Leon W. Couch II, Prentice Hall of India Pvt. Ltd., New Delhi (1998)
3. Discrete time Signal procession –2nd Edition, A.V. Oppenhiem, R. W. Schafer and J. R. Buck, Prentice Hall, New Jersey (1999).
4. Digital Signal Processing – A Computer Based approach: Sajith K. Mitra, Tata – McGraw Hill Publications, New Delhi (2000).
5. Principles of Electronic Instrumentation: A. J. Diefenderfer, and B.E. Hotton, Saunders college Publishing, London (1994).

PG85T 303N: Nuclear Detectors, Accelerators and Neutron Physics

Teaching hours per week: 4
No. of credits: 4

Unit I

Nuclear Detectors: Scintillation detector, different types of scintillators, photomultiplier tubes; gain and types of photomultiplier tubes, Preamplifiers; charge sensitive, voltage sensitive and current sensitive preamplifiers, Amplifiers; linear and spectroscopy amplifiers, Single channel analyzers; integral, window and normal modes, Multichannel analyzer;

various types of ADC, memory, linear gate and working, NaI(TI) gamma ray spectrometer; Calibration, photopeak, Compton edge and back scattered peak, single escape and double escape peak. Role of thickness of the crystal for detecting the radiation.

Semiconductor Detector: Relation between applied voltage and depletion layer thickness, Lithium drifted germanium detector, High purity germanium detector, Lithium drifted silicon detector, position sensitive silicon detector. Principle and working of magnetic spectrometer and Cherenkov detector.

12 Hours

Unit II

Particle Accelerators and Applications: Basic components of accelerator, types of accelerations, principles of operation.

Ion sources: Duoplasmatron ion source and electron cyclotron resonance (ECR) ion source.

Accelerators: Principle and working of electrostatic accelerators, azimuthally varying field (AVF) cyclotron and pelletron accelerator, RIB accelerator, Microtron, Super Conducting Cyclotron, synchrotron source.

Application of ion beams: Rutherford Backscattering Spectroscopy (RBS), Elastic Recoil Detection (ERD), Nuclear Reaction Analysis (NRA).

12Hours

Unit III

X – ray Fluorescence Spectroscopy: X ray Fluorescence; Energy and wavelength dispersive X – ray fluorescence spectrometers. microXRF, Total XRF and their applications

Positron Annihilation Spectroscopy: Principles, positron sources and experimental arrangements, Angular correlation of annihilation radiation (ACAR), positron annihilation life time (PALT) measurement. Applications

Perturbed angular correlation (PAC): PAC sources, experimental arrangement, magnetic dipole interaction, electric quadruple interaction, applications. 12 Hours

Unit IV

Neutron Physics: Basic properties of neutron, production of neutrons, detection of slow and fastneutrons; BF3 counter and 3He based neutron detector, scintillation detectors for fast neutrons, detection of ultra-high energy neutrons, cloud chamber as a neutron detector, the crystal monochromator, neutron diffraction (theory), powder and single crystal neutron diffraction, neutron diffraction from magnetic materials, neutron diffraction in fluids, reflection of neutrons, polarization of neutrons, small angle neutron scattering (SANS).

12 Hours

Course Outcomes:

After completing this course, the students should be able to

- Learn about theclassification, mechanisms, properties andfactors affecting performance of scintillator detectors.
- Learn about the differences between single channel analyzer and multichannel analyzer in NaI(TI) gamma ray spectrometers and to estimate calibration constant.

- Know the basics, construction, working, advantages and disadvantages of semiconductor detectorsand types and characteristics of solid-state detectors.
- Understand about the various types of nuclear accelerators and their basic components and types of accelerations and principles of operation.
- Understand the basic principles, construction and working of energy and wavelength dispersive X-rayfluorescence spectrometers.
- Learn the basics and working principles of positron annihilation spectroscopy andperturbed angular correlation for study of condensed matter.
- Learn about the neutron classification, sources of neutrons and neutron detectors, especially BF_3 counter and ^3He based neutron detector.
- Understand the theory of neutron diffraction of powder and single crystals, neutrondiffraction patterns ofsuperconductors and magnetic materials.

Text Books

1. Atomic and Nuclear Physics Volume II: S. N. Goshal, S. Chand and company (1998)
2. Nuclear Radiation Detectors: S. S. Kapoor and V. S. Ramamurthy, Wiley Eastern Limited (1986)
3. Techniques for Nuclear and Particle: W. R. Leo, Springer Verlag (1987).
4. Radiation Detection and Measurement: Glenn. F. Knoll, John Wiley and sons (1989)
5. Principles of Charged Particle Acceleration: S. Humphris, John Wiley (1986)
6. Introduction to Neutron Physics: L. F. Curtis, East west press (1958)
7. Nuclear Electronics: P.W. Nicholson, John Wiley & Sons (1974)
8. Experimental neutron scattering: B.T.M. Willis & C.J. Carlie, Oxford University Press (2009)
9. Introduction to Neutron Physics: L.F. Curtiss, East West Press (1969)

Reference Books

1. Introduction to Nuclear Physics: Herald A. Enge, Addison – Wesley (1983)
2. Physics of Nuclei and Particles Vol II: P. Marmier and E. Sheldon, Academic Press (1969)
3. Nuclei and Particles (second edition): E. Segre, Benjamin (1977)
4. Nuclear and Particle Physics: W. Burcham and M. jaobes, Addison Wesley (1998)

5. Physics of Nuclei and Particles: P. Marmier and E. Sheldon Academic press (1970)
6. Alpha, Beta and Gamma Spectroscopy: K Seighban Vol. I and II North Holland (1966)
7. Experimental Techniques in Nuclear Physics: Dorin N. Poenaru, Walter Greiner Walter de Gruyter, Berlin(1997)
8. Experimental Neutron Scattering: BTM Willis and C J Calile Oxford University Press (2009)
9. Quantitative X ray Fluorescence analysis: G. R. Lachance and F. Claisse John Wiley and sons (1995)
10. Ion Implantation Science and Technology: J. P. Ziegler, Academic Press (1988).
11. Nuclear electronics: Kowalski E., Springer Verlag, Berlin (1970)
12. Nuclear Physics Experimental and theoretical, Hans H.S., New Age International Publishers (2001)

PG85T 304O Open Elective Course – II:
A) Instrumental Methods

Teaching hours per week: 4
No. of credits: 4

Unit I

Electronic instruments for measurement – Single and dual power supply units. Digital voltmeter principles of electronic multimeter, digital multimeter, Q meter, Power meter, Electronic LCR meter, Frequency & time interval counters. Electronic instruments for signal generation & analysis – Function generators, Pulse generators, Frequency synthesizer, Principles & applications of cathode ray oscilloscope.

12 Hours

Unit II

UV/Visible Absorption Spectrometry: Concept of electronic energy levels, transitions, Beer's law and its limitations. Instrumentation: Components of Colorimeter, Single beam spectrometer, Double beam spectrophotometer; principle, construction and working, sampling technique; Applications.

Infrared Absorption Spectrometry: Concept of molecular vibrational energy levels, transitions. Instrumentation: Components of single beam and double beam spectrometers; principle, construction, working, sampling technique; Applications

12 Hours

Unit III

Fluorescence Spectrometry: Fluorescence and Phosphorescence phenomena (with energy level diagram). quantum yield, fluorescence quenching, rate parameters, radiative and natural lifetime. Fluorimeter: Basic components, principle, construction, working, sampling technique; Applications.

Nuclear Magnetic Resonance Spectrometry: Principle of resonance; the chemical shift. Components of NMR spectrometer: principle, construction, working, sampling technique; Applications.

12 Hours

Unit IV

Radioactivity and its Applications

Radioactivity: Unit of radioactivity, source strength, production and decay of radioactivity, alpha decay, beta decay, gamma decay, natural and artificial radioactivity, Geiger counter, NaI(Tl) detector.

Applications of Nuclear Physics: Trace element analysis, mass spectrometry with accelerators. Alpha decay application, diagnostic nuclear medicine, therapeutic nuclear medicine, food preservation, plant metabolism.

12 Hours

Course Outcomes:

At the end of this course, the students will be able to

- Understand the basic principles of working of Digital voltmeter, electronic multimeter, digital multimeter, power meter, electronic LCR meter and cathode ray oscilloscope.

- Learn about UV/Visible absorption spectrometry and gain knowledge of about Single/double beam spectrometer. Infrared absorption spectroscopy, sample techniques etc.
- Understand the basic principles of Fluorescence and Phosphorescence, energy level diagram, Fluorimeter construction, working its applications.
- Learn about radioactivity and its applications as well as nuclear Physics applications

Text Books

1. Cooper W. Electronic Instrumentation & Measurement Technique – Prentice Hall of India.
2. George C. Barney, Intelligent Instrumentation – Prentice Hall India
3. Instrumental Methods of Analysis : H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
4. Principles of Instrumental Analysis (5th ed) : D. A. Skoog, F. J. Holler & T. A. Nieman, Harcourt Asia Pte. Ltd. (1998)
5. Fundamentals of Molecular Spectroscopy : C. N. Banwell and E.M. McCash, Tata Mc Graw Hill Co., 4th revised edition, (9th reprint, 2000).
6. Introductory Nuclear Physics: Kenneth s Krane, John Wiley and Sons (2005).

PG85T 304O Open Elective Course – II:
B) Physics of Nanomaterials

Teaching hours per week: 4

No. of credits: 4

Unit I

Basics of nanoscience: The nanoscale, historical background, quantum confinement, size dependent properties, types of nanomaterials, fullerenes, nanowires, nanotubes, thin film.

Basic quantum mechanics: Wave particle duality, Heisenberg uncertainty principle Schrödinger equation solution of one dimensional time independent equation, particle in a one dimensional box; density of states for zero , one , two and three dimensional box; particle in a coulomb potential. Tunneling of a particle through potential barrier

12 Hours

Unit II

Synthesis of nanomaterials: Physical methods mechanical ball milling, melt mixing; evaporation ion sputtering, laser ablation, laser pyrolysis, chemical vapour deposition, molecular beam epitaxy.

Chemical methods: colloidal synthesis and capping of nanoparticles. Types of nanoparticles metals, semiconductors, graphene, carbon nano tubes etc.

12 Hours

Unit III

Characterization techniques: microscopes optical, SEM, TEM, STM, AFM; diffract tion techniques XRD, EXAFS neutron diffraction; spectroscopes UV visible IR absorption, FTIR, Photoluminescence.

12 Hours

Unit IV

Properties of nanomaterials: Mechanical; Electrical classification metals semi conductors, insulators, band structures; mobility, resistivity, Hall effect, magneto resistance; Optical absorption and transmission, photoluminescence, electro luminescence, thermoluminescence; Magnetic magnetism and types of magnetic materials dia, para, ferro, antiferro; nano magnetism.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- The course offers a good understanding on the basics of nanoscience.
- The course offers a good understanding basic quantum Mechanics.

- It also helps to synthesis and characterization of nano-materials using SEM, TEM, STEM, AFM and Diffraction techniques.
- Learn about properties of nano-materials like electrical mechanical, band structures etc.

Text books

1. Nanotechnology: Principles and practices, S. K Kulkarni, Capital Publ. Co., New Delhi (2007)
2. Nanocrystals : Synthesis, Properties and Applications, C.N.R.Rao, P. John Thomas and G.U. Kulkarni, Springer series in Materials Science 95, Springer Verlag, Berlin, Heidelburg (2007).

Reference books

1. Quantum Mechanics – Vol 1 & 2, Cohen, Tannoudji
2. The Physics and Chemistry of Solids, Stephen Elliot & S.R. Elliot
3. Solid State Physics A.J. Dekker
4. Introduction to Nanotechnology Charles P.Poole Jr and Franks J. Owens
5. Electronic Transport in macroscopic systems, Supriyo Datta
6. Nanotubes and Naowires CNR Rao and A Govindaraj, RCS Publishing.
7. From Atom to Transistor Supriyo Datta
8. Encyclopedia of Nanotechnology Hari singh Nalwa

PG85P 305A: Atomic & Molecular Physics Practical – I

Contact hours per week: 4

No. of credits: 4

1. Study of Constant Deviation Spectrograph

2. Study of Grating spectrograph
3. Study of Small Quartz Spectrograph
4. Vibrational analysis of CN violet bands
5. Study of Copper Spark Spectrum
6. Spectrochemical analysis of Mixture
7. Rotational analysis of HCl

(New Experiments / Assignments may be added)

Course Outcomes:

After completion of this course the students would

- Learn analysis of given wavelength data of atomic & molecular phenomena by applying theoretical principles learnt by them.
- Learn how to validate theoretical models by analyzing given empirical data.
- Learn advanced level of analysis by taking measurements from physical experiments.

Reference Books

1. Experimental Spectroscopy (3rd Edition): R. A. Sawyer. Dover Publication, Inc, New York (1963).
2. Atomic Spectra and Atomic Structure (2nd Edition) – G. Herzberg. Dover Publication New York (1944)
3. Atomic Spectra – H.E. White, Mc Graw –Hill, New York (1934).
4. A Course of Experiments with He-Ne Lasers (2nd Edition): R. S. Sirohi. Wiley Eastern, New Delhi (1991).
5. Lab. Manuals.
6. Molecular Spectra & Molecular Structure Vol. I: G. Herzberg, D. Van Nostrand Co, New York (1950)
7. Instrumental Methods of Analysis: H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
8. The Identification of Molecular Spectra: R.W. B. Pears & A. G. Gaydon, Wiley, New York (1961).
9. Fiber Optic Laboratory Experiments: Joel Ng.

PG85P 305C: Condensed Matter Physics Practical – I

Contact hours per week: 4
No. of credits: 4

1. Structure factor calculations
2. d spacing calculations

3. Indexing of cubic systems
4. Determination of Debye temperature by study of specific heat of metals
5. Assignment using FORTRAN programming
6. Calculation of relative integrated intensity
7. Indexing of tetragonal systems
8. Obtaining X ray pattern for a given substance using X ray diffractometer and indexing the pattern.

(New experiments/assignments may be added)

Course Outcomes:

The specific outcomes of this course are as under:

- Calculation of d-spacing, structure factor and indexing of cubic and non-cubic pattern can be understood.
- The significance of intensity of X-ray scattering and its relation to the position of atoms in a unit cell can be learnt.
- The experimental measurement of specific heat of different metals can be realized.

Reference Books

1. X ray diffraction: B.D. Cullity, Addison Wesley, New York (1972).
2. X ray diffraction procedures: H.P. Klug and L.E. Alexander, John Wiley and sons, New York.
3. Interpretation of X ray powder diffraction pattern: H.P. Lipson and H. Steeple, Macmillan, London (1968).
4. Introduction to Solid State Physics: 5th Ed. C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
5. Elementary Solid StatePhysics: M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000)
6. Introduction to magnetochemistry: A. Earnshaw, Academic press, London (1968).
7. Lab manuals.

PG85P 305E: Electronics & Communication Practical – I

Contact hours per week: 4

No. of credits: 4

1. Square, triangular and ramp generation using op amp
2. Instrumentation amplifier gain, CMRR and input impedance

3. Active notch and twin T filter realization using Op Amp
4. Precision half wave and full wave rectifier using Op amp
5. 2’s complement adder and subtractor
6. 4 – bit bidirectional shift register

(New experiments/assignments may be added)

Course Outcomes:

Upon completion of this course, the students will be able to-

- Design and learn implementing the operational amplifier IC 741 based wave form generator circuits
- Design and learn implementing op-amp 741 based instrumentation amplifier and characterize it
- Design and learn implementing op-amp based twin-T and notch filter circuits.
- Implementation of 2’s complement adder and subtractor and bidirectional shift registers

Reference Books

1. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op Amps and linear Integrated Circuits: R Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 8th edition: Thomas L Floyd, Pearson Education (2003)
5. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
6. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
7. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt.Ltd New Delhi (2000).
8. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).

PG85P 305N:Nuclear & Particle Physics Practical – I

Contact hours per week: 4

No. of credits: 4

1. Calibration of NaI(Tl) scintillation spectrometer
2. Attenuation beta particles I

3. Verification of Mosley's law
4. Positron annihilation
5. Multvibrator circuit using transistors and IC 555
6. Pulse generator using IC 4049
7. Attenuation gamma rays I
8. Calibration of X ray proportional counter spectrometer
9. Magnetic beta ray spectrometer I
10. Nuclear rotational studies
11. Regulated power supply using transistors and LM 309
12. R.C coupled amplifier

(New experiments/assignments may be added)

Course Outcomes:

After successful completion of this course, the students will be able to

- acquire practical knowledge on calibrating NaI(Tl)gamma ray spectrometer and to determine the energy of a given gamma ray source.
- Learn various modes in a multichannel analyzer and use them to calculate the energy resolution, energy of gamma ray.
- Determine the mass attenuation coefficient of beta particles from ^{204}Tl, ^{210}Pb and ^{137}Cs sources in Al foils using G.M. Counting system.
- Able to verify the Bohr's frequency condition and Moseley's law using MCA based NaI(Tl) scintillation detector.
- Understand the defects present in metals and semiconductors using positron annihilation lifetime parameters.
- Learn to construct and design the multvibrator circuit using transistors and IC 555
- Learn to construct the pulse generator circuit using IC 4049 and study its output waveforms.
- Determine the gamma ray attenuation coefficient for different absorbers using NaI(Tl) gamma ray spectrometer using 137Cs source.
- Learn the rotational energy and angular momentum of a compound nucleus.
- Learn to construct and study regulated power supply circuit using transistors &M 309
- Learn to construct and study the R.C coupled amplifier properties

Reference Books

1. Experiments in Modern Physics: A. C. Melissions, Academic Press (NY) (1966)
2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC, (1971)
3. (Available in Nuclear Physics Laboratory)
4. Practical Nucleonics: F. J. Pearson., and R. R.Osborne, E & F. N. Spon Ltd. London (1960)
5. The Atomic Nucleus: R. D. Evans, Tata Mc Graw Hill Pub. Comp. Ltd. (1960)
6. Nuclear Radiation DetePG85T 303N Nuclear Detectors, Accelerators and Neutron Physicists: S. S. Kapoor and V. S. Ramamurthy, Wiely Eastern Limited (1986)
7. Experimental Nucleonics: E. Bleuler and G. J. Goldsmith, Rinehart & Co. Inc. (NY) (1958)
8. A manual of experiments in reactor physics: Frank A. Valente, Macmillan company (1963)
9. A practical introduction to electronic circuits: Martin Harthley Jones, Cambridge University Press (1977)
10. Integrated circuit projects: R. M. Marston, Newnes Technical Books (1978)
11. Semiconductor projects: R. M. Marston, A Newnes Technical Books (1978)
12. Waveform generator projects: R. P. Marston, A Newnes Technical Books (1978)

PG85P 306A: Atomic & Molecular Physics Practical – II

Contact hours per week: 4

No. of credits: 4

1. Determination of screening constants for sodium doublets
2. Vibrational analysis of AlO bands
3. Zeeman Effect (Photographic method):

4. Vibrational Analysis of I2 absorption bands
5. Verification of Lande's interval rule
6. Verification of Beer's law using USB spectrometers
7. Optical fiber attenuation

(New Experiments / Assignments may be added)

Course Outcomes:

After successful completion of this course, the students will be able to

- To determine the screening constants for sodium doublets
- Do vibrational analysis of band spectra of diatomic.
- Be able to analyze the data of Zeeman Effect experiment by Photographic method
- Be able to verifyLande's interval rule for a given multiplet spectra.
- Be able to verify the Beer's law on a USB spectrometer and learn the optical fiber attenuation.

Reference Books

1. Experimental Spectroscopy (3rd Edition): R. A. Sawyer. Dover Publication, Inc, New York (1963).
2. Atomic Spectra and Atomic Structure (2nd Edition) – G. Herzberg. Dover Publication New York (1944)
3. Atomic Spectra – H.E. White, Mc Graw –Hill, New York (1934).
4. A Course of Experiments with He-Ne Lasers (2nd Edition) : R. S. Sirohi. Wiley Eastern, New Delhi (1991).
5. Lab. Manuals.
6. Molecular Spectra & Molecular Structure Vol. I : G. Herzberg, D. Van Nastrand Co, New York (1950)
7. Instrumental Methods of Analysis : H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
8. The Identification of Molecular Spectra: R.W. B. Pears & A. G. Gaydon, Wiley, New York (1961).
9. Fiber Optic Laboratory Experiments: Joel Ng.

PG85P 306C: Condensed Matter Physics Practical – II

Contact hours per week: 4
No. of credits: 4

1. Hall effect and Hall mobility
2. Determination of e/k_B
3. Susceptibility of paramagnetic substance by Gouy's method

4. Specific heat of metals
5. Magnetoresistance of semiconductors
6. Determination of Curie temperature of a ferromagnet.
7. Electron spin resonance
8. Resistivity by four probe method.
9. Determination of elastic constants.
10. Thermoluminescence studies of alkali halides by X ray irradiations
11. Size estimation of nanocrystals

(New experiments/assignments may be added)

Course Outcomes:

The specific outcomes of this course are as under:

- It helps to experimentally measure the ratio of fundamental constants like e and k_B.
- The magneto-resistance effect in a semiconductor can be determined.
- The ferromagnetic to paramagnetic phase transition in a metallic sample can be carried out.
- The experimental determination of electrical resistivity of semiconductor by four probe method can be understood

Reference Books

1. X ray diffraction: B.D. Cullity, Addison Wesley, New York (1972).
2. X ray diffraction procedures: H.P. Klug and L.E. Alexander, John Wiley and sons, New York.
3. Interpretation of X ray powder diffraction pattern: H.P. Lipson and H. Steeple, Macmillan, London (1968).
4. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
5. Elementary Solid State Physics : M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000)
6. Introduction to magnetochemistry: A. Earnshaw, Academic press, London (1968).
7. Lab manuals.

PG85P 306E: Electronics & Communication Practical –II

Contact hours per week: 4

No. of credits: 4

1. Crystal oscillator and frequency division circuits
2. Optical fiber experiments: Analog & digital

3. Phase locked loop ICs and characteristics
4. Dual power supply using IC regulators.
5. Staircase generator using 4-bit counters
6. Decade counter with 7-segment display

(New experiments/assignments may be added)

Course Outcomes:

Upon completion of this course, the students will be able to-

- Implement Use of crystal oscillator and frequency division circuits
- Conduct Analog and digital optical fiber experiments
- Study of staircase generator using 4-bit counters and decade counter with 7-segment display
- Study Phase locked loop ICs and characteristics

Reference Books

1. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op Amps and linear Integrated Circuits: R Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 8th edition: Thomas L Floyd, Pearson Education (2003)
5. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
6. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
7. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt.Ltd New Delhi (2000).
8. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).

PG85P 306N: Nuclear & Particle Physics Practical –II

Contact hours per week: 4

No. of credits: 4

1. Attenuation beta particles II
2. Half-life of Indium

3. Attenuation gamma rays II
4. Compton Scattering
5. Study of emitter follower circuit
6. FET amplifier
7. Magnetic beta ray spectrometer I I
8. X ray fluorescence studies
9. Rutherford scattering
10. Pulse stretcher and pulse delay using IC 74121
11. Pulser: variable width and frequency using LM 310
12. Scale of two circuit

(New experiments/assignments may be added)

Course Outcomes:

After successful completion of this course, the students will be able to

- Understand the mass attenuation coefficient of 2260 keV and 545 keV beta particles inAlfoils using ^{90}Sr - ^{90}Y source using G.M. Counting system.
- Determine the half-life of ^{116}In nucleus by observing the beta activity with time usingG.M. Counting System
- Learn the gamma ray attenuation coefficient for different absorbers using NaI(Tl) gamma ray spectrometer using ^{137}Cs source.
- Determine the end point energy of beta particles from ^{204}Tl source using Nomogram method using G. M. Counting System.
- Estimate the K x-ray fluorescence yield and K x-ray production cross section in silver target using ^{57}Co source using MCA based NaI(Tl) scintillation spectrometer.
- Design and construct linear pulse amplifier using BC 107 and AC 128 transistors and to study its performance, output pulse height is linearly proportional to input pulse height.
- Determine the rest mass energy of electron using NaI(Tl) gamma ray spectrometer using different gamma sources (^{137}Cs, ^{60}Co, ^{54}Mn).

Reference Books

1. Experiments in Modern Physics : A. C. Melissions, Academic Press (NY) (1966)
2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC, (1971)
3. (Available in Nuclear Physics Laboratory)
4. Practical Nucleonics : F. J. Pearson., and R. R.Osborne, E & F. N. Spon Ltd. London (1960)
5. The Atomic Nucleus : R. D. Evans, Tata Mc Graw Hill Pub. Comp. Ltd. (1960)
6. Nuclear Radiation Detectors : S. S. Kapoor and V. S. Ramamurthy, Wiely Eastern Limited (1986)
7. Experimental Nucleonics : E. Bleuler and G. J. Goldsmith, Rinehart & Co. Inc. (NY) (1958)
8. A manual of experiments in reactor physics : Frank A. Valente, Macmillan company (1963)
9. A practical introduction to electronic circuits : Martin Harthley Jones, Cambridge University Press (1977)
10. Integrated circuit projects : R. M. Marston, Newnes Technical Books (1978)
11. Semiconductor projects : R. M. Marston, A Newnes Technical Books (1978)
12. Waveform generator projects : R. P. Marston, A Newnes Technical Books (1978)

SEMESTER – IV

PG85T 401: Classical Electrodynamics

Teaching hours per week: 4
No. of credits: 4

Unit I

Electrostatics: Divergence and curl of electrostatic field, Gauss law in integral and differential forms, Poisson and Laplace equations, Boundary conditions and uniqueness theorem, electrostatic potential energy and energy density of a continuous charge distribution. Multipole expansion of the potential and energy of a localized charge distribution, monopole and dipole terms, electric field of a dipole, dipole-dipole interaction. Electrostatic fields in matter, polarization, macroscopic field equations, electrostatic energy in dielectric media.

12 Hours

Unit II

Magnetostatics: Current density, continuity equation, magnetic field of a steady current, the divergence and curl of B, Ampere's law, magnetic vector potential, multipole expansion of vector potential of a localized current distribution, magnetic moment. Torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits. Magnetic fields in matter, macroscopic equations, magnetostatic boundary conditions, magnetic scalar potential. Energy in the magnetic field.

12Hours

Unit III

Electrodynamics: Faraday law of induction, displacement current, Maxwell's equations. Vector and scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge. Continuity equation, Poynting's theorem, momentum, Maxwell's stress tensor, conservation of energy and momentum in electromagnetic fields.

Electromagnetic Waves: Propagation of waves in linear media, reflection and transmission at normal and oblique incidence, Electromagnetic waves in non conducting and conducting medium, skin depth, reflection at conducting surface.

Wave guides: Fields at the surface and within a conductor, modes in rectangular wave guide,TE waves in a rectangular wave guide, Co axial transmission line and cylindrical cavities.

12 Hours

Unit IV

Electromagnetic radiation: Retarded Potentials, Lenard Wiechert potentials, fields of a moving point charge.Electric dipole radiation, Magnetic dipole radiation,Power radiated by a point charge, Larmor formula, Power radiated by a point charge with collinear velocity and acceleration, Bremsstrahlung radiation, radiation from a charged particle moving in a circular orbit, cyclotron and synchrotron radiation.

Plasma Physics: Plasma behavior in magnetic field, plasma as a conducting fluid magneto hydrodynamics, magnetic confinement Pinch effect.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- Understand the basics of Electrostatics, Poisson Laplace equations, boundary conditions and electrostatic energy in dielectric media.
- Learn about Magneto statics, current density, continuity equation, magnetic moment and energy in the magnetic field.

- Understand the basics of electrodynamics, faradays laws of induction, displacement current, Maxwell's equations, conservation of energy and momentum in electromagnetic fields.
- Learn about electromagnetic waves, propagation of waves in linear media, reflection and transmission at normal and oblique incidence, skin depth and refection at conducting surface.

Text Books

1. Classical Electrodynamics: J.D.Jackson , Wiley Eastern Ltd., Bangalore (1978)
2. Introduction to Electrodynamics: D.J.Griffiths, Prentice Hall of India, Ltd., New Delhi (1995).

Reference Books

1. Electromagnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore (1987)
2. Classical Electromagnetic Radiation: J.B. Marion, Academic press, NewYork (1968).
3. Classical Electrodynamics; S P Puri, Tata McGraw Hill Publishing Company Ltd., New Delhi, (1990).

PG85T 402: Statistical and Thermal Physics

Teaching hours per week: 4

No. of credits: 4

Unit I

Classical Statistics: Basic postulates of statistical mechanics, phase spaces, Liouville equation;concept of ensembles, postulate of equal a proiri probability; microstates and macrostates; general expression for probability; canonical ensemble: most probable distribution of energies,thermodynamic relations in canonical ensemble; canonical partition function; micro canonicalensemble; grand canonical ensemble, grand partition function. Partition function for the system and for the particles, translational partition function; Gibbs paradox: Sackur-Tetrode equation;Boltzmann equipartition theorem; rotational partition function; vibrational contribution to thermodynamic quantities; electronic partition function.

12 Hours

Unit II

Quantum Statistics: Postulates of quantum statistical mechanics, ideal quantum gases, quantumstatistics in classical limit, symmetric and antisymmetric wave functions for indistinguishableparticles; Bose-Einstein and Fermi-Dirac distributions, ideal Bose and Fermi gases, their properties at high temperature and densities, weak and strong degeneracy of perfect gases, Bose-Einstein condensation, black body radiation, phonons and specific heats of solids.

12 Hours

Unit III

Fluctuations and Brownian motion: Fluctuations in canonical, grand canonical and microcanonical ensembles, number fluctuations in quantum gases. Brownian motion: Langevin equation, random walk problem. Diffusion: Einstein relation for mobility. Time dependence of fluctuations: power spectrum, spectral density; persistence and correlation of fluctuations; Wiener-Khinchin theorem, Johnson noise, Nyquist theorem; shot noise; Fokker-Planck equation.

12 Hours

Unit IV

Irreversible thermodynamics: Reversible and irreversible processes, Onsager reciprocity relations and their derivations; thermoelectric phenomena, linear response theory, Kubo relations, fluctuation dissipation theorem; Saha theory of ionization.

Liquid helium: phase diagram, superfluid properties, two fluid model, thermo-mechanical, fountain and mechano-caloric effects, quantum theory of superfluid liquid ^3He and mixture of ^3He-^4He.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- Understand the basic postulates of statistical mechanics, different types of ensembles,fundamental differences between microstates and macrostates.
- Learn about different types of partition functions for the system of particles and apply these to calculate important thermodynamical quantities.

- Learn the fundamental differences between classical and quantum statistics and learn about postulates of quantum statistical mechanics.
- Formulate the quantum statistical distribution laws, viz. Fermi-Dirac (FD) and Bose-Einstein (BE) statistics and origin of Bose-Einstein condensation and its applications.
- Understand fluctuations in ensembles and quantum gases and their analysis.
- Describe the theoretical basis of Brownian motion on the basis of Langevin approach.
- Understand the concept of randomwalk, Einstein relation for mobility and diffusion, time dependence of fluctuations, their spectral analysis and applications in noises.
- Understand the reversible and irreversible thermodynamic processes, analysis of Onsager reciprocity relationsin thermoelectric phenomena.
- Understand the Saha theory of ionization of a gas in thermal equilibrium to the temperature and pressure.
- Understand superfluid properties andquantum theoryof ^3He and mixture of ^3He-^4He.

Text Books

1. Statistical mechanics and properties of matter: Theory and applications: E.S.R. Gopal, John Wiley & Sons, New York (1974).
2. Statistical mechanics (3rded.): B.K.Agarwal and M. Eisner, New Age International (P) Ltd. Publishers, New Delhi (2013).

Reference Books

1. Fundamentals of statistical and thermal Physics: F.Reif, McGrawHill Ltd., New Delhi (1965).
2. Elementary statistical physics: C. Kittel, John Wiley & Sons, New York (1958).
3. Statistical mechanics; Theory and applications; S.K.Sinha, TMH Pub. Ltd., New Delhi(1990).
4. Statistical Thermodynamics: M.C. Gupta, New Age Publishers (2nd ed.) (2010)
5. Statistical Mechanics, R.K. Pathria& Paul D. Beale, Bufferworgh Heinemann (2nded.) (2012)
6. Fundamentals of Statistical Mechanics: B.B. Laud, New Age International (2012)

PG85T 403A Molecular Spectra & Structure of Polyatomic Molecules

Teaching hours per week: 4

No. of credits: 4

Unit I

Molecular Symmetry: Point Groups, symmetrically equivalent atoms.

Rotational Spectra: Classification of molecules as rotors: Linear, Symmetric top, Spherical top, Asymmetric top molecules. Energy levels: thermal distribution, symmetry properties and statistical weights of rotational levels, Spectrum; IR and Raman spectra.

12 Hours

Unit II

Molecular Vibrations: Separation of rotational and vibrational motions; the secular equation for small vibrations (classical treatment). Normal modes of vibration. Normal coordinates. Simple illustrations. Internal coordinates, symmetry co-ordinates, determination of number of normal co-ordinates (symmetry species). Potential energy functions and force fields.

12 Hours

Unit III

Vibrational Energy levels and Selection Rules: The Schrodinger's vibrational wave equation. Energy levels, Vibrational Spectra and Degeneracy. Symmetry properties of wave functions, overtones, combinations, components of electric dipole moment, and the polarizability. Selection Rules for Infrared and Raman Spectra. The rule of mutual exclusion. Group frequencies; the Product rule; Fermi resonance.

12 Hours

Unit IV

Electronic Structure & Spectra: Classification of Electronic States based on angular momentum, spin, multiplet components. Types of electronic transitions; Allowed transitions, general selection rules, spin selection rules. Forbidden transitions: Magnetic and electric quadrupole transitions.

12 Hours

Course Outcomes:

At the end of this course, students will learn:

- Interpretation of vibrational IR and Raman spectra of polyatomic molecules.
- Methods of determining vibrational properties of polyatomic molecules based on IR and Raman spectra.

- How to apply combined analysis of vibrational & electronic spectra for characterizing vibrational properties that may be correlated to identification of molecules, structure and other phenomena.

Text Books

1. Molecular Vibrations: E. Bright Wilson, J. C. Decius, P. C. Cross, Dover Pub., Inc., N.Y. (1955)
2. Introduction to the theory of Molecular Vibrations and Vibrational Spectroscopy: L A Woodward, Clarendon Press, Lon, (1976)
3. Vibrational Spectroscopy – Theory and Applications : D. N. Sathyanarayana, New Age International Pub., New Delhi (1996)
4. Fundamentals of Molecular Spectroscopy: C. N. Banwell, Tata Mc Graw-Hill, New Delhi (1983)
5. Molecular Spectra and Molecular Structure(Vol.III)-Electronic Spectra & Electronic Structure of Polyatomic Molecules : G. Herzberg, D. van Nostrand & Co. N. J. (1966)

Reference Books

1. Molecular Spectra and Molecular Structure(Vol.II)-Infrared & Raman Spectra of Polyatomic Molecules : G. Herzberg, D. Van Nostrand & Co. N. J. (1945)
2. Atoms &Molecules : Mitchel Weissbluth, Academic Press, N. Y. (1978)
3. Raman Spectroscopy: D. A. Long, McGraw-Hill, NY (1977).
4. Introduction to Infrared and Raman Spectroscopy: N.B. Colthup, L. H. Daly and S.E. Wiberley, Academic Press, N. Y. (1975)
5. Vibrating Molecules : P. Gans, Chapman & Hall, London (1971)
6. Vibration Spectra and Structure Vol. 4 : (Ed) J. R. Durig, Elsevier Sci. Pub. Co. N. Y. (1975).
7. Microwave Spectroscopy: C.H.Townes and Arthur Schawlow, McGraw Hill, 1955.

PG85T 403C: Semiconductor Physics & Devices

Teaching hours per week: 4
No. of credits: 4

Unit I

Semiconductors: General properties of semiconductors, Elemental and compound semiconductors, band structure of real semiconductors.

Intrinsic semiconductors: Carrier concentration, Fermi energy, extrinsic semiconductors: Binding energy of impurity, impurity levels, Population of impurity levels, carrier concentration, Fermi energy and its dependence on impurity concentration and temperature.

12 Hours

Unit II

Transport in Semiconductors: Electrical conductivity and mobility, their dependence on temperature and scattering mechanisms, energy gap determination. Diffusion, Einstein relation, diffusion equation and diffusion length.

Magnetic Field Effects: Hall effect, Hall resistance, magnetoresistance (qualitative), cyclotron resonance and effective mass determination.

Optical Properties: Interband and intraband absorption, fundamental absorption, absorption edge, exciton absorption, free carrier absorption, impurity involved absorption. Photoconductivity, luminescence.

12 Hours

Unit III

Low-dimensional semiconductor structures: Metal-oxide-semiconductor junction, Inversion layer, quantum well. Modulation doping, quantum well wire, quantum dot and superlattice. Two – dimensional electron gas, energy levels and density of states. Quantum Hall effect (qualitative)

Thin Film Physics: Preparation: Thermal evaporation spray pyrolysis and spin coating. Epitaxial growth and Chemical vapor deposition, methods. MBE, MOCVD, Thickness measurements: Electrical methods, (resistivity and capacitance measurements), Optical methods (optical absorption and interference) and vibrating quartz crystal method.

12 Hours

Unit IV

Semiconductor Devices: p-n junction in e Metal-oxide-semiconductor junction quilibrium: Space charge region, barrier potential, barrier thickness, contact field, junction capacitance and its determination, potential diagram of p-n junction.

p-n junction in non – equilibrium: generation and recombination current. Continuity equations, current voltage relation, saturation current, tunnel diode, Gunn diode, semiconductor lasers, LED and photocell.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- The course offers a good understanding on the basics of semiconductors.
- Theoretical understanding of charge transport in semiconductors can be understood.

- It also helps to clear the basic concepts on the effect of external fields on the electron transport in a crystalline state.
- It makes is clear how the working of basic devices like p-njunction, Gunn diode, laser diode etc. can be understood.
- Finally, the course gives an idea on the importance of low dimensionalsemiconductors, their synthesis and the formation of electronic devices.

Text Books

1. Solid State and Semiconductor Physics: J. P. McKelvey, Harper and Row, New York (1966)
2. Solid State Physics: N. W. Aschroft and A. S. Mermin, Saunders College Publishing, New York (1976).
3. The Physics of Low Dimensional Semiconductors: J. H. Davies. Cambridge University press, (1998).
4. Elementary Solid State Physics: M.A. Omar, Addison – Wesley Pvt.Ltd., New Delhi (1993).
5. Thin Film Phenomena: K. L. Chopra. Mc Graw – Hill Book Company, New York (1969).

Reference Books

1. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)
2. Physics of Thin Films: L. Eckertova, Cambridge University Press, Cambridge (1998).

PG85T 403E:Microprocessor & Microcontroller

Teaching hours per week: 4

No. of credits: 4

Unit I

Microprocessor Architecture: Introduction, microprocessor and its operations, architecture of 8085 microprocessor, memory, input and output devices, basic interfacing concepts, memory interfacing, interfacing input and output devices.

12 Hours

Unit II

Programming of 8085: Introduction, instruction classification, instruction format, over view of instruction set of 8085, data transfer operations, arithmetic operations, logic operations, branch operation; Instructions for Looping, counting, and indexing, additional data transfer instructions, 16-bit arithmetic operation, logic operations: rotate, compare; stack, subroutine, conditional call and return instructions.

12 Hours

Unit III

Interfacing peripherals and applications: The 8085 interrupt, multiple interrupts and priorities, additional 8085 interrupts: TRAP, RST 7.5, 6.5 and 5.5, triggering levels, additional I/O concepts, DMA; Interfacing A/D and D/A converters, handshaking and polling, the 8155 multipurpose programmable interfacing devices; interfacing 7-segment display, the 8259 timer as square wave generator.

12 Hours

Unit IV

Microcontroller: 8051 architecture: 8051 microcontroller hardware-I/O pins, ports and circuits-External memory-Counter and Timers-Serial data I/O Interrupts. 8051 programming: instruction syntax-moving data-logical operations-arithmetic operations-branching instructions.

12 Hours

Course Outcomes:

At the end of this course, the students will be able to-

- Understand the architecture of 8085 microprocessor which completes the basic foundation necessary to understand how CPU works and communicates with RAM, ROM and external devices.
- Get information about execution of each command written in language form. This includes knowledge of arithmetic operations, looping, stacking, etc.
- Understand Interfacing peripherals of 8085 microprocessor with 7-segment display, analog to digital system vice-versa, additional input/output devices etc., incorporated to account the applications.
- Gain knowledge about 8051 microcontroller architecture to programming, the complete idea of execution of commands, instructions to interfacing with external input/output devices.
- Will be able to implement the above practically with the help of Numerical problems solving.

Text Books

1. Microprocessor Architecture, Programming, and Applications with 8085/8080 A: Ramesh S. Gaonkar, New Age International Publishers Ltd.
2. The 8051 Microcontroller, Architecture, Programming and Applications, Kenneth J Ayala, International Thompson Publishing.

References Books

1. Microcomputer theory and Applications: Rafiquzzaman Mohamed, John Wiley and Sons, New York (1987)
2. Introduction to Microprocessors (3rd Edition): Aditya P. Mathur, Tata – Mc Graw – Hall Publishing Company Ltd., New Delhi (1989)
3. The 8051 Microcontroller and Embedded systems: M.A. Mazidi, J.G. Mazidi, Pearson, Prentice Hall (2005)

PG85T 403N Nuclear Models, Nuclear Reactions and Weak Interactions

Teaching hours per week: 4

No. of credits: 4

Unit I

Nuclear Models

Shell model: evidences for nuclear shell structure-energy levels according to the infinite square well potential and harmonic oscillator potential, effect of spin orbit interaction, prediction of ground state spin – parity of odd A nuclei and odd-odd nuclei,Nordhiem's rules,
Collective Model: Evidences for collective motion, vibrational energy levels of even nuclei. Rotational energy levels of deformed even-even nucleus, moment of inertia-rigid body value, back bending, spectrum of odd A nuclei,
Nilsson model: Calculation of energy levels and prediction of ground state.

12 Hours

Unit II

Nuclear Reaction I: Comparison of features of compound nucleus model and direct reaction model. Partial wave analysis of nuclear reactions, expressions for scattering and reaction cross sections and their interpretation – shadow scattering – resonance theory of scattering and absorption – overlapping and isolated resonance – Briet –Wigner formula for scattering and reaction shape of cross section curve near a resonance. Inverse nuclear reactions – principle of detailed balance–optical model–mean free path – optical potential and its parameters for elastic scattering.

12 Hours

Unit III

Nuclear Reaction II: Transfer reactions – semi-classical description – plane wave Born approximation (PWBA) – its predictions of angular distributions – distorted wave Born approximation (DWBA)- spectroscopic factors – transfer reactions and the shell model.
Heavy ion reactions: Importance of heavy ion reactions, Elastic scattering; critical angle, deflection function, Rainbow scattering and diffraction. Nuclear and Coulomb scattering and its experimental results, compound nucleus formation, formation of nuclear molecule, fusion of heavy ions and formation of super heavy nuclei in heavy ion reactions.

12 Hours

Unit IV

Particle Physics: Weak interactions Weak decays, neutral Kaons, the K^o- K^o systems, regeneration of short lived component of neutral kaons, lifetimes and cross sections, Feynman diagrams, leptonic, semi leptonic and non-leptonic processes, verification of electromagnetic and weak interactions intermediate vector bosons, quark flavour changing interactions with examples, muon decay – Fermi's four particle coupling and modern perspective with a mediating vector boson, W and Z bosons; their masses and range of weak interactions. Charged weak interactions of quarks: Cabibbo factor, GIM mechanism (Glashow Iliopoulos Miani mechanism) Neutral kaons: CP as a symmetry, CP violation in neutral kaon decay (Fitch Cronin experiment), CPT theorem (qualitative), evolution of a neutral kaon beam with time, regeneration experiments. 12 Hours

Course Outcomes:

After completion of this course, a student should be able to

- Learn the evidences for nuclear shell structure and understand the energy levels according to the infinite square well potential and harmonic oscillator potential.
- get knowledge about the collective nuclear model, vibrational energy levels of even nuclei and rotational energy levels of deformed even-even nucleus.
- know the concept of cross section and apply it to resonance theory of scattering and absorption and learn the Briet –Wigner formula for scattering and reaction.
- understand the principle of detailed balance–optical model–mean free path – optical potential and itsparameters for elastic scattering.
- understand the plane wave Bornapproximation (PWBA) and its predictions of angular distributions, distorted wave Bornapproximation (DWBA) and spectroscopic factors.
- learn the importance of heavy ion reactions, formation compound nucleus,fusion of heavy ions and formation of super heavy nuclei in heavy ion reactions.
- understand the Feynman diagrams, leptonic, semi leptonic and non-leptonic processes, verification of electromagnetic and weak interactions.
- learn about the intermediate vector bosons: W and Z bosons, their masses and range of weak interactions, charged weak interactions of quarks: Cabibbofactor, CPTtheorem

Text Books

1. Nuclear Physics : Theory and Experiment : R.R.Roy and B. P. Nigam, Wiley Eastern Publications (1986)
2. Atomic and Nuclear Physics volume II : S. N. Goshal, S. Chand and company (1998)
3. Introductory Nuclear Physics : K. S. Krane, Wiley and sons (1988)
4. Nuclear Reaction with heavy Ions : Reiner Bass, Springer – Verlag (1980)
5. Heavy Ion Reaction : R. A. Broglia and Aage Winter, Addison Wesley (1991)
6. Nuclear reaction : R. Sing and S. N. Mukherjee, New Age International (1996)
7. Nuclear Physics Experimental& Theoretical: H.S. Hans, New Age International, (2001)

Reference Books

1. Subatomic Physics: Nuclei and Particles (Volume II): Luc Valentin North Holland (1981)

2. Subatomic Physics (Second Edition): Hans Frauenfelder and E. M. Henley, Prentice Hall (1991)
3. Introduction to Nuclear Physics: Herald. A. Enge Addison-Wesley (1983)
4. Introduction to Nuclear Physics: Samuel S. M. Wong Prentice – Hall (1996)
5. Atomic Nucleus: R. D. Evans, Tata McGraw-Hill (1982)
6. Theoretical Nuclear Physics Volume I : Nuclear structure : Amos de Shalit and Herman Feshbach, John Wiley (1974)
7. Nuclear and Particle Physics: W. Burcham and M. Jobes, Addison – Wesley (1998).
8. Introduction to Elementary Particles, D. Griffiths: John Wiley, 1987.
9. Quarks and Leptons, F. Halzen&A.D. Martin, John Wiley & Sons, New York, 1984.
10. Unitary Symmetry and Elementary Particles, D. B. Lichtenberg:2nd Ed, Academic Press, 1978.
11. Elementary Particles, J. M. Longo:II edition, Mc Graw-Hill, New York, 1973.
12. Particles and Nuclei: Povh, Rith, Scholz, Zetsche, Springer (1999)
13. Subatomic Physics: Hans Frauenfelder and Ernest M. Henley, Prentice Hall (1991)
14. Introduction to High Energy Physics: Donald H. Perkins, Addison Wesley Publishing, (1987)

PG85T 404A Lasers, Nonlinear Optical Effects and Laser Spectroscopy

Teaching hours per week: 4

No. of credits: 4

Unit I

Laser Amplifiers: Requirements for population inversions for Two, Three and Four level systems:necessary and sufficient conditions for laser action, threshold requirements for laser action with and without cavity, rate equations. Pumping requirements and techniques.

Laser Resonators: Longitudinal and transverse modes: Fabry Perot resonator, its cavity modes.Properties of modes: spatial dependence, frequency dependence and mode competition. Spherical, Plane parallel, confocal resonator and unstable resonators. Stability criteria, properties of Gaussian beams. Q switching and mode locking: general techniques and examples.

12 Hours

Unit II

Lasers with low density gain media: General description, laser structure, excitation mechanism and applications of Copper vapor laser, Helium-Cadmium laser, Argon and Krypton ion lasers. Nitrogen laser, Carbon-dioxide laser, Excimer laser, X-ray laser, and Free Electron laser.

12 Hours

Unit III

Lasers with high density gain media: General description, laser structure, excitation mechanism and applications of Dye lasers, Neodymium YAG and Glass lasers, Alexandrite laser, Titanium sapphire laser, Fiber lasers and semiconductor diode lasers (homo and hetero junction and quantum well lasers)

12 Hours

Unit IV

Nonlinear Optical Effects: Wave propagation in an anisotropic crystal, Second harmonic generation, Phase matching, Parametric oscillation, Self focusing light.

High Resolution Spectroscopy: Idea of hole burning, the Lamb dip, Inverse Lamb dip, stabilization of frequency. Doppler free and Doppler limited Spectroscopy. Two photon spectroscopy.

Laser Raman Spectroscopy: Hyper Raman spectroscopy, Stimulated Raman effect, Inverse Raman effect, CARS (Coherent Anti Stokes Raman Spectroscopy).

12 Hours

Course Outcomes:

At the end of the course, students will learn:

- Principles, working and scientific and practical applications of different laser types.

- How design parameters will produce lasers.
- How intense lasers can be used to produce nonlinear optical effects & their exploitation in the working of lasers.
- How high-resolution spectroscopy is achievable based on principles of nonlinear effects, lasers and physical optics.
- How nonlinear Raman effects can be produced by intense laser as radiation sources combined with physical optics. In addition, wide ranging applications in spectroscopy and other fields.

Text Books

1. Laser and Non Linear Optics: B.B.Laud, Wiley Eastern Ltd., New Delhi(1991)
2. Laser Electronics: Joseph T. Verdeyen, Prentice Hall of India Pvt Ltd. New Delhi.
3. Introduction to Fiber Optics: A. Ghatak& K. Thagarajan, Cambridge Univ. Press (1999)
4. Lasers: Theory of Applications: A. Ghatak& K. Thagarajan, MacMillan India (1981)
5. Modern Spectroscopy (4th ed), J.Michael Hollas, John Wiley, 2004.
6. Optical Fiber & Communication Principles & Practice: John M. Senior, Prentice Hill Intl. Ltd. London (1992)
7. Laser Fundamentals: W. Silfvast, Cambridge Univ. Press.

Reference Books

1. Principles of Lasers: O. Svelto, Plenum Press, N.Y(1982)
2. Introduction to Gas Lasers Population Inversion Mechanisms: C.S.Willet, Permon Press, Oxford (1974)
3. High Resolution Spectroscopy: K. Shimoda, Springer Verlag, Berlin (1976)
4. Raman Spectroscopy: D.A. Long, McGraw Hill Intl. Book Co (1977)
5. Laser Principles & Applications: J. Wilson & J.F.B. Hawkes, Prentice Hall Intl. Inc.(1983)
6. Encyclopedia of Lasers & Optical Technology: Robert A. Meyers, Academic Press, Cal.(1991)
7. Laser Spectroscopy: H. Walther, Springer Verlag, Berlin (1976)

PG85T 404C Superconductivity and Advanced Materials

Teaching hours per week: 4

No. of credits: 4

Unit I

Superconductivity: Occurrence of superconductivity, destruction of superconductivity by magnetic field, heat capacity and energy gap, microwave and infrared properties, type I and type II superconductors, high Tc superconductors (qualitative ideas only).Thermodynamics of superconductivity, London equations, coherence length, flux quantization in superconducting ring, duration of persistent current.

12 Hours

Unit II

BCS Theory: Attraction between Cooper – pairs, accomplishments of BCS theory.

Tunneling: Basic concepts of tunneling, metal-insulator tunneling, metal-insulator-superconductor tunneling, superconductor-insulator-superconductor tunneling, Cooper-pair tunneling, A. C. and D. C. Josephson effect, macroscopic quantum interference.

12 Hours

Unit III

Amorphous Semiconductors: Preparation of amorphous semiconductors, classification, band structure, electronic conduction, optical absorption, electrical switching (Ovonic diode).

Polymers: Basic concepts, classification of polymers, effect of temperature, mechanical properties of general polymers. Conducting polymers, classes, synthesis, charge transport mechanism.

Liquid crystals: Classification, orientational order and inter-molecular forces, magnetic effects, optical properties and general applications.

12 Hours

Unit IV

Nanostructured materials: Introduction, electronic and optical properties: quantum confinement effect. Synthesis of nanoparticles: gas phase and colloidal synthesis. Carbon based nanomaterials: qualitative ideas of carbon nanotubes and graphene. Magnetic nanostructures. Applications of nanomaterials.

Characterization techniques: X-ray diffraction, optical spectroscope, scanning electron and transmission electron microscopies. The basic concepts of scanning tunneling and atomic force microscopies.

12 Hours

Course Outcomes:

The specific outcomes of this course are as under:

- The experimental discovery and various experimental properties of superconductors can be understood.
- The concept and predictions of fundamental BCS theory of superconductivity can be studied.
- The concepts, classification, and important properties of new materials like amorphous semiconductors, polymers and liquid crystals can be explored.
- Nanoscience is emerging branch of Physics, its concepts, importance, characterizations are studied and selected applications will be explored.

Text Books

1. Introduction to Solid State Physics: C. Kittel, Editions: 2,5,6,7, Wiley Eastern Ltd., Bangalore.
2. Elementary Solid State Physics: M.A. Omar Addison-Wesley Pvt. Ltd., New Delhi, (2000).
3. Amorphous Semiconductors: D. Adler, CRC, London, (1972).
4. Introduction to Nanotechnology: C.P. Poole Jr. and F.J. Owens, John Wiley and Sons, Singapore (2006).
5. Nano: The Essentials: T. Pradeep, Tata McGraw-Hill Publishing New Delhi (2007).

Reference Books

1. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
2. Solid State Physics: F. W. Aschroft and N. D. Mermin, Saunders College Publishing, New York, (1976).
3. Electronic processes in Non-Crystalline Materials : N. F. Mott and E. A. Davis, Clarendon press, Oxford, (1979).
4. Nanoscale Materials – (Ed) L.M. Liz-Marzan and P.V.Kamat, (Kluwer, 2003)
5. Nanostructured Materials and Nanotechnology, (Ed) H.S.Nalwa, (Academic,2002)
6. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009)
7. Solid State Physics, J.D. Patterson and B.C. Bailey, Springer Verlag, Berlin (2007)

PG85T 404E Analog and Digital Modulation

Teaching hours per week: 4

No. of credits: 4

Unit I

Amplitude Modulation: Amplitude Modulation, Theory, Frequency spectrum of the AM wave,Representation of AM, Power relations in the AM wave, Generation of AM, Basic requirements,Modulated transistor amplifiers, Single Sideband Techniques, Evolution and Description of SSB,Suppression of Carrier, Effect of nonlinear resistance on added signals, balanced modulator,Suppression of unwanted Sideband, filter system, phase shift method, The "third" method, System evaluation and comparison, Vestigial sideband transmission, AM transmitter and receiver, TRF and super heterodyne receivers, SNR in DSBSC and SSBSC systems.

12 Hours

Unit II

Frequency Modulation: Theory of Frequency and Phase Modulation, Description of Systems,Mathematical Representation of FM, Frequency Spectrum of FM Wave, Phase Modulation, Intersystem Comparisons, Noise and Frequency Modulation, Effects of Noise on Carrier NoiseTriangle, Pre emphasis and De emphasis, Comparison of Wideband and Narrowband FM, Stereophonic FM Multiplex System, Generation of Frequency Modulation, Direct Methods, Stabilized Reactance Modulator AFC, Indirect Method, Basic FM demodulators

12 Hours

Unit III

Analog Pulse Modulation: Sampling theorem for band pass signals, Pulse Amplitude modulation: generation and demodulation, PAM/TDM system, PPM generation and demodulation, PWM, Spectra of Pulse modulated signals, SNR calculations for pulse modulation systems. Waveform coding: quantization, PCM, DPCM, Delta modulation, Adaptive delta modulation Design of typical systems and performance analysis.

12 Hours

Unit IV

Pulse Shaping, Nyquist criterion for zero ISI, Signaling with duobinary pulses, Eye diagram, Equalizer, Scrambling and descrambling. Signal space concepts: geometric structure of the signal space, L2 space, distance, norm and inner product, orthogonality Base band pulse data transmission: Matched filter receiver, Inter symbol interference, Gram Schmidt Orthogonalization Procedure.Digital modulation schemes: Coherent Binary Schemes: ASK, FSK, PSK, MSK. Coherent MarySchemes, Calculation of average probability of error for different modulation schemes.

12 ours

Course Outcomes:

Upon completion of this course, the students will be able to-

- Get a complete knowledge of use of modulation in electronic communication, amplitude modulation, the instrumentation and techniques of amplitude modulation, transmitters and receivers used in amplitude modulation and their functioning.
- Understand theory of frequency modulation, FM instrumentation, its advantages over AM, experimental techniques of FM, etc.
- Learn the basics of pulse modulation, types of pulse modulation, pulse amplitude modulation, pulse position modulation, pulse width modulation and other methods that form basis of Digital Communication.
- Deal with communication techniques which lie in the base band region with explanation of inter symbol interference, pulse data transmission, scrambling and descrambling, pulse shaping, etc.
- Will be able to implement the above practically with the help of Numerical problems solving.

Text Books

1. Electronic communications, 4th edition: Dennis Roddy and John Coolen, Prentice – Hall of India Pvt. Ltd. New Delhi (1997)
2. Modern Communication Systems – principles and applications: Leon W. Couch II, Prentice Hall of India Pvt. Ltd. New Delhi (1998).
3. Electronic Communication systems – 4th edition: George Kennedy and Bernard Davis, Tata McGraw – Hill Publishing Company Ltd., New Delhi (1999).
4. Communication Systems, 3rd ed., Simon Haykin, John Wiley & Sons.
5. Modern Digital and Analog Communication, 3rd Ed., B.P. Lathi, Oxford University Press.

Reference Books

1. Communication Systems: Simon Haykin, Wiley Eastern Ltd., New Delhi (1978).
2. Radio Engineering: G. K. Mittal, Khanna Publishers, Delhi (1998).

PG85T 404N Nuclear Reactors and Nuclear Decays

Teaching hours per week: 4

No. of credits: 4

Unit I

Nuclear Fission: Bohr-Wheeler theory of nuclear fission, saddle point, scission point, barrier penetration, shell correction to the liquid drop model, Strutinsky's smoothing procedure, evidence for the existence of second well in fission isomers. Nuclear fission with heavy ions. Nuclear fission-fission time scale.

Nuclear Fusion: Basic fusion processes, characteristics of fusion, fusion in stars. Controlled thermonuclear reactions. magnetic pressure, pinch effect, magnetic confinement systems for controlled thermonuclear fusion.

12 Hours

Unit II

Slowing down of Neutrons: Slowing down of neutrons by elastic collisions, – logarithmic decrement in energy, number of collisions for thermalization, slowing down power, moderating ratio.

Neutron diffusion: Elementary theory of diffusion of neutrons, spatial distributions of neutron flux (I) in an infinite slab with a plane source at one end (II) in an infinite medium with point source at the center – reflections of neutrons – albedo.

Reactor Theory: Slowing down density – Fermi age equation correction for absorption – resonance escape probability – the pile equations – buckling-critical size for spherical and rectangular piles – condition for chain reaction – the four factor formula – Classification of reactors – thermal neutron and fast breeder reactors.

12 Hours

Unit III

Beta decay: Classification of beta transition on the basis of ft values, selection rules and shapes of beta spectra. Universal fermi interaction. The neutrino in beta decay-inverse beta decay processes- detection of neutrino; Cowan and Reins experiment, determination of neutrino mass, different types of neutrinos, Symmetry breaking in beta decay- parity operation: relevance of pseudoscalar quantities. The Wu-Ambler experiment and fall of parity conservation. Discovery of W and Z bosons. Double beta decay, beta delayed nucleon emission. Elementary theory of K-electron capture.

12 Hours

Unit IV

Gamma decay: Qualitative discussion of multiple radiation, selection rules, determination of gamma decay transition probability for single particle transition in nuclei-Weisskopf's estimates, comparison with experimental values. Elementary theory of internal conversion and discussion of experimental results. Lifetime measurements, the angular correlation for dipole-dipole transitions, gamma-gamma correlation studies. Polarization of gamma radiation.

12 Hours

Course Outcomes:

Upon completion of this course, a student should be able to

- Learn the theory of nuclear fission,evidence for the existence of second well in fission isomers, nuclear fission withheavy ions and nuclear fission-fission time scale.
- Understand the basic nuclear fusion processes,controlledthermonuclear reactionsand magnetic confinement systems for controlled thermonuclear fusion.
- Learn the slowing down of neutrons by elastic collisions,logarithmicdecrement in energy, thermalization, slowing down power and moderating ratio.
- Understand the theory of diffusion of neutrons, spatial distributions of neutron flux in different mediums, reflections of neutrons – albedo.
- Learn about Fermi age equation, correction for absorption, resonance escape probability, pile equations, buckling: critical size for spherical andrectangular piles.
- Know the classification of beta transition on the basis of ft values and learn the selection rules, detection of neutrino and its properties.
- learn the symmetry breaking in beta decay, the relevance of pseudoscalar quantities,Wu-Ambler experiment, fall of parityconservation and discovery of W and Z bosons
- understand the gamma decay transition probability for single particle transition in nuclei-Weisskopf's estimates:comparison with experimental values.
- Learn the lifetime measurements and understand the angular correlation for dipole-dipole transitions, gamma-gamma correlation and polarization of gammaradiation.

Text Books

1. Structure of the Nucleus: M. A. Preston and R.K. BhaduriAddision – Wesley (1975).
2. Nuclear Physics Vol. II: S. N. Goshal. S. Chand and Company (2013).
3. Introductory Nuclear Physics : Kenneth S. Krane, John Wiley and sons (1998)
4. Subatomic Physics: Nuclei and Particles (Volume – II): Luc Valentin North Holland (1981).
5. Introduction to Neutron Physics: L. F. Curtis, East west press (1958).
6. Nuclear Reactor Engineering: Glasstone S and Sesonske A, CBS, Delhi, (1994)

Reference Books

1. Theoretical Nuclear Physics: J. M. Blatt and V. F. Weisskoff, Wiley (1992).
2. Subatomic Physics (Second Edition) : Hans Frauenfelder and E.M.Henley, Prentice Hall (1991)
3. Introduction to Nuclear Physics: Herald. A. Enge, Addison-Wesley (1983).
4. Introductory Nuclear Physics: Samuel S. M. Wong, Prentice – Hall (1996).
5. Reactor Physics: Zweifel P F, International student Edn. (McGraw Hill, 1973)

PG85P 405A: Atomic & Molecular Physics Practical – III

Contact hours per week: 4

No. of credits: 4

1. Rotational analysis of (0, 0) band of BeO:
2. Study of Spatial and Temporal Coherence of He-Ne Laser:
3. Determination of refractive index of the material using He-Ne Laser
4. Study of Absorption spectra on a Single Beam Spectrophotometer
5. Fiber Optic Sensors
6. Vibrational analysis of emission bands of N2.
7. Rotational spectral analysis of N2
8. Measurements of Emission spectra on USB Spectrometer
9. Vibrational Analysis of Emission band spectrum of C2

(New Experiments / Assignments may be added)

Course Outcomes:

Upon completion of this course, a student should be able to

- Learn analysis of given atomic and molecular wavelength data by applying theoretical principles learnt by them.
- Learn how to analyze given empirical data so as to validate theoretical models.
- Learn advanced level of principles of instrumental methods and taking spectral measurements on a given spectrometer system, organize and analyze data.

Reference Books

1. Experimental Spectroscopy (3rd Edition) : R. A. Sawyer. Dover Publication, Inc, New York (1963).
2. Atomic Spectra and Atomic Structure (2nd Edition) – G. Herzberg. Dover Publication New York (1944)
3. Atomic Spectra – H.E. White, Mc Graw –Hill, New York (1934).
4. A Course of Experiments with He-Ne Lasers (2nd Edition): R. S. Sirohi. Wiley Eastern, New Delhi (1991).
5. Principles of Lasers: Svelto. O, Plenum Press New York (1982).
6. Lab. Manuals.
7. Molecular Spectra & Molecular Structure Vol. I: G. Herzberg, D. Van Nostrand Co, New York (1950)
8. Instrumental Methods of Analysis: H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
9. The Identification of Molecular Spectra: R.W. B. Pears & A. G. Gaydon, Wiley, New York (1961).
10. Fiber Optic Laboratory Experiments: Joel N.G

PG85P 405C: Condensed Matter Physics Practical – III

Contact hours per week: 4

No. of credits: 4

1. Indexing of hexagonal systems.
2. Precise parameter determination:
    a. Extrapolation method.
    b. Cohen's method
3. Structure determination of CdTe.
4. Universal curves for ferromagnets
5. Determination of skin depth
6. Phase transition in ferroelectric crystals
7. Temperature dependence of susceptibity of a paramagnetic substance
8. Characteristics of a solar cell
9. Defect formation energy in metals
10. Diamagnetic susceptibility of water molecule.
11. Fermi energy of copper
12. Dielectric constant of non polar liquids (benzene)
13. Dipole moment of organic molecule (acetone)
14. BH curve using integrator

(New experiments/assignments may be added)

Course Outcomes:

The specific outcomes of this course are as under:

- Indexing of tetragonal and hexagonal patterns can experimentally realize.
- Precise lattice parameters on the experimentally recorded X-ray patterns can be studied.
- Characterization of solar cell, magnetic materials and skin depth in metals can be carried out.
- Many other experiments to measure the basic properties of dielectrics and ferroelectrics can be carried out under this course.

Reference Books

1. X ray diffraction: B.D. Cullity, Addison Wesley, New York (1972).
2. X ray diffraction procedures: H.P. Klug and L.E. Alexander, John Wiley & Sons, New York.
3. Interpretation of X ray powder diffraction pattern: H.P. Lipson and H. Steeple, Macmillan, London (1968).
4. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
5. Elementary Solid State Physics : M. A. Omar, Addison Wesley Pvt. Ltd., New Delhi (2000)
6. Introduction to magnetochemistry: A. Earnshaw, Academic press, London (1968).
7. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
8. Solid State Physics : N. W. Aschroft and A. D. Mermin, Saunders College Publishing New York (1976)

PG85P 405E: Electronics & Communication Practical – III

Contact hours per week: 4

No. of credits: 4

(8085 Interfacing)

1. Stepper motor interface
2. ADC and DAC circuit interfacing

(8085 programming)

1. Mathematical operations, block transfer and sorting of 8-bit data
2. Mathematical operations with 16-bit data
3. Code conversion methods
4. 8085 Interrupts and subroutines

(New experiments /Assignments may be added)

Upon completion of this course, the students will be able to-

- Implement 8085 microprocessor interfacing – stepper motor interface
- Cary out ADC and DAC circuit interfacing
- Implement 8085 Programming – mathematical operations, block transfer and sorting of 8-bit and 16-bit data
- Understand the use of code conversion methods
- Study 8085 interrupts and subroutines

References Books

1. Microprocessor Architecture, Programming, and Applications with 8085/8080 A: Ramesh S. Gaonkar, New Age International Publishers Ltd.
2. Microcomputer theory and Applications: Rafiquzzaman Mohamed, John Wiley and Sons, New York (1987)
3. Introduction to Microprocessors (3rd Edition): Aditya P. Mathur, Tata – Mc Graw – Hall Publishing Company Ltd., New Delhi (1989)
4. Modern Digital and Analog Communication, 3rd Ed., B.P. Lathi, Oxford University Press.

PG85P 405N: Nuclear & Particle Physics Practical – III

Contact hours per week: 4

No. of credits: 4

1. Z dependence of external bremsstrahlung
2. Anthracene crystal beta ray spectrometer
3. Electron capture transition energy using internal bremsstrahlung
4. Coincidence circuit
5. Si(Li) beta ray spectrometer
6. Digital to analog converter circuits
7. Half life of 40K
8. Gamma gamma angular correlation
9. Nuclear reaction analysis
10. Schmidt trigger circuit using transistors and IC 555
11. Charge sensitive pre amplifier using LF 357
12. Function generator using IC 741

(New experiments/assignments may be added)

Course Outcomes:

The specific outcomes of this course are as under:

- Understand the Z^2 dependence of external bremsstrahlung radiations using NaI(Tl)gamma ray spectrometer using ^{90}Sr – ^{90}Y beta source.
- Design and construct the double coincidence circuit using transistors, study its output wave form and determine its resolving time.
- Understand the energy spectrum of beta particles using ^{204}Tl source and determine the end point energy of beta particles from ^{204}Tl using Si(Li) detector spectrometer.
- Determine the K shell internal conversion coefficient αK of ^{137}Ba using NaI(Tl) gamma ray spectrometer.
- Determine the half-life of ^{40}K using GM counting system and to analyze the results.
- Determine the range of 1.150 MeV beta particles from ^{210}Pb by Feather's method using G.M. counting system with unknown source ^{204}Tl.
- Determine the effective atomic number of brass by measuring gamma ray attenuation coefficient using NaI(Tl) gamma ray spectrometer.

Reference Books

1. Experiments in Modern Physics: A.C. Melissions, Academic Press (NY) (1966).

2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC, (1971) (Available in Nuclear Physics Laboratory).
3. Practical Nucleonics: F. J. Pearson., R. R. Osborne, E & F. N. Spon Ltd., London (1960).
4. The Atomic Nucleus: R. D. Evans, tata Mc Graw Hill Pub. Comp. Ltd. (1960).
5. Nuclear Radiation Detectors: R. D. Kapoor V.S.Ramamurthy, Wiley Eastern Ltd (1986).
6. Experimental Nucleonics: E. Bleuler, G. J. Goldsmith, Rinehart & Co. Inc. (NY)(1958)
7. A manual of experiments in reactor physics: Frank A. Valente the Macmillan company(1963).
8. A practical introduction to electronic circuits: Martin Harthley Jones Cambridge University Press (1977).
9. Integrated Circuit Projects: R. M. Marston Newnes Technical Books (1978).
10. Semiconductor Projects: R. M. Marston A Newnes Technical Books (1978).
11. Linear Integrated Circuits: D. Roy Choudhary and Shail Jain, New Age International (1995).
12. Op-Amps and Linear Integrated Circuits: Ramakanth A Gayakawad, Prentice-Hall of India (1995).

PG85PJ 406: Project

Contact hours per week: 6
No. of credits: 6

PG85PJ 406A: Project in Atomic & Molecular Physics

Topic(s) for the project may be selected in consultation with the project supervisor.

Reference/Text books to be recommended by the Course Teacher

Course Outcomes:

The specific outcomes of this course are as under:

- The students directly acquire experiential learning by handling physical devices, instruments, etc., while setting up an experiment or by reading in-depth assigned subject for theoretical analysis.
- The students learn how to select a problem for the project study by reading monographs, scientific papers and review articles.
- The students learn the scientific methodology in carrying out project work including planning and execution of the experiment, taking measurements, analyzing data and organizing all the results into a systematic project dissertation.
- The students learn the importance of team work, mutual participation and nurture their motivation either toward theoretical or experimental work.

PG85PJ 406C: Project in Condensed Matter Physics

Topic(s) for the project may be selected in consultation with the project supervisor.

Reference/Text books to be recommended by the Course Teacher

Course Outcomes:

The specific outcomes of this course are as under:

- Project helps students to search the research problem.
- It also helps to carry out the systematic research work on individual topics with the help of research mentor.
- Students also leans how present, prepare and if possible, to publish their findings in the projects work.

PG85PJ 406E: Project in Electronics & Communications

Topic(s) for the project may be selected in consultation with the project supervisor.

Reference/Text books to be recommended by the Course Teacher

Course Outcomes:

Upon completion of this course, the students will be able to implement a Project in analog/digital electronics under guidance of a supervisor

PG85PJ 406N: Project in Nuclear and Particle Physics

Topic(s) for the project may be selected in consultation with the project supervisor.

Reference/Text books to be recommended by the Course Teacher

Course Outcomes:

The specific outcomes of this course are as under:

- Demonstrate knowledge and understanding of the scientific principles, gain experience in researchable to design the nuclear physics research project.
- Understand need of literature review to decide the research problem andunderstand the synthesis methods and characterization techniquesfordifferent applications.
- Understand and get familiar with operation of various instruments and softwarefor characterizations, datacollection and analysis of results using computer programs.
- Understand how to analyze, interpret the experimental data, make conclusions based on the results and able to write a research article and scientific research project.
- They will understand the researchmethodology and will help them in their futureresearch career.