ADAMAS
UNIVERSITY
KOLKATA
PURSUE EXCELLENCE

# School of Science
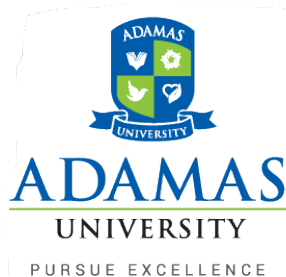
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Programme

# HANDBOOK

Department of

# PHYSICS

# School of Science

# Department of Physics

# M.Sc. in PHYSICS

# Program Student Handbook

This handbook contains basic information and policies regarding the B.Sc. Program in the Department of Physics. More information for current graduate students in our department can be found online: http://adamasuniversity.ac.in/

The matters covered by this booklet are subject to periodical review and amendments.

*Message from the Department....*

*"What we know is a drop, what we don't know is an ocean"-*

*--- Isaac Newton*

# Table of Contents

**Message from the Dean, School of Science**

I would like to welcome you in the School of Science, which has been established right at the inception of the university in 2015, in the domain of Physics, Chemistry, Mathematics, Geography, and Psychology. The school has a vision, to be recognised globally as a provider of education in Basic and Applied Sciences, fundamental and interdisciplinary research. The School has a rich heritage of qualified teaching and research works in the field of aforesaid subjects. It is currently running UG, PG as well as PhD programmes in many areas of Physics, Chemistry, Mathematical Science, Geography and Psychology. It has started some joint inter-disciplinary programmes in collaboration with other departments.

The School of Science believes that the education is not only conventional book-based classroom pedagogy. It should be outcome-based education, which ensures the professional establishment of graduates. The professional establishment is possible only when a student can acquire the skill through hands-on training and real problem-solving exercise. Building the capability of handling real problem is only possible if research based and project-based learning can be imparted. Accordingly, the academic programmes are being designed towards project and research directions. The school enriched of a pool of well knowledgeable professors, is committed to impart student centric Outcome Based Education through project and research-based pedagogy and State-of-the art laboratory facility.

Best regards
Prof. Bimal Kumar Sarkar

**Welcome to the Department of Physics under School of Science, Adamas University.**

As everybody says, "*Physics is the Law of Nature*" and if you want to explore nature, and learn its patterns, Physics is absolutely the right destination for you. All the under graduate and post-graduate programs are designed meticulously to make these a comprehensive study with focus on basic theoretical foundations in a rigorous way and applications in currently relevant academic and industry fields.

Physics is everywhere, from functioning of the miniaturized Nano-scale devices to the understanding of Large Astronomical object with the emerging success of Astrophysical concepts, from the application of Non-Linear Dynamics in Weather forecasting to the prediction of Economical Markets by using Novel Statistical ideas, from using Bulk materials to manipulating Molecules in new age Transport phenomena, from Conventional Electronic devices to the mind boggling success of Robotics and Artificial Intelligence. Physics lies at the heart of every breakthrough fundamental Concepts. So, work hard and prepare yourself to be a successful and bright Physicist and make your learning experience an unique one!

While we hope that you will be so involved with your studies but at the same time we want you to enjoy the outstanding scenic beauty of the campus. The University provides lots of opportunity to learn though extracurricular activities and different club activities. Try not to learn only from the classrooms or laboratories. Life never stops you from surprising, so enjoy each moment with your friends and fellow classmates also. We want you to have an experience of a life time.

BestRegards,
Dr. Moumita Dey
Head of the Dept., Physics

**About the Department**

Vision of the Physics department is to lay the foundational stone of excellence and spur development of the University as a premier Institution in the field of Physics, by igniting and nurturing enthusiasm, interests and passion, among the students through the advanced curricula.

Located in the scenic green campus of Adamas University, Kolkata, the Department of Physics started its activity in 2015. The department is an active beehive of research being carried out in the wide variety of frontier areas as well as high quality Under-graduate, Post-graduate and Doctoral program. The research program of the department cover both pure and applied physics areas like Condensed Matter Physics, Particle Physics, Theoretical Nano-Science, Material Science, Plasma Physics and Microelectronics, Bio-Medical Instrumentation, Electronics, Applied Electronics, Thin Film, Biophysics and many more…

The department has flexibility in framing courses and conducting tests and examinations. The Department conducts programs at the Bachelor's, Master's as well as at the Doctoral Research levels. Establishment of state-of-the art experimental and computational facilities has allowed us to venture into emergent career oriented programs like Medical Physics and Instrumentation and interdisciplinary area like Nano-science and Nano-technology. With a vibrant and active Ph.D. program, in which research students are currently enrolled, Department of Physics thrives to be one of the leading research group of the world.

In addition to these programs conducted by the Department, the faculties regularly offer several core and elective physics courses to the Engineering, Science (other than Physics) and Law students of the University**.**

**Mission of the Department of Physics**

1. To provide quality training to the students for Physics education and equip them with skills required for higher studies in International and National institutions of great repute.

2. To motivate young minds and unravel their talents both in the fields of Theoretical and Experimental Physics, through dedication to teaching, commitment to students and innovative teaching learning methods and assessment throughout the year.

3. To provide the students state of the art knowledge through upgraded and advanced syllabus, modern laboratories and to make them competent from a global perspective.

4. To enable the students having a clear perspective of ongoing research activities in different fields of Physics by introducing several enriched courses like "Seminar on Contemporary in Physics", "Dissertation", "Projects" etc.

5. To prepare the students ready for industry oriented jobs by having hands on training through "Summer Internship" program in different reputed Companies or Research Organizations.

6. To add to the values of the University by introducing pioneering programs like M.Sc. (Tech) in Medical Physics and Instrumentation which is more job oriented program.

7. To evolve strategies in the Department for continuous Improvement in all aspects of academic and administrative issues.

**Program Name: M.Sc. In Physics (Honours)**

- *Introduction to the Program:*

The program Masters in Physics is a beginning step towards a flourishing research career. For students who have completed their graduation with Physics as core subject, and who want to pursue their career as an academician in the field of Physics, this course should be the very next logical step. This course brings forth all the domains of Physics, along with its recent developments starting from the beginning, with proper mathematical rigor through detailed analytical calculations, realization of the theoretical propositions through various laboratory experiments and computational simulations. Inclusion of Projects, Dissertations, Seminars on Contemporary Research in Physics, Summer Internships in various industries and reputed Research Organizations will help the students to think outside the box and igniting the young minds with scientific inquisitiveness.

- *Program Outcome:*

  After completion of the program, students will be able

1. To apply theoretical knowledge of principles and concepts of Physics to practical problems.
2. To develop approaches with a concern for accuracy and precision in significance to science and technology.
3. To identify, formulate and solve scientific problems based on design, experiment, data interpretation and analysis of results.
4. To investigate various problems and ways to solve which will be very beneficial to society.
5. To show ability in using modern tools for design and analysis.
6. To contribute both in professional and communal settings and also in legal and social implications of their work.
7. To design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.
8. To understand and practice professional ethics.
9. To work in teams on multi-disciplinary projects in research organizations and industries.
10. To demonstrate the ability to undertake a major, individual, physics-related project and reporting the results in a full scientific report and oral and poster presentation.
11. To develop the ability to critically evaluate theories, methods, principles, and applications of pure and applied science.

*Programme Eligibility:*

Qualified B.Sc. in Physics or equivalent examination from any UGC approved University or Universities at abroad with equivalent curriculum.

*Teaching - Learning Process:*

While framing teaching-learning process for postgraduate physics, we follow a holistic view of learning including situational, continuous, and transformational aspects which relies on principle of 'continuity of experience' i.e. continuously transformed by the transactions that occur between the individual and his or her surroundings. This occurs when present experiences are carried forward by being connected to previous experiences in a continuous process.

The teaching-learning processes for undergraduate students doing M.Sc. in Physics are oriented towards enabling students to understand the fundamentals and applications of physical and scientific theories portrayed within the M.Sc. in Physics program.

The outcome based approach, particularly in the context of postgraduate level studies in Physics has been designed to significantly shift from teacher-centric to learner-centric pedagogies, and from passive to active/participatory pedagogies.

Each course of the study lends itself to well-structured and sequenced acquisition of knowledge and skills in physical sciences. An important aspect of the teaching-learning process is that the undergraduate student will achieve the practical skills in physical sciences which include an appreciation of the link between theories and experiments through hands on experiments.

Teaching methods, guided by such a framework, comprises of (i) lectures supported by group tutorial work, (ii) lab based on hands on training, (iii) the use of prescribed textbooks and e-learning resources and other self-study materials, (iv) open-ended project work, some of which may also be team-based, (v) activities (presentations, seminar etc.) designed to promote the development of generic/transferable skills in physical sciences.

There will be home works based on fundamental knowledge and their the capability of their application (problem solving approach) that will allow students to demonstrate their knowledge on each chapter and to increase their analyzing power further. There will be regular quiz and class presentations which shall enable the students to demonstrate knowledge and enhance communication skills. Two/Three class tests will be given through the semester along with one Mid-term and one End-term examinations to have students demonstrate mastery of key concepts. Information and communication system (ICT) will be used selectively for decoding and interpreting mainly graphs and shapes as well as to process experimental measurements or to

simulate solid state or high energy physics related phenomena. Students are trained in various programs (e.g., Mathematica, Matlab, Python, Fortran, C etc.).

### *Attendance and Condonation:*

Students must have 75% of attendance in each semester to appear for the examination. Students who have attendance below 75% shall apply for condonation in the prescribed form with the prescribed fee. Students who have attendance below 75% are not eligible to appear for the examination. They shall re-do the semester(s) following approval of the competent authority.

### *About the Course Structure*

School of Science has implemented an advanced and well developed curriculum for all postgraduate programmes run under its umbrella. The Course structure provides an opportunity for the students to choose courses from the prescribed courses comprising Foundation course, Core (Theory and lab), Advanced Electives (Theory and Lab) etc. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Elaboration of some terms in course structure:

1. **Core Course:** A course, which should compulsorily be studied by a candidate to gather the essential knowledge about the subject to make the foundation stronger i.e., a core requirement is termed as a Core course.

2. **Advanced Elective Course:** Department of Physics offers specialization in different branches like High Energy Physics, Condensed Matter Physics, Electronics, Bio-Medical Instrumentation etc. A student can choose any option as per their choice or orientation and study the courses (booth theory and lab) offered under this specialization.

3. **Dissertation/Project:** Dissertation is compulsory for postgraduate student during the last two semesters. This course helps the student to get introduced to the various research fields and the related works that is being going on all over the world. Through such open ended courses, students are encouraged to study beyond curriculum and express their learning and views through presentation.

4.  **Internship:** Summer internship is compulsory during summer vacation in any reputed academic organization or industry. Such courses enables the students to have a hands on training directly in the fields of research or industry related jobs. This is exceptionally helpful for broadening of the exposure of students in academic and industry fields.

5.  **Foundation Course**: As per UGC guideline there is only one foundation paper, "*Environmental Science and Energy Resources*" of 2 credits.

**Meaning of Credits and Contact Hours:**

**Practical : 3 credit means** 6 hour(s) per week for full term (15 weeks in a Semester)

**Lecture: 4 credit means** 4 hour(s) per week for Full Term (15 weeks in a Semester)

**Tutorial: 1 credit means** 1 hour(s) per week for Full Term (15 weeks in a Semester)

**Course Structure**

### Semester I

| Subject Code | Subject | L | T | P | C |
|---|---|---|---|---|---|
| SPH51101 | Mathematical Methods | 4 | - | - | 4 |
| SPH51103 | Classical Mechanics | 4 | - | - | 4 |
| SPH51105 | Quantum Mechanics I | 4 | - | - | 4 |
| SPH51107 | Electronics | 4 | - | - | 4 |
| SPH51201 | Physics Lab I | - | - | 6 | 3 |
| SPH51203 | Physics Lab II | - | - | 6 | 3 |
| SGY51111 | Environmental Science and Energy Resources | | | | 2 |
| | English/ Foreign Language (Non-credit course) | | | | |
| | TOTAL CREDIT | | | | 24 |

### Semester II

| Subject Code | Subject | L | T | P | C |
|---|---|---|---|---|---|
| SPH51102 | Classical Electrodynamics | 4 | - | - | 4 |
| SPH51104 | Quantum Mechanics II | 4 | - | - | 4 |
| SPH51106 | Statistical Mechanics | 4 | - | - | 4 |
| SPH51108 | Atomic and Molecular Spectroscopy | 4 | - | - | 4 |
| SPH51202 | Physics Lab III | - | - | 6 | 3 |
| SPH51204 | Physics Lab IV | | | 6 | 3 |
| SPH51206 | Numerical Modelling for Physicists and Engineers | | | 6 | 3 |
| | English/ Foreign Language (Non-credit course) | | | | |
| | TOTAL CREDIT | | | | 25 |

## Semester III

| Subject Code | Subject | L | T | P | C |
|---|---|---|---|---|---|
| SPH52101 | **Solid State Physics** | 4 | - | - | 4 |
| SPH52103 | **Nuclear Physics** | 4 | - | - | 4 |
| SPH52105/ SPH52107/ SPH52109/ SPH52111 | **Advanced Elective I**<br><br>**(**Solid State Devices and VLSI/ Many Body Theory/ Anatomy and Physiology/ Quantum Field Theory I**)** | 4 | - | - | 4 |
| SPH52121/ SPH52123/ SPH52125/ SPH52127 | **Advanced Elective II**<br><br>**(**Microwave Devices and Circuits/ Material Science/ Bio instrumentation and Medical Physics/ Particle Physics I**)** | 4 | - | - | 4 |
| SPH52201 | **Physics Lab V** | - | - | 6 | 3 |
| SPH52203/ SPH52205/ SPH52207/ SPH52209 | **Advanced Elective Lab I**<br><br>**(**Solid State Device & Microwave Lab / Material Science Lab/ Bio instrumentation Lab/ Simulation Lab**)** | | | 4 | 2 |
| SPH52701 | **Term Paper Leading to Dissertation** | | | 3 | 3 |
| SPH52601 | **Industry Internship** | | | | 2 |
| | English/ Foreign Language<br><br>(Non-credit course) | | | | |
| | TOTAL CREDIT | | | | **26** |

**Semester IV**

| Subject Code | Subject | L | T | P | C |
|---|---|---|---|---|---|
| SPH52102/ SPH52104/ SPH52106/ SPH52108 | **Advanced Elective III** (Microprocessor and Communication Electronics/ Collective Phenomena of Solids/ Biomedical / Spectroscopy and Medical Imaging Technique/ | 4 | - | - | 4 |
| SPH52120/ SPH52122/ SPH52124/ SPH52126 | **Advanced Elective IV** (Nano-electronics / Dielectric, Optical and Transport properties of Solids/ Biosensors and LASER in Medical Application/ ) | 4 | - | - | 4 |
| SPH52202/ SPH52204/ SPH52206/ SPH52208 | **Advanced Elective Lab II** (Microprocessor and Electronics Circuit Design Lab/ Condensed Matter Physics Lab/ Microprocessor and Image Processing Lab/ | - |  | 6 | 3 |
| SPH52302 | **Seminar on Contemporary Research in Physics & Applied Physics** |  |  |  | 2 |
| SPH52702 | **Dissertation** |  |  |  | 12 |
|  | English/ Foreign Language |  |  |  |  |
|  | TOTAL CREDIT |  |  |  | **25** |

**Total: 100 credits**

**Course Name: Mathematical Methods**    **Course Code: SPH51101**

**Course Aim:** This course aims to establish a strong foundation of mathematical formulations at undergraduate level to have a clear understanding of basic courses of classical and quantum physics. The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Linear Vector space, Hilbert space and Matrices** | (8 L) |
| **Complex variables** | (10L) |
| **Theory of Second Order Linear Homogeneous Differential Equations** | (7L) |
| **Special functions** | (12L) |
| **Inhomogeneous differential equations** | (4L) |
| **Integral transforms** | (7L) |
| **Group theory** | (7L) |

**Course Outcome**

1. Students will be able to develop idea of vector space and applications in quantum mechanics.
2. Students will be able to acquire the knowledge in complex no and complex analysis.
3. Students will be able to solve differential equations that are common in physical sciences.
4. Students will be able to develop the knowledge of special function and its application.
5. Students will be able to learn Green's Function technique and to apply it in specific physics problem.
6. Students will be able to apply integral transform techniques to mathematical problem.
7. Students will be able to build the basic mathematical knowledge of Group theory and its application in crystal structure, molecular spectroscopy etc.

**Teaching Methodology**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts through which several problems of other fields in physics can be addressed. Regular class tests are taken to nurture the ideas of the subject and related domain and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods**

The evaluation process consists of the following components.

1. **Internal Assessment : 30**
2. **Attendance: 10**

3. **Mid-Term Examination: 20**
4. **End-Term Examination: 40**

*In the Internal Assessment component Class Tests/ Presentations/ and Assignments will be there.

In case of distribution of marks of attendance the following pattern is maintained

| Attendance | Marks Obtained |
| --- | --- |
| 95%-100% | 10 |
| 90%-95% | 8 |
| 85%-90% | 6 |
| 80%-85% | 4 |
| 75%-80% | 2 |
| < 75% | 0 |

**List of Books:**

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, Mc. Graw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical Methods in Physical Sciences, Mary L. Boas, Wiley
6. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson, S. J. Bence, Cambridge University Press
7. Mathematical Physics, H K Dass, S Chand Publisher
8. Theory and problems Complex variables, Schaum's outline series M. R. Spiegel.
9. Complex Variables and Applications by, Brown and Churchill.
10. Matrices and Tensor in Physics, by A. W. Joshi
11. Elements of group theory for physicists, by A. W. Joshi
12. Group Theory (Dover Books on Mathematics) by, W. R. Scott

**Course Name: Classical Mechanics**                    **Course Code: SPH51103**

**Course Aim:** This course aims to impart the fundamental concepts and applications of analytical Mechanics through Lagrangian formalism, Hamiltonian formulations etc. and related ideas to the students.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Variational Principle and Lagrange's Equations** | (8L) |
| **The Hamilton Equations of motion** | (6L) |
| **Canonical Transformations** | (8L) |
| **Hamilton-Jacobi Theory Action-Angle Variables** | (6L) |
| **Small Oscillations** | (4L) |
| **Rigid Body Motion** | (10L) |
| **Classical mechanics of Special Theory of Relativity** | (10L) |
| **Introduction to Lagrangian and Hamiltonian Formulations for continuous systems and fields** | (6L) |

**Course Outcome:**

1. Students will be able to discuss on action, Hamilton's principle and variational principle leading to Lagrange's equation.
2. Students will be able to understand cyclic coordinates & conserved quantities, Legendre transformation and derivation of Hamilton's equation of motion.
3. Students will be able to acquire knowledge of canonical transformations, canonical invariants and Poisson brackets.
4. Students will be able to understand symmetry and symmetry groups.
5. Students will be able to simplify a problem using Hamilton-Jacobi's theory of action-angle variables and solving simple problems like harmonic oscillator and small oscillation using the same.
6. Students will be able to analyse rigid body motion by the knowledge of Principle axis transformation, Euler angles and Coriolis force.
7. Students will be able to understand covariant Lagrangian formulation of special theory of relativity; foundation of classical relativistic electrodynamics.
8. Students will be able to acquire and apply knowledge on classical fields, Noether's theorem.

**Teaching Methodology**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of classical mechanics are required . Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Introduction to Classical Mechanics, David Morin, Cambridge University Press.
3. Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rdEdn. 2002, Pearson Education.
4. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
5. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
6. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
7. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
8. K.C. Gupta: Classical Mechanics of Particles and Rigid Bodies
9. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press.

**Course Name: Quantum Mechanics I**                    **Course Code: SPH51105**

**Course Aim:** This course aims to provide the knowledge of quantum mechanical formalism which will help the students to study the physics of microscopic length scale further.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Recapitulation of Basic Concepts:** | (6L) |
| **Mathematical Formulation of Quantum Mechanics:** | (10L) |
| **Postulates of Quantum Mechanics:** | (10L) |
| **One Dimensional Problems:** | (8L) |
| **Three Dimensional Problems**: | (6L) |
| **Angular Momentum** | (12L) |

**Course Outcome:**

1. Students will be able to understand quantum interpretation of variables/observables and its distinction from the classical interpretation.
2. Students will be able to go through basic mathematical framework of Quantum Mechanics and use them as tool to set up interesting problems.
3. Students will be able to practice with simple 1dimensional, 3dimensional model problems to see the direct effect of quantization.
4. Students will be able to deal with important operators like angular momentum or spin and their representations and to study the addition of these vectors.
5. Students will be able to understand the Stern-Gerlach experiment.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of quantum mechanics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books:**

1. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
2. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Ed.,
3. 2010, McGraw Hill.
4. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
5. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
6. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
7. J.J. Sakurai : Modern Quantum Mechanics
8. S. Gasiorowicz : Quantum Physics.
9. Quantum Mechanics: Theory and Applications Author: A. *Ghatak*, S. *Lokanathan* Published by Springer Netherlands.

**Course Name: Electronics**                                    **Course Code: SPH51107**

**Course Aim:** This course aims to provide the theoretical knowledge and applications of different aspects in both the fields of digital and analogue electronics.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Passive Networks** | (4L) |
| **Active Circuits** | (4L) |
| **Physical Mechanisms** | (8L) |
| **Semiconductor Devices** | (6L) |
| **Special Device** | (6L) |
| **Transducers & industrial instrumentation (working principle, efficiency, applications)** | (6L) |
| **Vacuum Systems** | (4L) |
| **Analogue circuits** | (2L) |
| **Digital MOS circuits** | (2L) |
| **Data processing circuits** | (4L) |
| **Shift registers** | (2L) |
| **Counters (4 bits)** | (2L) |
| **Intel 8085 and 8086 Microprocessor Architecture** | (2L) |
| **Introduction to Assembly Language** | (2L) |

**Course Outcome:**

1. Students will be able to develop idea about networking system.
2. Students will be able to distinguish between different types of amplifier and feedback mechanism.
3. Students will be able to learn about basic physical mechanism of semiconductor junction, semiconductor devices, doping mechanism and underlying transport properties.
4. Students will be able to develop the knowledge of different types of p-n junction semiconductor devices including diodes and transistors.
5. Students will be able to devise various special devices, required for classified applications.
6. Students will be able to conceive the knowledge of different types of transducers / sensors and their applications.
7. Students will be able to apply depth knowledge of vacuum systems.
8. Students will be able to develop in depth knowledge of analogue circuits.
9. Students will be able to adapt and apply the knowledge on digital MOS, device/circuits and interactions, shift register, counter etc.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of fundamental electronics

are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. J.D. Ryder: Network, Lines and Fields
2. J. Millman and C. Halkias: Integrated Electronics
3. J.D. Ryder: Electronic Fundamental and Applications
4. J. Kennedy: Electronic Communication Systems
5. J. Millman and A. Grabel: Microelectronics
6. B.G. Streetman, S. Banerjee: Solid State Electronic Devices
7. Sedra and Smith: Microelectronic Devices
8. Taub and Schilling: Digital Integrated Electronics
9. P. Bhattacharyya: Semiconductor Optoelectronic Devices
10. S.M. Sze: Physics of Semiconductor Devices
11. Boylestad and Nashelski: Electronic Devices and Circuit Theory

**Course Name: Physics Lab I**                                          **Course Code: SPH51201**

**Course Aim:** To provide hands on training in some general experiments related to post graduate level physics.

**Course Content**

1. Determine Plank's Constant using photo-cell with filters for different light wave length ($\lambda$). Also verify the inverse square law.
2. Determine the electron charge by Millikan's Oil drop method and hence determine the terminal velocity of the oil drop.
3. Determination of e/m of electrons by magnetic focusing method.
4. Determine energy band gap of Ge crystal by Four Probe Method.
5. Determination of Hall coefficient of n-type semiconductor material.
6. Determination of Hall coefficient of p-type semiconductor material.

**Course Outcome:**

1. Students will be able to experiment Planck's Constant determination using photo-cell and determination of energy band gap of Ge crystal by Four Probe Method.
2. Students will be able to determine electronic charge by Millikan's Oil drop method and also to determine the ratio e/m of electrons by magnetic focusing method.
3. Students will be able to determine the Hall coefficients of n-type and p-type semiconductor materials.
4. Students will be able to be acquainted with the Study of para-ferromagnetic phase transition and Verification of Bohr's atomic theory by Franck Hertz Experiment.
5. Students will be able to build up the concept of Acousto-optical effect using piezo-electric crystal and to determine of energy band gap of semiconductor by studying the luminescence spectra.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**
The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Name: Physics Lab II**                    **Course Code: SPH51203**

**Course Aim:** To provide hands on training in some general experiments related to post graduate level physics.

**Course Content:**

**Experiments using LASER**

1. Determination of refractive index of a glass plate using Laser source based on Michelson interferometer technique.
2. To observe the diffraction pattern and calculate the slit width using Laser light.
3. Study of response characteristic of a solar-cell using Laser light.
4. Study of V-I characteristic of a LDR. Also study the response characteristic of a LDR.
5. Study of V-I characteristic and response characteristic of a phototransistor.
6. To study the response characteristic of a photodiode.
7. To study response characteristic of an opto-coupler.
8. To study polarization properties of light and verify the Malu's Law using Laser source.

**Experiments using Optical Fibre**

9. Determination of numerical aperture of an Optical fiber
10. Study the bending loss in an optical fibre.

**Course Outcome:**

1. Students will be able to determine the refractive index of a glass plate using Laser source based on Michelson interferometery  technique.
2. Students will be able to study the response characteristic of a solar-cell, photodiode, opto-coupler using Laser light.
3. Students will be able to study of V-I characteristic and the response characteristic of a LDR and phototransistor.
4. Students will be able to verify  polarization properties of light and with the help of Malu's Law using Laser source.
5. Students will be able to estimate the of numerical aperture of an Optical fibre and study the bending loss in an optical fibre.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**SEMESTER – II**

**Course Name: Classical Electrodynamics**                    **Course Code: SPH51102**

**Course Aim:** This course aims to provide the basic understanding and knowledge in the field of non-relativistic and relativistic classical electrodynamics.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Electrostatics and Magnetostatics** | (12L) |
| **Maxwell's Equations in stationary and moving media** | (6L) |
| **Fields due to time dependent charge and current distributions** | (12L) |
| **Radiation from moving point charges** | (12L) |
| **Radiation Reaction** | (8L) |
| **Relativistic Electrodynamics** | (6L) |

**Course Outcome:**

1. Students will be able to learn the techniques to calculate field at a faraway point due to static charge distribution.
2. Students will be able to have a clear understanding of Maxwell's equations and electromagnetic boundary conditions.
3. Students will be able to apply the techniques to solve inhomogeneous wave equations and learn the various aspects of radiation from moving charges.
4. Students will be able to extend and adapt their understanding of special theory of relativity by including the relativistic electrodynamics.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of classical electrodynamics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books:**

1. J.D. Jackson: Classical Electrodynamics
2. W.K.H. Panofsky and M. Phillips: Classical Electricity and Magnetism
3. J. R. Reitz, F.J. Milford and R.W. Christy: Foundations of Electromagnetic theory
4. D.J. Griffiths: Introduction to Electrodynamics
5. Classical Electromagnetic Radiation, Mark A. Heald and J. B. Marion, Dover Books on Physics
6. Modern Problems in Classical Electrodynamics, C. A. Brau

**Course Name: Quantum Mechanics II**                    **Course Code: SPH51104**

**Course Aim:** This course aims to impart knowledge regarding the understanding of advanced level quantum mechanics and apply it in different physical systems.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Approximation methods in quantum mechanics** | (15L) |
| **Time dependent perturbation theory** | (8L) |
| **Scattering Theory** | (12L) |
| **Symmetries in quantum mechanics** | (8L) |
| **Identical Particles** | (6L) |
| **Relativistic Quantum Mechanics** | (4L) |

**Course Outcome:**

1. Students will be able to solve the Schrodinger Equation with analytically unsolvable potentials distributions with the help of several approximation methods such as time independent perturbation theory, variational method, W-K-B approximation, Variational method etc.
2. Students will be able to understand the concept of perturbation theory in atomic spectroscopy and spectral resolutions.
3. Students will be able to develop a knowledge of time dependent perturbation theory and its applicability in different Lab based real scenario problems.
4. Students will be able to understand the concepts and applications of scattering theory in Quantum Mechanics.
5. Students will be able to apply the fundamentals of symmetry operations and group theory in Quantum Mechanics.
6. Students will be able to analyze systems containing many particles, constructing the wave function of the full system.
7. Students will be able to understand the merging concepts of relativity with Quantum Mechanics and understand its failure and birth of Quantum Field Theory

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of advanced level quantum mechanics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. L.I. Schiff: Quantum Mechanics
2. Quantum Mechanics, Nouredine Zettili, John Wiley and Sons Ltd.
3. Quantum Mechanics, David J. Griffiths
4. J.J. Sakurai: Advanced Quantum Mechanics
5. C. Cohen-Tannoudji, B. Dier, and F. Laloe: Quantum Mechanics vol. 1 and 2
6. E. Merzbacher: Quantum Mechanics
7. Messiah: Quantum Mechanics, Vol. II
8. Quantum Mechanics, Bransden and Joachain, Pearson Education.
9. J.D. Bjorken and S.D. Drell: Relativistic Quantum Mechanics
10. F. Halzen and A.D. Martin: Quarks and Leptons
11. W. Greiner: Relativistic Quantum Mechanics
12. A. Lahiri and P.B. Pal: A First Book of Quantum Field Theory

**Course Name: Statistical Mechanics**                    **Course Code: SPH51106**

**Course Aim:** This course enables the students to develop a strong theoretical base to deal with both classical and quantum systems having large number of particles and apply the formalism in real physical systems.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Introduction** | (6L) |
| **Micro-canonical Ensemble** | (8L) |
| **Canonical Ensemble** | (8L) |
| **Grand Canonical Ensemble** | (6L) |
| **Quantum statistical mechanics** | (8L) |
| **Ideal Bose Systems** | (8L) |
| **Ideal Fermi Systems** | (4L) |
| **Special topics** | (8L) |

**Course Outcome**

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

1. Students will be able to analyze Classical Statistical systems by learning about micro canonical, canonical and grand canonical ensembles.
2. Students will be able to adapt the principles of Quantum statistical mechanics.
3. Students will be able to understand ideal Bose gas and Bose-Einstein Condensation.
4. Students will be able to learn the properties of ideal Fermi gas and to apply those in real physical systems.
5. Students will be able to learn about phase transition, critical point, and critical exponents etc.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where concepts of statistical mechanics are required . Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. F. Reif: Fundamentals of Statistical and Thermal Physics, McGraw-Hill.
2. R.K. Pathria: Statistical Mechanics, Elsevier
3. K. Huang: Statistical Mechanics, Wiley Student edition
4. F. Mandl: Statistical Physics
5. Statistical Mechanics, F. Schwabl, Springer international edition.
6. Statistical Mechanics, R. Feynman

**Course Name: Atomic and Molecular Spectroscopy**       **Course Code: SPH51108**

**Course Aim:** To develop the preliminary concept about atomic and molecular spectroscopy, by learning atomic and molecular structural configuration and related transitions.

**Number of Lectures and Course Content Module wise:**

**Atomic Spectroscopy**

| | |
|---|---|
| Dirac equation, Relativistic correction | (12L) |
| Interaction of atoms with electromagnetic radiation | (8L) |
| Interaction with external electric and magnetic field: Stark effect, Zeeman effect | (6L) |
| Two electron system | (3L) |
| Many electron system | (5L) |

**Molecular Spectroscopy**

| | |
|---|---|
| General Concept | (6L) |
| Microwave spectroscopy | (6L) |
| Infrared spectroscopy | (4L) |
| Raman spectroscopy | (4L) |
| Spin resonance spectroscopy | (4L) |
| Mossbauer spectroscopy | (2L) |

**Course Outcome**

1. Students will be able to adapt the theoretical formulation of one electron atom, Dirac Equation and relativistic corrections.
2. Students will be able to develop concepts about quantization of the electro-magnetic field and interaction with atoms.
3. Students will be able to analyze Stark effect and Zeeman effect with all limiting cases.
4. Students will be able to distinguish between single electron and many electron systems.
5. Students will be able to gather the general concept of molecular structure.
6. Students will be able to learn about Rotational, Vibrational and Raman spectroscopy of molecular systems.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of classical mechanics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. B.H. Bransden and C.J. Joachain: Physics of Atoms and Molecules
2. R. Shankar: Principles of Quantum Mechanics
3. C.B. Banwell: Fundamentals of Molecular Spectroscopy
4. G.M. Barrow: Molecular Spectroscopy
5. K. Thyagarajan and A.K. Ghatak: Lasers, Theory and Applications
6. B.H. Eyring, J. Walter and G.E. Kimball: Quantum Chemistry
7. H. Herzberg: Spectra of Diatomic Molecules
8. B.B. Laud: Lasers and Non-linear Optics.

**Course Name: Physics Lab III**                                    **Course Code: SPH51202**

**Course Aim:** This course aims to provide hands on experience in performing various post graduate level experiments.

**Course Content:**
1. Study of photo-conductivity of a semiconductor material.
2. Study of Current Voltage characteristic of a CdS, a photo resistor as a function of Intensity using optical bench.
3. To determine temperature dependence of Hall coefficient of n-type and p-type semiconductor material.
4. To determine the Magneto-resistance of n-type and p-type semiconductor material.
5. Determination of magnetic parameters of a Ferromagnetic substance by using Hysteresis Loop Tracer.
6. Study of Temperature Transducer.

**Course Outcome:**
At the end of the course the students will be able to

1. Students will be able to measure the photo-conductivity of a semiconductor material and to study the Current Voltage characteristic of CdS, a photo resistor.
2. Students will be able to determine the temperature dependence of Hall coefficient of n-type and p-type semiconductor material and to estimate the Magneto-resistance of n-type and p-type semiconductor material.
3. Students will be able to determine the magnetic parameters of a Ferromagnetic substance by using Hysteresis Loop Tracer.
4. Students will be able to experiment with Temperature Transducer.
5. Students will be able to determine the ratio of e/m.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**
The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Name: Physics Lab IV**                    **Course Code: SPH51204**

**Course Aim:** This course aims to provide hands on experience in performing various post graduate level experiments.

**Course Content**

**Study of Filters**

1. Design and study frequency response of Passive filters (a) High pass (b) Low pass (c) Notch filters. (d) Wide Band pass Filter
2. Design and study frequency response of 1st order Active filters (use OPAMP as active element) (a) High pass (b) Low pass (c) Band pass (d) Band reject (e) Narrow band pass filters etc..
3. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.To build JK Master-slave flip-flop using Flip-Flop ICs
4. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
5. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.].
6. Study of Amplitude modulation and demodulation.
7. Study of Frequency modulation and demodulation.
8. Design and study of an Astable, Monostable and Bi-stable multivibrator by using transistor.
9. Design and study of an Astable, Monostable and Bi-stable multivibrator by using 555 Timer.

**Course Outcome:**

1. Students will be able to design the frequency response of Passive filters (a) High pass (b) Low pass (c) Notch filters. (d) Wide Band pass Filter.
2. Students will be able to design and study the frequency response of 1st order Active filters (use OPAMP as active element) (a) High pass (b) Low pass (c) Band pass (d) Band reject (e) Narrow band pass filters.
3. Students will be able to design Flip-Flop ( RS, Clocked RS, D-type and JK ) circuits using NAND gates and building of JK Master-slave flip-flop using Flip-Flop ICs.
4. Students will be able to develop a 4-bit Counter using D-type/JK Flip-Flop Ics, and design of a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop Ic's.
5. Students will be able to study of Amplitude/Frequency modulation and demodulation.
6. Students will be able to design and study of an Astable, Monostable and Bi-stable multivibrator by using transistor and 555 Timer.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Name: Numerical Modelling for Physicists and Engineers**

**Course Code: SPH51206**

**Course Aim:** This course aims to help the students to learn programming from the very basic to verify the mathematical concepts they have learn in their theory class. The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

**Course Content**
**A brief review on any language C/ Python**

Numerical solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods, Solution of linear and quadratic equation, solving diffraction equation

$\alpha = \tan \alpha$ , $I = I_0 \left( \dfrac{\sin \alpha}{\alpha} \right)^2$ in optics.

Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation. Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method.

Finding zeros of a real valued function using Newton-Raphson method.

**Scilab/ Matlab/Mathematica**

Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems, Solution of mesh equations of electric circuits (3 meshes), Solution of coupled spring mass systems (3 masses).

**Solution of ODE**

First order differential equation, Euler, Modified Euler and Runge-Kutta second order method. Solve equations for radioactive decay, Newton's  law of cooling , classical equations of motion etc.

Second order differential equation, Harmonic oscillator (no friction), Fixed difference method, Damped Harmonic oscillator,  Over damped, Critical damped, Oscillatory,  Forced Harmonic oscillator,  Transient and Steady state solution.

To solve some problems on differential equations like :

1. Solve the coupled first order differential equations

for different initial conditions [e.g., x(0) = 0, y(0) = -1, -2, -3, -4]. Plot x vs. y for each of the four initial conditions on the same screen for $0 \leq t \leq 15$.

2. The ordinary differential equation describing the motion of a pendulum is
$\theta'' = -\sin(\theta)$
   The pendulum is released from rest at an angular displacement $\alpha$ i.e. $\theta(0) = \alpha$, $\theta'(0) = 0$. Use the RK4 method to solve the equation for $\alpha = 0.1, 0.5$ and $1.0$ and plot $\theta$ as a function of time in the range $0 \leq t \leq 8\pi$. Also, plot the analytic solution valid in the small $\theta$ ($\sin\theta \approx \theta$).

3. Solve the differential equation:

with the boundary conditions:  at x = 1, $y = (1/2) e^2$, $dy/dx = -(3/2) e^2 - 0.5$, in the range $1 \leq x \leq 3$. Plot y and dy/dx against x in the given range. Both should appear on the same graph.

**Course Outcome**
At the end of the course the students will be able to

1. solve numerically Algebric and Transcendental equations by Bisection, Newton Raphson and Secant methods.
2. learn Numerical Differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules)
3. find zeros of a real valued function using Newton-Raphson method.
4. Solve the Linear system of equations by Gauss elimination method and Gauss Seidal method.
5. understand matrix Operations (Multiplication, Diagonalization, Inverse etc.).
6. solve 1st order and 2nd order Differential equations by Euler, Modified Euler and Runge-Kutta  method.

**Teaching Methodology**
The course will consist of practical classes of computer programming. The problems given in the classes and in the assignments focuses on the practical implementation of real life problems. This computer programming knowledge will help them to simulate several problems of Physics numerically.

**Assessment Methods**
The evaluation process is same as already been given in the previous courses. In the Internal Assessment component assignments will be there. In case of distribution of marks of attendance the same  rule is followed as given previously.

**List of Books**
1. V. Rajaraman: Computer Programming in Fortran
2. V. Rajaraman: Computer Oriented Numerical Methods
3. Numerical Recipes

**SEMESTER – III**

**Course Name: Solid State Physics**                    **Course Code: SPH52101**

**Course Aim:** This course aims to provide knowledge about several physical properties (structural, dynamical, electronic, electrical, magnetic etc.)of a solid substance and understanding the origin of those using the basic concepts of quantum and statistical physics.

**Number of Lectures and Course Content Module wise:**

Binding of Solids                                                    (4L)
Crystalline State                                                    (12L)
Electronic states in Solids                                          (14L)
Transport properties of Metals                                       (10L)
Basic introduction to Magnetism and Superconductivity                (16L)

**Course Outcome:**

1. Students will be able to learn the concepts of Bonding and Binding in Solids.
2. Students will be able to acquire the knowledge of X-ray crystallography, crystal diffraction, different surface fabrication techniques and imperfections in solids.
3. Students will be able to learn and compare electronic properties from Free Electron Theory, Nearly Free Electron Model, Tight Binding Model etc.
4. Students will be able to develop an idea of transport phenomena in bulk systems using Boltzmann Transport Equation.
5. Students will be able to understand the basic concepts of Lattice dynamics and application in specific heat calculation of solids.
6. Students will be able to learn the fundamental physics behind the occurrence of Dielectricity, Magnetism and Superconductivity in solids

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of solid state physics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. C. Kittel: Introduction to Solid State Physics
2. N.W. Ashcroft and N.D. Mermin: Solid State Physics
3. J.R. Christman: Fundamentals of Solid State Physics
4. A. J. Dekker: Solid State Physics
5. H.Ibach and H. Luth: Solid State Physics: An Introduction to Theory and Experiment
6. J.P.Srivastava: Elements of Solid State Physics

**Course Name: Nuclear Physics**                          **Course Code: SPH52103**

**Course Aim:** This course aims to impart theoretical knowledge and also the applications of Nuclear and Particle Physics.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| Nuclear Properties | (8L) |
| Two-body bound state | (4L) |
| Two-body scattering | (8L) |
| β-decay | (6L) |
| Nuclear Structure | (8L) |
| Nuclear Reactions and Fission | (12L) |
| Particle Physics | (8L) |

**Course Outcome:**

1. Students will be able to analyze the nuclear interactions, properties and relevant decay processes and it's implication in present day research. Informed about current research on nucleon properties and fundamental particles.
2. Students will be able to study of nuclear structures and limitations of understanding of present day nuclear Physics which will inspire them to further research in the area.
3. Students will be able to understand the main motivation today for the study of nuclear physics is the training of students having the ability to master its numerous applications in a safe and effective way.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of classical mechanics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. M.K. Pal: Theory of Nuclear Structure
2. R.R. Roy and B.P. Nigam: Nuclear Physics
3. S.N. Ghoshal: Atomic and Nuclear Physics (Vol. 2)
4. D.H. Perkins: Introduction to High Energy Physics
5. D.J. Griffiths: Introduction to Elementary Particles
6. W.E. Burcham and M. Jobes: Nuclear and particle Physics

**Course Type: Advanced Elective I**

**Course Name: Many Body Theory**                    **Course Code: SPH52107**

**Course Aim:** This course mainly focuses on the foundation of theoretical formulation of many electron systems and application of those in real physical systems.

**Number of Lectures and Course Content Module wise:**

**Fundamentals of many-electron system and Hartree-Fock theory**         (15L)
**The interacting free-electron gas**                                     (15L)
**Higher Order Time dependent perturbation Theory**                       (15L)

**Course Outcome:**

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

1. learn the fundamentals about dealing with a many electron system, writing its wave function and calculating matrix element with a determinantal wave function acquire the knowledge of Low pass and High pass $\pi$ filters.
2. apply Many Electron Theory in Free Electron Gas system to Cohesive energy, specific heat etc.
3. approach to solve many body system analytically. Concepts and applications of Feynman diagrams.
4. apply Green's function theory to solve many particle Hamiltonian and calculation of self energy

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where concepts of many body theory are required . Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. S. Raimes: Many Electron Theory
2. Many Body Theory in Condensed Matter Physics, Henric Bruus and Karsten Flensberg
3. A Guide to Feynman Diagrams in the Many-body Problem, R. D. Mattuk
4. The Green Function Method in Statistical Mechanics, V. L. Bonch-Bruevich
5. Many Particle Physics, Gerald D. Mahan, Springer US.

**Course Type: Advanced Elective I**

**Course Name: Anatomy and Physiology**                    **Course Code: SPH52109**

**Course Aim:** This course aims to impart knowledge regarding the principles and applications of anatomy and physiology.

**Number of Lectures and Course Content Module wise:**
| | |
|---|---|
| Cell | (2L) |
| Blood | (2L) |
| Heart (Circulatory System) | (6L) |
| Respiratory System | (6L) |
| Digestive system | (3L) |
| Kidney and Urinary system | (4L) |
| Muscle Tissues | (6L) |
| Nervous system | (7L) |
| Skeletal systems | (6L) |

**Course Outcome:**

1. discuss the organization of human body from cell to organ and systems
2. explain the musculo-skeletal system and its connection with nervous system
3. describe the circulatory system and its functions in living body
4. discuss the reproductive and endocrine system as a part of human body systems
5. analyse the different sensory organs and their normal anatomy

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of anatomy and physiology are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:** The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. Human Anatomy and Physiology, Ross and Wilson
2. Anatomy and Physiology, Kenneth and Salad

**Course Type: Advanced Elective I**

**Course Name: Quantum Field Theory I**          **Course Code: SPH52111**

**Course Aim:** This course aims to impart knowledge regarding the principles of basic Quantum Field Theory.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Preliminaries** | **(5L)** |
| **Free Field** | **(15L)** |
| **Invariance Principles** | **(8L)** |
| **Interacting fields** | **(8L)** |
| **QED** | **(10L)** |

**Course Outcome:**

1. Students will be able to understand the failure of relativistic quantum mechanics and appreciate the necessity of the new formalism called Quantum Field Theory.
2. Students will be able to adapt the concepts of free fields and Gauge Invariance principles.
3. Students will be able to learn the formalism related to interacting fields.
4. Students will be able to adapt to the new concepts of Quantum Electrodynamics.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of anatomy and physiology are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:** The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books:**

1.  A first book of Quantum Field theory, A Lahiri and P B Pal, 2005, 2nd Edn, Narosa.
2.  Quantum Field Theory, L H Ryder, 1996, 2nd Edn, Cambridge University Press.
3.  Quantum field theory, Itzykson& Zuber, 2006, Dover Publications Inc.
4.  An introduction to quantum field theory, M.E. Peskin and D.V. Schroeder, 1995, Perseus Books.
5.  Relativistic Quantum Fields, J.D. Bjorken and S.D. Drell, 1965, FIrst Edition, McGraw-Hill College.
6.  Quantum Field Theory, F. Mandl and G. Shaw, 2010, 2nd Edn, Willey-Blackwell.
7.  Field Theory: A Modern Primer, P. Ramond, 2007, Benjamin/Cummings Pub. Co./Sarat Book House.

**Course Type: Advanced Elective II**

**Course Name: Material Science**                    **Course Code: SPH52123**

**Course Aim:** This course aims to impart knowledge regarding the principles and applications of material science.

**Number of Lectures and Course Content Module wise:**
Crystal Symmetry                                                      (15L)
Overview of materials                                                 (12L)
Synthesis and preparation of materials                               (15L)
Characterization of materials                                        (15L)

**Course Outcome:**
1. Students will be able to discuss about various types and characteristic of materials.
2. Students will be able to develop concept about different symmetry and crystal structure.
3. Students will be able to study defects in crystalline structure.
4. Students will be able to acquire knowledge about electronic transport magnetic properties of materials.
5. Students will be able to study phase diagrams, statistical theories of phase transitions, critical phenomena and critical exponents.
6. Students will be able to develop some idea about characterization of samples.

**Teaching Methodology:**
The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where concepts of material science are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**
The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books:**
1. C. Kittel: Introduction to Solid State Physics
2. R. Zallen: The Physics of Amorphous Solids.
3. N.F. Mott and E.A. Davies: Electronic Processes in Non-crystalline Materials
4. C.N.R. Rao and B. Raveau: Colossal Magnetoresistance, Charge Density and Related Properties of Manganese oxides
5. Quantum Theory of Solids, C. Kittel

**Course Type: Advanced Elective II**

**Course Name: Bio instrumentation and Medical Physics**          **Course Code: SPH52125**

**Course Aim:** This course aims to impart knowledge regarding the principles and applications of Bio-instrumentation and Medical Physics.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Evoked potential** | (5L) |
| **Principles of electromyography detection & application** | (6L) |
| **Impedance Techniques** | (6L) |
| **Bioelectric Signals and Electrodes** | (10L) |
| **Biomedical Recording Systems & Recorders** | (8L) |
| **Oximeters, Blood Flow & Cardiac Output Measurement** | (8L) |
| **Respiratory Diagnostic & Therapeutic Instruments** | (7L) |
| **Pacemakers & Defibrillator** | (8L) |
| **Advanced Diagnostic & Therapeutic Instruments** | (10L) |

**Course Outcome:**

1. Students will be able to understand the basics of evoked potential, its application and measurement technique
2. Students will be able to demonstrate the circuit of EMG - its principle and application.
3. Students will be able to learn the basics of impedance techniques, its application and limitations
4. Students will be able to interpret the basics of bioelectric signal and electrodes, its different types, operation principle.
5. Students will be able to apply the principles of biomedical recording systems, its different types, principle of operation.
6. Students will be able to conceive the concepts of oxymeter, blood flow and cardiac output.
7. Students will be able to understand the basics of pacemaker, diagnostics systems, advanced diagnostic equipment

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts

which can be addressed further to solve various real life problems where concepts and applications of bio-instrumentation and medical physics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. Hand Book Of Biomedical Instrumentation, Khandpur
2. Fundamentals of Bio-medical engineering, G. S. Sawhney.

**Course Type: Advanced Elective II**

**Course Name: Particle Physics I**                    **Course Code: SPH52127**

**Course Aim:** This course aims to impart knowledge regarding the principles and applications of Particle Physics I.

**Number of Lectures and Course Content Module wise:**

1. Introduction to Elementary Particles                                   (25L)
2. Hadron spectroscopy                                                    (20L)
3. Deep Inelastic Scattering                                             (15L)

**Course Outcome:**

1. Students will be able to get an overview of modern particle physics stressing on fundamental concepts and experimental processes in particle detection.
2. Students will be introduced to particle physics, where the detailed studies of Hadron spectroscopy is included. It provide an insight into the hadron structure and dynamics. Deep inelastic scattering has been included in detail with mathematical formulation. This is a very important area of present day particle physics to probe the structure of nucleons.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where concepts and applications of basic particle physics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**:
1. Introduction to Elementary Particles: David Griffiths
2. An introduction to Quarks and Partons: F.E. Close.
3. Introduction to Gauge Field Theories: M. Chaichian and N.F. Nelipa.

**Course Name: Physics Lab V**                    **Course Code: SPH52201**

**Course Aim:** This course aims to impart advanced experimental experience to students through hands on training

**Course Content**

1. Studies on Characteristics of SCR (Silicon controlled Rectifier).
2. Studies on different types of characteristics of DIAC.
3. Studies on different types of characteristics of TRIAC.
4. Study of Dynamic characteristics of a JFET and hence determine the FET parameters.
5. Determination of Lande-g factor by Electron Spin Resonance Spectroscopy.
6. Determination of wavelength of a monochromatic source by using Michelson's Interferometer.
7. Study of Vibrational Coarse Structure of $I_2$ molecule.

**Course Outcome:**

1. Student will be able to design and study higher order Low pass and High pass higher order filters.
2. Student will be able to experiment with different types of characteristics of SCR/DIAC/TRIAC.
3. Student will be able to estimate static emitter characteristic of a UJT.
4. Student will be able to determine Lande-g factor by Electron Spin Resonance Spectroscopy.
5. Student will be able to determine the wavelength of a monochromatic source by Michelson's Interferometer.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:** The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Type: Advanced Elective Lab I**

**Course Name: Material Science Lab**                    **Course Code: SPH52205**

**Course Aim:** This course aims to focus on the hands on training on properties of materials.

**Course Content:**

1. Synthesis of metal thin films of (Al/Ag metal) on a glass substrate by using thermal evaporation technique and structural characterization through XRD.
2. Study of I-V characterization of Solar Cell.
3. Measurements of dielectric constant of $BaTiO_3$
4. Determination of Lande-g factor by Nuclear Magnetic Resonance Spectroscopy.
5. Study of Current Voltage characteristic of a CdS (photo resistor) as a function of wavelength, by using a monochromator.

**Course Outcome:**

1. Students will be able to synthesize metal thin films of (Al) on a glass substrate and structural characterization through XRD.
2. Students will be able to Study the I-V characterization of Solar Cell.
3. Students will be able to measure dielectric constant of $BaTiO_3$.
4. Students will be able to Determine Lande-g factor by Nuclear Magnetic Resonance Spectroscopy.
5. Students will be able to study the Current Voltage characteristic of a CdS (photo resistor) as a function of wavelength, by using a monochromator.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**
The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Type: Advanced Elective Lab I**

**Course Name: Bio-instrumentation Lab**                    **Course Code: SPH52207**

**Course Aim:** This course aims to focus on the hands on training on Bio-instrumentation instruments.

**Course Content**

1. Experiments and calibration with EEG machine
2. Experiments and calibration with ECG machine
3. Experiments with Pulse-oximeter machine
4. Experiments with Audiometer.
5. Sensor and Transducer Lab

**Course Outcome**

1. Students shall be able to calibrate of ECG machine.
2. Students shall be able to calibrate of EEG machine.
3. Students shall be able to experiment with Pulse-Oximeter machine and audiometer machines.
4. Students shall be able to design and study the characteristics of high-pass and low-pass filters.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Type: Advanced Elective Lab I**

**Course Name: High Energy Physics Lab I**                    **Course Code: SPH52207**

**Course Aim:** This course aims to impart hand on training related to Nuclear radiation and Detectors.

**Course Content**

1. Gamma Ray spectroscopy with NaI(Tl) with different sources.
2. Pleatueing for plastic scintillator detector with cosmic ray.
3. Measurement if gain for gaseous detector.
4. Estimation of the branching ratios of alpha to fission fragments 252Cf using Nuclear Track Detector

**Course Outcome**

1. Students shall be able to demonstrate Gamma ray spectroscopy using NaI.
2. Students shall be able to experiment with plastic scintillator detector.
3. Students shall be able to experiment with various gaseous detector.
4. Students shall be able to estimate the fission fragments 252Cf using Nuclear Track Detector.

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same  rule is followed as given previously.

**References:**

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Type: Advanced Elective III**

**Course Name: Collective Phenomena of Solids**          **Course Code: SPH52104**

**Course Aim:** This course aims to focus on the fundamental principles of the theoretical formalism needed to study many electron systems.

**Number of Lectures and Course Content Module wise:**

Spin and Magnetic Systems, Magnons and Ising Model                    (25L)
Superconductivity, BCS Theory                                          (25L)
Density Functional Theory                                             (10L)

**Course Outcome:**

1. Students will be able to understand different kinds of exchange interaction as the source of Ferromagnetism.
2. Students will be able to acquire the concepts of magnons, Renormalization group and RKKY interaction.
3. Students will be able to understand and interpret the Ising model.
4. Students will be able to develop a clear perception about origin of superconductivity and its properties.
5. Students will be able to acquire idea of BCS Theory and BCS wave functions
6. Students will be able to acquire the concepts of Landau-Ginzberg Theory
7. Students will be able to develop idea of Density Functional Theory and its applications.

**Teaching Methodology:**

The course will consists of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various condensed matter physics problems where concepts of many electron system are required . Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same  rule is followed as already given.

**List of Books**

1. C. Kittel: Introduction to Solid State Physics
2. H. Ibach and H. Luth: Solid State Physics: An Introduction to Theory and Experiments
3. J.M. Ziman: Principles of the Theory of Solids
4. C. Kittel: Quantum Theory of Solids
5. J.M. Yeomans: Statistical Mechanics of Phase Transitions
6. Magnetism in Condensed Matter, Stephen Blundell, Oxford Master Physics
7. Solid State Physics: Essential Concepts, avid W. Snoke.
8. Introduction to Superconductivity: Michael Tinkham, Dover Publication
9. A Quantum Approach to Condensed Matter Physics: Philip Taylor
10. Condensed Matter in a Nutshell: Gerald D. Mahan
11. Condensed Matter Physics: Michael P. Marder

**Course Type: Advanced Elective III**

**Course Name: Biomedical Spectroscopy and Medical Imaging Technique**

**Course Code: SPH52106**

**Course Aim:** This course aims to focus on the principles and applications of Biomedical Spectroscopy and Medical Imaging Technique.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| Image Fundamentals | (10L) |
| Image processing | (5L) |
| Image analysis and classification | (10L) |
| Reconstruction of CT and MRI Image | (7L) |
| Transmission of Medical Images | (8L) |
| Optical characteristics of bio molecules from the point of spectroscopy | (20L) |

**Course Outcome:**

1. Students will be able to explain light matter interaction and spectroscopy
2. Students will be able to discuss on different medical imaging techniques
3. Students will be able to understand digital image and its properties
4. Students will be able to process digital image to improve image quality
5. Students will be able to extract clinical information through digital image processing

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of techniques which can be addressed further to solve various real life problems where concepts of medical imaging technique and biomedical spectroscopy are required . Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:** The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same  rule is followed as already given.

**List of Books:**

1. Fundamentals of Medical Imaging, Paul Suetens.
2. Digital image processing using Matlab, R. C. Gonzalaz, Richard. E. Woods, Steven L Eddins

**Course Type: Advanced Elective III**

**Course Name: Quantum Field Theory II**

**Course Code: SPH52108**

**Course Aim:** This course aims to focus on the principles and applications of advanced level quantum field theory.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| Loops and Divergences | (12L) |
| QCD | (12L) |
| Path integral approach of quantisation: Scalar and Spinor fields | (15L) |
| Path integral approach of quantisation: Gauge fields | (6L) |

**Course Outcome:**

1. Students will be able to understand the various divergences that arise in quantum field theory and how to extract physical information from the divergences.
2. Students will be able to understand the basics of theory of strong interaction known as Quantum Chromodynamics.
3. Students will be able to understand the path integral procedure to quantize scalar and spinor fields.
4. Students will be able to understand the path integral procedure to quantize gauge fields.

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve problems where concepts of advanced quantum field theory are required . Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same  rule is followed as already given.

**List of Books:**

1. A first book of Quantum Field theory, A Lahiri and P B Pal, 2005, 2nd Edn, Narosa.
2. Quantum Field Theory, L H Ryder, 1996, 2nd Edn, Cambridge University Press.
3. Quantum field theory, Itzykson& Zuber, 2006, Dover Publications Inc.
4. An introduction to quantum field theory, M.E. Peskin and D.V. Schroeder, 1995, Perseus Books.
5. Relativistic Quantum Fields, J.D. Bjorken and S.D. Drell, 1965, FIrst Edition, McGraw-Hill College.
6. Quantum Field Theory, F. Mandl and G. Shaw, 2010, 2nd Edn, Willey-Blackwell.
7. Field Theory: A Modern Primer, P. Ramond, 2007, Benjamin/Cummings Pub. Co./Sarat Book House.

**Course Type: Advanced Elective IV**

**Course Name: Dielectric Optical and Transport properties of Solids**

**Course Code: SPH52122**

**Course Aim:** This course aim to provide knowledge about different spectral, electronic and transport related properties of solids.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---:|
| **Optical properties of solids** | (20L) |
| **Electronic properties** | (15L) |
| **Quantum Transport** | (25L) |

**Course Outcome**

1. Students will be able to understand Dielectric and Optical Properties of Solids
2. Students will be able to acquire the concepts of Phonon, Polaron and Polaritons
3. Students will be able to learn about electronic properties of metals and semiconductors
4. Students will be able to understand band bending at different Junctions, Mott insulators
5. Students will be able to understand the concepts of Quantum Confinement, Super lattice structures and 2DEG
6. Students will be able to learn of Transport properties at mesoscale and nanoscale length
7. Students will be able to understand concepts and applications of Quantum Hall Effect (QHE) and Spin Hall Effect (SHE).

**Teaching Methodology:**

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various solid state physics related problems where ideas of spectral, electronic and transport properties of solids are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. Optical Properties of Solids: Mark Fox, Oxford Master series
2. H. Ibach and H. Luth: Solid State Physics: An Introduction to Theory and Experiments
3. Solid State Physics: Essential Concepts, avid W. Snoke.
4. J.M. Ziman: Principles of the Theory of Solids
5. Electronic Transport in Mesoscopic systems: Supriyo Datta, Cambridge Universuty Press
6. Quantum Transport: Atom to Transistor, Supriyo Datta, Cambridge Universuty Press
7. Lessons from Nanoelectronics: Supriyo Datta

**Course Type: Advanced Elective IV**

**Course Name: Biosensors and LASER in Medical Application**

**Course Code: SPH52124**

**Course Aim:** This course aims to provide knowledge regarding the applications of Biosensors and LASER in the field of Biomedical instrumentation.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| **Unit 1:** Displacement, motion and Pressure Measurement | (8L) |
| **Unit 2:** Temperature Measurement, Radiation Sensors | (7L) |
| **Unit 3:** Chemical Sensors, Fiber Optic sensors | (8L) |
| **Unit 4:** MEMS technology | (8L) |
| **Unit 5:** Laser systems in medicine and biology | (8L) |
| **Unit 6:** Surgical Applications Of Lasers | (7L) |
| **Unit 7:** Lasers In Diagnosis And Therapy | (7L) |
| **Unit 8:** Laser Safety Regulations | (7L) |

**Course Outcome**

1. Students will be able to illustrate the guidelines of high energy radiation
2. Students will be able to design consideration of X-ray imaging rooms
3. Students will be able to asses radiation protection devices
4. Students will be able to measure radiation exposure to patient and technician
5. Students will be able to interpret rules and regulations related to radiation technique

**Teaching Methodology:**

The course will consists of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the principles and applications of biosensors and LASERs which can be addressed further to solve various real life problems. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**

1. Leonie Munro, Editor: Herald Ostensen, Gudrun Ingolfsdottir. Basics of Radiation protection for everyday use How to achieve ALARA: Working tips and Guidelines. World Health Organization. 2004
2. Krishan, Step by Step Management of Chemo and Radiotherapy
3. CEMBER, H., Introduction to Health Physics, 3rd Edition, McGraw-Hill, New York (2000).
4. INTERNATIONAL ATOMIC ENERGY AGENCY, The Safe Use of Radiation Sources, Training Course Series No. 6, IAEA, Vienna 1996

**Course Type: Advanced Elective IV**

**Course Name: Particle Physics II**

**Course Code: SPH52126**

**Course Aim:** This course aims to provide knowledge regarding the theoretical formalism and possible applications in nature of advanced particle physics.

**Number of Lectures and Course Content Module wise:**

| | |
|---|---|
| Invariant Lagrangian | (20L) |
| QCD | (15L) |
| Quark Gluon Plasma | (15L) |

**Course Outcome**

**Teaching Methodology:**

The course will consists of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the principles of advanced particle physics which can be addressed further to solve various findings in nature. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

**Assessment Methods:**

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance the same rule is followed as already given.

**List of Books**:

1. Introduction to Elementary Particles: David Griffiths
2. An introduction to Quarks and Partons: F.E. Close.
3. Introduction to Gauge Field Theories: M. Chaichian and N.F. Nelipa.

**Course Type: Advanced Elective Lab II**

**Course Name: Condensed Matter Physics Lab**

**Course Code: SPH52204**

**Course Aim:** This course aims to provide hands on experience regarding different physical properties of solids.

**Course Content**

1. Determination of susceptibility of a paramagnetic solution ($FeCl_3/MnSO_4$) by Quinck's Method.
2. Determination of Dielectric constant of a specimen (liquid) at high frequency
3. Determination of Curie temperature of Monel metal.
4. Determination of Heat Capacities of Solids.
5. Dispersion Relation in periodic electrical circuit- Study of electrical analogue mono-atomic and di-atomic chain.
6. Study of Ferromagnetic-Paramagnetic phase transition in Ferrites.
7. Synthesis of metal thin films of (Cu/Ag metal) on a glass substrate by using thermal evaporation technique and structural characterization through XRD.
8. Synthesis of bulk/ nano structured Oxide materials ($ZnO/SnO_2$) and structural characterization through XRD and morphological study through SEM.

**Course Outcome**

1. Students will be able to determine the susceptibility of a paramagnetic solution (FeCl3/MnSO4) by Quinck's Method.
2. Students will be able to measure Dielectric constant of a specimen (liquid) at high frequency.
3. Students will be able to estimate Curie temperature of Monel metal.
4. Students will be able to measure Heat Capacities of Solids.
5. Students will be able to experiment on Ferromagnetic-Paramagnetic phase transition in Ferrites.
6. Students will be able to synthesize metal thin films of (Ag/Cu) on a glass substrate and characterize through XRD.
7. Students will be able to synthesize Oxide materials (ZnO/SnO2) and to perform structural and morphological characterization by XRD SEM

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Type: Advanced Elective Lab II**

**Course Name: Microprocessor and Image Processing Lab**

**Course Code: SPH52206**

**Course Aim:**

**Course Content**

1. Addition and subtraction of Two 16 bit data and store the result in Memory.
2. Multiplication and division of two 8 bit numbers and store the result in memory address
3. Programs for image gray-level transform.
4. Program to show histogram equalization effect for an image.
5. Programs for image filtering in spatial domain
6. Programs for image filtering in frequency domain.
7. Program for image segmentation.

**Course Outcome**

**Teaching Methodology:**

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

**Assessment Methods:**

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

**Course Type: Advanced Elective Lab II**

**Course Name: High Energy Physics Lab II**

**Course Code: SPH52208**

**Course Aim:** This course aims to impart programming knowledge which shall be helpful in simulating different high energy physics related phenomena.

**Course Content:**

**Numerical methods**
**Data analysis**
**Advanced tools for High Energy Physics**
**Short projects**
**Course Outcome:**

1. Students will be able to use Numerical methods to find the solutions of different non-linear equations, solution of different differential equations, partial differential equations and how to do various numerical integrations.
2. Students will be able to apply the basic principles of data analysis with special emphasis to data analysis in High Energy Physics.
3. Students will be able to apply basic principles of various object oriented programming languages.
4. Students will be able to solve various problems in High Energy Physics.

**Teaching Methodology**

The course will consist of practical classes of computer programming. The problems given in the classes and in the assignments focuses on the practical implementation of real life problems. This computer programming knowledge will help them to simulate several problems of Physics numerically.

**Assessment Methods**
The evaluation process is same as already been given in the previous courses. In the Internal Assessment component assignments will be there. In case of distribution of marks of attendance the same rule is followed as given previously.

**References:**

The reference are given in Computer Lab. Students are also encouraged to do research from different open access materials available in internet.
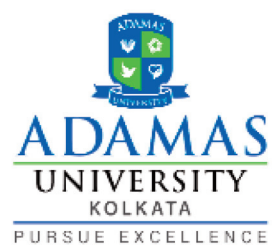
# ADAMAS UNIVERSITY

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