Ahmednagar Jilha Maratha VidyaPrasarakSamaj's

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

(Affiliated to SavitribaiPhule Pune University, Pune)

## Choice Based Credit System (CBCS)

## Bachelor of Science (B. Sc.)

Syllabus of

## T. Y. B. Sc. Physics

Implemented from

## Academic Year 2023-24

Ahmednagar Jilha Maratha VidyaPrasarakSamaj's

# New Arts, Commerce and Science College, Ahmednagar (Autonomous)

## Board of Studies (BOS) in Physics

| Sr. No. | Name | Designation |
|---|---|---|
| 1. | Prof. (Dr.) Avinash V. Mancharkar | Chairman |
| 2. | Dr. Ashok A. Jadhavar | Member |
| 3. | Dr. AppasahebTorane | Academic Council Nominee |
| 4. | Dr. Vijay M. Mayekar | Academic Council Nominee |
| 5. | Prof. (Dr.) Arun G. Banpurkar | Vice Chancellor Nominee |
| 6. | Prof. (Dr.) Nandu B. Chaure | Alumnus |
| 7. | Dr. Vinay Hasabnis | Industry Expert |
| 8. | Dr. Shrikrushna B. Gaikwad | Member (Co-opt) |
| 9. | Mr. Dattatray K. Sonwane | Member (Co-opt) |
| 10. | Mr. Dipak S. Shelar | Member (Co-opt) |

## 1. Prologue/ Introduction of the programme:

The curriculum for the B. Sc. in Physicsdesigned for the requirement of Choice Based Credit System (CBCS) following the University Grants Commission (UGC) and SavitribaiPhule Pune University guidelines. As per the guidelines, we proposed structure including Core courses, Discipline specific courses - Physics and Elective Courses, along with Ability Enhancement and Skill based Courses. In the CBCS pattern, continuous assessment of the students is an integral part. This continuous assessment carried out through systematic based on better understanding of the subject. During the curriculum designing, we have added the skill oriented courses to encourage students for achieving fruitful skills while completing their bachelor degree in Physics. Curriculum is designed to motivate students for the pursuing higher studies in Physics and inculcate enough skills for becoming anentrepreneur.

## 2. Programme Outcomes (POs)

Students enrolled in the program complete a curriculum that exposes and trains students in a full range of essential skills and abilities.

I. To inculcate scientific approach to get basic knowledge of concepts of Physics.
II. To motivate students for participation in scientific events like science exhibition.
III. To motivate students to scientific institutes, industrial visits, etc. so that they can understood scientific and technological aspects of Physics.
IV. To enhanced knowledge through problem solving, minor and major projects, seminars, tutorials, etc.
V. To motivate students to peruse higher career in physics.
VI. To give hands on experience to conduct various experiments, which help students to learn various concepts of Physics.
VII. To motivate to solve real life problems with experimental and computational tools, this will helps to develop ability to address real world problems.
VIII. To train students in skills related to conduct experiments, research and education through major and mini projects.
IX. To help students to build-up a progressive and successful career in Physics.
X. To motivate students to use the knowledge for the society.
XI. During the regular learning process, we provide them soft skill for their bright future.

# Program Structure and Course Titles

| Sr. No. | Class | Semester | Course Code | Course Title | Credits |
|---|---|---|---|---|---|
| 1. | F.Y.B.Sc. | I | BSC-PH 101 T | Mechanics and Properties of Matter | 02 |
| 2. | | | BSC-PH 102 T | Physics Principles and Applications | 02 |
| 3. | | | BSC-PH 103 P | Physics Laboratory- 1A | 1.5 |
| 4. | | II | BSC-PH 201 T | Heat and Thermodynamics | 02 |
| 5. | | | BSC-PH 202 T | Electricity and Magnetism | 02 |
| 6. | | | BSC-PH 203 P | Physics Laboratory- 1B | 1.5 |
| 7. | S.Y.B.Sc. | III | BSC-PH 301 T | Mathematical Methods in Physics I | 02 |
| 8. | | | BSC-PH 302 T (A) | Electronics I | 02 |
| 9. | | | OR | | |
| 10. | | | BSC-PH 302 T (B) | Instrumentation I | |
| 11. | | | BSC-PH 303 P | Physics Laboratory-2A | 02 |
| 12. | | IV | BSC-PH 401 T | Oscillations, Waves and Sound | 02 |
| 13. | | | BSC-PH 402 T | Optics | 02 |
| 14. | | | BSC-PH 403 P | Physics Laboratory-2B | 02 |
| 15. | T.Y.B.Sc. | V | BSC-PH 501 T | Mathematical Methods in Physics II | 02 |
| 16. | | | BSC-PH 502 T | Electrodynamics | 02 |
| 17. | | | BSC-PH 503 T | Classical Mechanics | 02 |
| 18. | | | BSC-PH 504 T | Atomic and Molecular Physics | 02 |
| 19. | | | BSC-PH 505 T | Computational Physics (C Programming) | 02 |
| 20. | | | BSC-PH 506 T | Astronomy and Astrophysics - I (Elective I) | 02 |
| 21. | | | BSC-PH 507 P | Physics Laboratory-3A | 02 |
| 22. | | | BSC-PH 508 P | Physics Laboratory-3B | 02 |
| 23. | | | BSC-PH 509 P | Project I | 02 |

| | | | | | |
|---|---|---|---|---|---|
| **24.** | | | BSC-PH 510 T | Internet of Things (IoT) (Skill Enhancement Course – I T) | **02** |
| **25.** | | | BSC-PH 511 P | Internet of Things (IoT) (Skill Enhancement Course – I P) | **02** |
| **26.** | | **VI** | BSC-PH 601 T | Solid State Physics | **02** |
| **27.** | | | BSC- PH 602 T | Quantum Mechanics | **02** |
| **28.** | | | BSC- PH 603 T | Thermodynamics and Statistical Physics | **02** |
| **29.** | | | BSC- PH 604 T | Nuclear Physics | **02** |
| **30.** | | | BSC- PH 605 T (A) | Electronics II | **02** |
| **31.** | | | OR | | |
| **32.** | | | BSC- PH 605 T (B) | Advanced Electronics | |
| **33.** | | | BSC- PH 606 T | Astronomy and Astrophysics – II (Elective II) | **02** |
| **34.** | | | BSC- PH 607 P | Physics Laboratory-4A | **02** |
| **35.** | | | BSC- PH 608 P | Physics Laboratory-4B | **02** |
| **36.** | | | BSC- PH 609 P | Project II | **02** |
| **37.** | | | BSC- PH 610 T | Python Programming (Skill Enhancement Course – II T) | **02** |
| **38.** | | | BSC- PH 611 P | Python Programming (Skill Enhancement Course – II P) | **02** |

| Semester –V | Paper –I |
|---|---|
| **Course Code:** BSC-PH 501 T | **Title of the Course:** Mathematical Methods in Physics II |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Recall the knowledge of calculus, vectors, vector calculus.<br>2. Illustrate methods of solving partial differential equations with the examples of important partial differential equations in Physics.<br>3. Determine transformation equations and construct various coordinate systems. | 1. Apply the various methods for solving differential equations in various physical problems.<br>2. Student can formulate the special functions, such as the Hermite polynomials, Legendre and Bessel Polynomial.<br>3. Student can compare cartesian, spherical and cylindrical coordinate systems. |

**Unit 1: Curvilinear Co-ordinates (9 Hrs.)**

Review of cartesian, spherical and cylindrical co-ordinate, transformation equation, General Curvilinear co-ordinate system: Co-ordinate surface, co-ordinate lines, length, surfaces and volume elements in curvilinear co-ordinate system. Orthogonal curvilinear co-ordinate system, expressions for gradient, divergence, Laplacian, and curl, special case for gradient, divergence and curl in Cartesian, spherical polar and cylindrical co-ordinate system, Problems.

**Unit 2: The Special Theory of Relativity (9 Hrs.)**

Introduction, Newtonian relativity, Galilean transformation equation, Michelson-Morley experiment, Postulates of special theory of relativity, Lorentz transformations, Kinematic effects of Lorentz transformation, Length contraction, Proper time, Problems.

**Unit 3: Partial Differential Equations (6 Hrs.)**

Introduction to Partial differential equations (PDE), General methods for solving second order PDE, Method of separation of variables in Cartesian, Spherical polar and cylindrical co-ordinate system (two dimensional Laplace's equation, one dimensional Wave equation),Singular points (x = x0), Solution of differential equation, Frobenius method of series solution.

**Unit 4: Special Functions (6 Hrs.)**

Introduction, generating function for Legendre Polynomials: Pn(x), Properties of Legendre Polynomials, Generating function for Hermite Polynomials: Hn(x), Properties of Hermite Polynomials, Bessel function of first kind: Jn (x), Properties of Bessel function of first kind, Problems.

**Reference books:**


1. Mathematical methods for physicists, Arfken and Weber, Academic Press (Ed.7th)
2. Mathematical methods in the physical sciences – M. L. Boas, John Willy & Sons, (Ed.3rd)
3. Introduction to special relativity, Robert Resnick, John Wiley & Sons, Inc.-1968.
4. Mathematical physics, H. K. Dass, Dr. Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition2014
5. The Special Theory of Relativity: A Mathematical Approach-Farook Rahman, Springer Publication -2014.
6. Introduction to Mathematical Physics - C. Harper (Prentice-Hall of India).
7. Mathematical Methods - M. C. Potter and J. Goldberg (Prentice-Hall of India).
8. NPTEL Video: https://youtu.be/MD40K7OUH24 Mathematical Methods in Physics 2, IISER Bhopal ,Prof. Auditya Sharma, How to construct orthogonal polynomials.
9. NPTEL Video: https://youtu.be/S0SPAWrxDSM Mathematical Methods in Physics 2, IISER Bhopal ,Prof. Auditya Sharma, Recursion relations.

| Semester –V | Paper -II |
|---|---|
| **Course Code:** BSC-PH 502 T | **Title of the Course:** Electrodynamics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain basics of electrostatics.<br>2. Explain concept of magnetostatics.<br>3. Explain various applications of the electrodynamics for day-to-day life.<br>4. Explain Ampere's law, Faraday's law of electromagnetic induction with the help of problems<br>5. Motivate to solve numerical problems. | 1. Understand basics of electrostatics.<br>2. Understand basics of magnetostatics.<br>3. Understand relationship between electrostatics and magneto statics.<br>4. Analyzed the basics of applied electrodynamics, and various applications.<br>5. Demonstrate quantitative problem solving skills in all the topics covered. |

**Unit 1: Electrostatics (10 Hrs.)**

Revision of Coulomb's law, Gauss law, Electric field, Electrostatic Potential, Potential energy of system of charges, Statement of Poisson's and Laplace's equation, Boundary Value problems in electrostatics, Boundary conditions, Polarization (P), Electric displacement (D), Electric susceptibility ($\chi$) and dielectric constant (k), bound volume and surface charge densities, Electric field at an exterior and interior point of dielectric, Problems.

**Unit 2: Magnetostatics I (04 Hrs.)**

Concepts of magnetic induction, magnetic flux and magnetic field, Magnetic induction due to straight current carrying conductor, magnetization of matter, relationship between B, H and M, Boundary conditions at the interface of two magnetic media (Normal and tangential components).

**Unit 3: Magnetostatics II (06 Hrs.)**

Biot-Savart's law, Ampere's force law, Magnetic force between two current carrying loops, Ampere's circuital law, Equation of continuity, Magnetic vector potential, Magnetic susceptibility and permeability, Problems.

**Unit 4: Electrodynamics (10 Hrs.)**

Concept of electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law, Maxwell's equations (Differential and Integral form) and their physical significance, Polarization, reflection & refraction of electromagnetic waves through media, Wave equation and plane waves in free space, Poynting theorem & Poynting vector, Problems.

**Reference Books:**

1. Introduction To Electrodynamics; D. J. Griffith; Cambridge India; Fourth Edition, (2020)
2. Classical Electrodynamics; J. D. Jackson; Wiley; Third Edition, (2007)
3. Introduction to Electrodynamics; A. Z. Capri, Panat P. V.; Alpha Science International Ltd; Illustrated Edition, (2002)
4. Foundations of Electromagnetic Theory; Reitz, Milford and Christy; Pearson Education India; Fourth Edition, (2010)
5. Electrodynamics; Gupta, Kumar, Singh; Pragati Prakashan; Ninteenth Edition, (2011)
6. NPTEL Video: https://nptel.ac.in/courses/115/106/115106122/ Electromagnetism, Prof. Nirmal Ganguli, Department of Physics, IISER Bhopal.
7. NPTEL Video: https://nptel.ac.in/courses/108/106/108106073/ Electromagnetic Fields - Prof. Harishankar Ramachandran, Department of Electrical Engineering, IIT Madras.

| Semester –V | Paper - III |
|---|---|
| **Course Code:** BSC-PH 503 T | **Title of the Course:** Classical Mechanics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Understand how charged particle will move in different applied fields.<br>2. Learn system of particles.<br>3. Study equation of motion other than Newton's.<br>4. Study real life use of projectile motion. | 1. Understand different equations of motion for different systems<br>2. Study all the physical quantities for system of particles<br>3. Understand the projectile motion<br>4. Study trajectories of charged particle in various fields. |

**Unit 1: Motion of Particles (07 Hrs.)**

Charged Particles: Motion of a charged particle in constant electric, magnetic and electromagnetic field, System of particles: Concept of Centre of mass, Conservation of linear momentum, angular momentum, energy of system of particles (statement only), Problems

**Unit 2: Central Force Field (07 Hrs.)**

Central force Field: Definition and Properties of central force field. Reduction of two body problem to an equivalent one body problem, Motion in central force field, Equation of orbit, Kepler's laws of planetary motion and their proof, Artificial satellite and its orbit, Problems.

**Unit 3: Scattering of Particles (08 Hrs.)**

Elastic and inelastic scattering: Definition and properties, Elastic scattering - Laboratory and center of mass system, Scattering angles in laboratory and center of mass system. Differential cross-section, impact parameter, total cross-section in brief, Problems

**Unit 4: Langrangian and Hamiltonian Formulation (08 Hrs.)**

Limitations of Newton's Law of Motion, Constraints and Their Classification, Example of Constrains, degrees of freedom, generalized coordinates, configuration space, Principle of Virtual work done, D'Almeberts Principle of virtual work, Langrangian equation from D' Alembert's principle, cyclic coordinates, Phase space, Hamiltonian's equations, Problems.

**Suggested Readings:**


1. Classical Mechanics, J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition (2005).
2. Introduction to Classical Mechanics, R. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi.
3. Classical Mechanics, NC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, (1991).
4. Classical Mechanics by P.V.Panat.
5. Classical Mechanics, Herbert Goldstein, Narosa Publishing House.
6. NPTEL Video: https://onlinecourses.nptel.ac.in/noc21_ph29/preview Introduction to Classical Mechanics Prof. Anurag Tripathi IIT Hyderabad.
7. NPTEL Video: https://onlinecourses.nptel.ac.in/noc21_ph32/preview Classical Mechanics: From Newtonian to Lagrangian Formulation Prof. Debamalya Banerjee, IIT Kharagpur,

| Semester –V | Paper – IV |
|---|---|
| **Course Code:** BSC-PH 504 T | **Title of the Course:** Atomic and Molecular Physics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain various atomic models, theories and properties atom.<br>2. Introduce various interactions of electrons with fields.<br>3. Explain various atomic models, theories and properties molecules.<br>4. Explain molecular spectroscopies. | 1. Understand various atomic models, theories and properties atom.<br>2. Analyze various interactions of electrons with fields.<br>3. Understand various atomic models, theories and properties molecules.<br>4. Learn molecular spectroscopies. |

**Unit 1: Atomic Structure (05 Hrs.)**

Revision of various atomic models, Vector atom model (Concepts of space quantization and electron spin), Pauli Exclusion Principle and electron configuration, Quantum states, Spectral notations of quantum states, Problems.

**Unit 2: One and Two Valence Electron Systems (10 Hrs.)**

Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na-atom, Selection rules, Spectra of sodium atom, Sodium doublet, Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ-coupling schemes, Singlet-Triplet separations for interaction energy of LS coupling, Lande's interval rule, Spectra of Helium atom, Problems.

**Unit 3: Zeeman Effect (04 Hrs.)**

Zeeman Effect, Experimental arrangement, Normal and anomalous Zeeman Effect, Stark effect (Qualitative discussion), Applications of Zeeman effect, Problems.

**Unit 4: Molecular Spectroscopy (06 Hrs.)**

Introduction of molecular spectra and its types, Rotational energy levels, Rotational spectra of rigid diatomic molecule, Vibrational energy levels, Rotational and Vibrational spectra, Electronic spectra of molecules, Applications of UV-Vis spectroscopy, Problems.

**Unit 5: Raman Spectroscopy (05 Hrs.)**

History of Raman Effect, Molecular polarizability, Classical theory and Quantum theory of Raman Effect, Characteristic Raman Lines and Applications of Raman spectroscopy, Problems.

**Reference books:**

1. R. Murugeshan, Er. K. Sivaprasath, Modern Physics, S. Chand, (2014).
2. Robert Eiseberg, Robert Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley, 2nd edition, (2016)
3. G. Aruldhas, Molecular structure and Spectroscopy, PHI, 2nd edition, (2015)
4. Colin Banwell, Elaine McCash, Fundamentals of Molecular Spectroscopy, TMH, 4th Ed.
5. Arthur Baiser, Concepts of Modern Physics, McGraw Hill International, 4th edition.
6. NPTEL Video: https://nptel.ac.in/courses/104/101/104101124/ Quantum Chemistry of Atoms and Molecules by Prof. Anindya Datta, Department of Chemistry, IIT Bombay.
7. NPTEL Video: https://nptel.ac.in/courses/115/105/115105100/ Atomic and Molecular Physics. Prof. Amal Kumar Das, Department of Physics, IIT Khargapur,
8. NPTEL Video: https://nptel.ac.in/courses/104/106/104106122/ Fundamental of Spectroscopy by Prof. Dr. Sayan Bagchi,Physical and Materials Chemistry Division, NCL, Pune and Prof. Dr. Anirban Hazra, Department of Chemistry, IISER – Pune.

| Semester –V | Paper - V |
|---|---|
| **Course Code:** BSC-PH 505 T | **Title of the Course:** Computational Physics (C-Programming) |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain importance of Programming Languages to solve real life problems.<br>2. Develop logic to solve the numerical problem using computer languages.<br>3. Explain the various program-coding, loops etc.<br>4. Motivate students to develop ability to compute numerical analysis. | 1. Understand basic structure of C language, concept of Flowchart and Algorithm.<br>2. Use C programming to solve the basic problems in Physics and objective oriented tasks.<br>3. Understand the basic of graphics in C programming.<br>4. Write the programs using C language. |

**Unit 1: Concepts of Programming (4 Hrs.)**

Definition and properties of algorithms, advantages and limitations of algorithm, algorithm development, some simple examples of algorithm, flow chart- symbols, properties of flow charts and simple examples of flowchart.

**Unit 2: Introduction to C-programming (13 Hrs.)**

Introduction and structure of C-program, 'C' character set, key words, identifiers, variables names, constants, data types, qualifiers and their declarations, symbolic constants. Input functions: scanf(), getchar(),gets() , Output functions: printf( ) , putchar(), puts().

Operators and expressions: arithmetic operators, relational operators, logical operators, assignment operators, conditional operator. control statements.

**Unit 3: Arrays and Pointers, User Defined Functions in C-Language (4 Hrs.)**

Arrays: definition, concepts, initialization, types of arrays: 1-d, 2-d. Examples: arranging numbers in descending and ascending order, sum of matrices, multiplication of matrices.

Concept of pointers with suitable illustrative examples. User defined functions: definitions and declaration of function, function prototype, passing arguments (call by value, call by reference). simple illustrative examples.

**Unit 4**: **Graphics in C-Language:** **(3 Hrs.)**

Concepts of graphics in C, Some simple graphic commands- Point, Line, Circle, Arc, Ellipse, Bar with suitable illustrative examples.

**Unit 5. Computational Physics** **(6 Hrs.)**

Numerical Methods to solve the Physics Problems: Iterative methods: Bisection method and Newton-Raphson Method– Algorithm, Flowchart and writing C- program for finding the roots of the equation, problems, Integration: Trapezoidal rule, Simpson's 1/3rd rule – Algorithm, Flowchart and C-program, problems.

**Suggested Readings:**

1. Programming in C- (Schaum's series), Gottfreid, TMH
2. Programming in C- Balgurusami, Prentice Hall publications
3. Let us C- Yashwant Kanetkar, BPB publications
4. Introductory methods of numerical Analysis-S. Sastry, Prentice Hall
5. Computer oriented numerical methods – V. Rajaraman.
6. NPTEL Video: https://youtu.be/JpN0GTJOxTk Introduction to programming in C, IIT Kanpur, Prof. Satyadev Nandakumar.
7. NPTEL Video: https://youtu.be/-wv-OERJK3M Problem Solving through Programming in C, IIT Kharagpur, Prof. Anupam Basu.
8. NPTEL Video: https://www.youtube.com/watch?v=wy5lKE2MO3E Decision making statements, IIT Kharagpur, Prof. Anupam Basu.

| Semester –V | Paper – VI |
|---|---|
| **Course Code:** BSC-PH 506 T | **Title of the Course:** Astronomy and Astrophysics - I |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. This course develops an interest about space and astronomy.<br>2. Introduce fundamental astronomical techniques.<br>3. Introduce instruments used for astronomical observation.<br>4. Creates awareness about Nuclear processes. | 1. On completion of the course, the students will be familiarize with the components of the Universe.<br>2. Explain nuclear reactions in stars and synthesis of elements in the universe and various cosmologies.<br>3. Able to classify stellar spectra.<br>4. On completion of the course, the students will be aware of theories about origin of universe. |

**Unit 1: Fundamentals of Astronomy (9 Hrs.)**

Components of the universe: stars, planets, asteroids, meteors, comets, galaxies. Solar system: introduction and structure of solar system, age, origin. Basic measurements: planetary orbits, distances, physical size, mass, density, temperature, rotation period determination.

**Unit 2: Astronomical Instruments (6 Hrs.)**

Optical telescopes: mounts, light gathering power, magnification, resolution. spectroscopes, CCD camera, photometer, radio telescopes, interferometry (only introduction).

**Unit 3: Star Systems and Basic Observations (9 Hrs.)**

Stars life cycle: Chandrasekhar limit, stellar processes (nuclear), neutron stars, black holes, spectral classification of stars : O, B, A, F, G, K, M , H-R diagram (introduction only). Star systems: Binaries, Cepheids, RR Lyrae, Basic observations: eclipses, moon, planets, meteor showers, transits, occultations.

**Unit 4: Galaxies, Dark Matter and Dark Energy (6 Hrs.)**

Galaxies, types, their formation, Hubble's tuning fork diagram, open and globular clusters, dark matter / energy (evidence for both). Cosmology: theories: BBT, Steady State, Oscillating universe theory. Observational astronomy: introduction to constellations.

**Suggested Readings:**


1. Astronomy structure of the Universe. A.E. Roy and D. Clarke, Adam Hilger Pub.
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Astrophysics, Baidyanath Basu.
6. Astrophysical Techniques, third Edition, C. R. Kitchin
7. Telescopes and techniques, C. R. Kitchin (Springer)
8. Fundamental Astronomy, Sixth edition,H. Karttunen, Pekka Kroger, Heikki Oja.
9. Introduction to Astronomy and Cosmology, Ian Morison, Willey.
10. A Textbook of Astronomy and Astrophysics, M. Kumar Sharma, S. Chandra , Willey
11. An Introduction to Astronomy and Astrophysics, P. Jain , CRC Press, T and F. Group
12. Astrophysics & Cosmology, IIT Kharagpur Prof. S. Bharadwaj , The Expanding Universe and the Cosmological Metric https://www.youtube.com/watch?v=bAg-dJJY46A&t=6s
13. NPTEL Video: Astrophysics & Cosmology, IIT Kharagpur Prof. S. Bharadwaj Introduction to astronomy https://youtu.be/vDv3iSMdYyc
14. NPTEL Video: Astrophysics & Cosmology, IIT Kharagpur Prof. S. Bharadwaj https://youtu.be/zEGYWbM9ilE

| Semester –V | Paper -VII |
|---|---|
| **Course Code:** BSC-PH 507 P | **Title of the Course:** Physics Laboratory-3A |
| **Credits: 2** | **Total Hours: 60 Hrs. (12 Experiments)** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Hands on experience to handle various instruments<br>2. Explain thermal, electrical and magnetic properties of material with the help of experiment.<br>3. Explain modulus of elasticity and application in real life.<br>4. Explain properties of fluid and<br>5. Study various phenomenon using Optical properties | 1. Handle various instruments<br>2. Analyze thermal, electrical and magnetic properties of material by various methods.<br>3. Determine young's modulus through experiment.<br>4. Understand different properties of fluid like surface tension/ viscosity<br>5. Determine wavelength of laser, diameter of wire using optical properties. |

**Section I- General Physics (Any Five)**

| Sr. No | Title of the experiment |
|---|---|
| 1) | Kater's pendulum |
| 2) | Moment of Inertia by Bifilar suspension |
| 3) | Young's modulus by Koeing method |
| 4) | Surface tension of mercury by ripple method |
| 5) | Surface tension liquid by Fergusson method |
| 6) | Surface tension of mercury by Quincke's method |
| 7) | 'Y' by vibration of wooden scale. |
| 8) | Young's modulus by Newton's rings. |
| 9) | Determination of wavelength of light by Michelson's interferometer |
| 10) | Study of damped oscillations of physical pendulum and finding log decrement |

**Section I - Electromagnetism Atomic, Molecular Physics and Optics (Any Five)**

| Sr. No | Title of the experiment |
|---|---|
| **1)** | Study of forced oscillations by electromagnetically driven simple pendulum |
| **2)** | Self-Inductance by Anderson's bridge |
| **3)** | Core losses in transformers |
| **4)** | Electromagnetic pendulum |
| **5)** | Self-Inductance by Maxwell's bridge |
| **6)** | Determination of Rydberg's constant |
| **7)** | Zeeman Effect |
| **8)** | Llyod's mirror |
| **9)** | Determination of Resolving Power of grating |
| **10)** | Determination of wavelength by Constant deviation spectrometer |

- Draw graphs for any 4 experiments from Section I and II using Microsoft Excel/ GNU Plot/MAXIMA/Wolfram Cloud/Origin or any other equivalent software activity equivalent to **Two** practical.
- Study tour visit report / mini project / demonstration / science exhibition participation or any other activity related to this course is equivalent to **Two** practical.

| Semester –V | Paper -VIII |
|---|---|
| **Course Code:** BSC-PH 508 P | **Title of the Course:** Physics Laboratory-3B |
| **Credits: 2** | **Total Hours: 60 Hrs. (12 Experiments)** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Introduction to experimental techniques.<br>2. Arrange the apparatus as per the requirements of the aims and objectives of the experiment.<br>3. Demonstrate the procedure to perform the experiments and the skills required for the particular experiment.<br>4. Perform the experiment, tabulate the data and obtain the result. | 1. Describe different experimental techniques to determine values of various constants, coefficients, parameters.<br>2. Explain the theory behind the formulae used.<br>3. Standardize the entire procedure to obtain reliable, repeatable results.<br>4. Student can hypothesize the result. |

**Section I: Electronics and Advanced Electronics (Any Two)**

| Sr. No | Title of the experiment |
|---|---|
| 1. | IV Characteristics of diode using Computer Interface |
| 2. | Measuring a value of a capacitor using CRO/Computer Interface |
| 3. | Temperature controller using AD590 |
| 4. | Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter. |

**Section II: Astronomy and Astrophysics I (Any Two)**

| Sr. No | Title of the experiment |
|---|---|
| 1. | Study of Binocular, refracting and reflecting telescopes and their mounts. |
| 2. | Determination of the diameter of the Moon or Sun. |
| 3. | Solar Eclipse and Lunar Eclipse. |
| 4. | Measurement of Solar Constant. |

## Section III: C-PROGRAMMING (Any Six)

| Sr. No | Title of the experiment C Programming |
|---|---|
| 1. | Factorial of a number by simple and recursive method. |
| 2. | To find out the first 100 prime numbers |
| 3. | Matrix multiplication |
| 4. | Addition of Two matrix. |
| 5. | Use of Arithmetic, Increment/ decrement and Logical operators. |
| 6. | Roots of an algebraic equation (Bisection) |
| 7. | Roots of polynomial (Newton Raphson) |
| 8. | Numerical Integration by Trapezoidal rule |
| 9. | Numerical Integration by Simpson's 1/3 rule |

**Additional Activities (Any ONE)**

- Draw graphs for any four experiments from Section I and II using Microsoft Excel/ GNU Plot/MAXIMA/Wolfram Cloud/Origin or any other equivalent software activity equivalent to **Two** practical.
- Study tour visit report / mini project / demonstration / science exhibition participation or any other activity related to this course is equivalent to **Two** practical.

| **Semester –V** | **Paper –IX** |
|---|---|
| **Course Code:** BSC-PH 509 P | **Title of the Course:** Project 1 |
| **Credits: 2** | **Total Hours: 60 Hrs.** |

**Guidelines:**

It is expected that,

1. The student does work equivalent to about twelve (12) laboratory experiments throughout the semester in the third year.
2. Project work is a practical course and it introduced to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the final presentation at the time of viva voce.
6. It also recommended that a teacher will look after Four (4) projects at one time.
7. Practical examination will be conducted semester wise.
8. The student can perform an Experimental/Theoretical/Computational Project in Physics or interdisciplinary areas under the supervision of one or more guides.
9. The student can learn the basics of the topic chosen for project, to learn how to do literature survey and set up the basic experimental/theoretical and computational techniques needed for the project.
10. The department encourage students to select projects from experimental as well as theoretical areas of Physics in collaboration with other institutes and industry.

The Project work shall consist of the following Criterions.

1. Project work is mandatory for all the T. Y .B. Sc. students.
2. All the T. Y. B. Sc. students will be have to complete the Project work prescribed by the Board of Studies in Physics of Department of Physics during the Vth Semester.
3. The Project work shall consist of the following Criterions.

- It expected that students must finalize the Title of Project, Aim and objective, Significance, Literature survey, Materials required, Method and Application etc.
- Introduction to foundations of Project Work.
- Study of Data Collection Methods.
- Project Problem Writing and Presentation Skills.
- Submission of the monthly Progress Report is Mandatory.

Evaluation weightage:

Project-I:

Semester End Examination: 35 Marks

Internal Examination: 15 Marks

**Note:**

During the End Semester examination, student have to submit the monthly progress report duly signed by respective guide. At the time of project examination, the candidate must submit the certified project progress report by the project in-charge and HOD.

| **Semester –V** | **Paper - X** |
|---|---|
| **Course Code:** BSC-PH 510 T | **Title of the Course:** Internet of Things (IoT) (Skill Enhancement Course I) |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain the basic building blocks of IoT.<br>2. Explain comprehend the concepts of cloud technology and cloud platforms used in IoT.<br>3. Introduced hardware components used for development of IoT based application. | 1. Understand the basic building blocks of IoT.<br>2. Comprehend the concepts of cloud technology and cloud platforms used in IoT.<br>3. Identify hardware components used for development of IoT based application. |

**Unit 1: Introduction to IoT (8 Hrs.)**

History, introduction, overview and motivations, definition and characteristics of IoT. Technical Building blocks of IoT, Devices, Physical design of IoT, basic nodal capabilities. M2M vs. IoT. Identification of IoT Objects and Services.

Structural aspects of the IoT: Environment characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture. IoT Issues and Challenges. Applications of IoT.

**Unit 2: Key IoT Technologies and Protocols (8 Hrs)**

IoT frameworks, Key IoT Technologies - Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology and Satellite Technology.

IoT Protocols - MQTT, CoAP, XMPP and AMQT, IoT communication models, IoT Communication technologies - Bluetooth, BLE, Zigbee, Zwave, NFC, RFID, etc.

**Unit 3: Cloud Technology and Hardware platforms for IoT (6 Hrs.)**

Role of cloud in IoT, cloud topologies, Cloud access, Cloud services – SaaS, PaaS, IaaS. Introduction to ThingSpeak and Blynk App. Arduino hardware platform – introduction, types, features, architecture, Pin configuration, analog and digital port.

**Unit 4: Arduino Programming and Peripheral Interfacing (8 Hrs.)**

Variables and data types, Operators - arithmetic, logical, relational, comparison, modulo and assignment, If-Else Statement, While and For Loop, Arduino program structure. Library functions for – Digital read write, analog read write and serial communication. Peripheral Interfacing: LED, button, buzzer, LM35 sensor and Bluetooth module interfacing.

**Suggested Readings:**


1. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications - Daniel Minoli, Willy Publications, 2013.
2. The Internet of Things: Key Applications and Protocols – Olivier Hersent, David Boswarthick, Omar Elloumi, ISBN: 978-1-119-99435-0, 2nd Edition, Willy, 2011.
3. The Internet of Things: Enabling Technologies, Platforms, and Use Cases" - Pethuru Raj and Anupama C. Raman, CRC Press, Auerbach Publications; 1st edition (2 March 2017)
4. Introduction to IoT., S. Misra, A. Mukherjee, A. Roy, Cambridge University Press, 2020.
5. Introduction to Industrial Internet of Things and Industry 4.0., S. Misra, C. Roy, and A. Mukherjee, CRC Press, 2020.
6. https://onlinecourses.nptel.ac.in/noc22_cs53/preview Prof. Sudip Misra, IIT Kharagpur, 2022
7. https://archive.nptel.ac.in/courses/106/105/106105166/ INTRODUCTION TO INTERNET OF THINGS, PROF. SUDIP MISRA, Department of Computer Science and Engineering, IIT Kharagpur
8. https://nptel.ac.in/courses/108108098 Design for Internet of Things, TV Prabhakar, Department of Electronic Systems Engineering, IISC, Banglore.

| **Semester –V** | **Paper – XI** |
|---|---|
| **Course Code:** BSC-PH 511 P | **Title of the Course:** Internet of Things (IoT) Lab (Skill Enhancement Course I) |
| **Credits: 2** | **Total Hours: 60 Hrs. (12 Experiments)** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain Arduino / Node MCU / Any other IoT hardware platform to perform different experiments.<br>2. Explain interface different I/O devices and wireless communication modules to Arduino / Node MCU / Any other IoT hardware platform.<br>3. Introduced ThingSpeak IoT cloud platform. | 1. Use Arduino / NodeMCU / Any other IoT hardware platform to perform different experiments.<br>2. Interface different I/O devices and wireless communication modules to Arduino / NodeMCU / Any other IoT hardware platform.<br>3. Use ThingSpeak IoT cloud platform. |

| **Sr. No** | **Title of the experiment** |
|---|---|
| **1.** | To get familiarize with Arduino and perform necessary installation procedure. |
| **2.** | LED blinking and LED Fade in, fade out. |
| **3.** | To turn on / off buzzer for different time intervals. |
| **4.** | To interface LDR and turn on / off LED based on light intensity. |
| **5.** | Temperature monitoring using LM35 sensor. |
| **6.** | LED switching using mobile. |
| **7.** | To interface LM35 sensor and turn on / off buzzer based on temperature. |
| **8.** | To interface DHT11 sensor and observe the output on smartphone. |
| **9.** | Study of RFID technology. |

| | |
|---|---|
| **10.** | To interface GSM module for sending / receiving SMS. |
| **11.** | To interface motion sensor for intruder detection. |
| **12.** | Servo motor interfacing. |
| **13.** | Get status of switch and send it to the LED. |
| **14.** | LED on/off using Blynk app. |
| **15.** | To interface sensor and send data to Thing Speak cloud. |

- Draw graphs for any 4 experiments from Section I and II using Microsoft Excel/ GNU Plot/MAXIMA/Wolfram Cloud/Origin or any other equivalent software activity equivalent to **Two** practical.
- Study tour visit report / mini project / demonstration / science exhibition participation or any other activity related to this course is equivalent to **Two** practical.

| Semester –VI | Paper –I |
|---|---|
| **Course Code:** BSC-PH 601 T | **Title of the Course:** Solid State Physics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain basics crystal structures.<br>2. Explain and analyze principle of XRD technique.<br>3. Explain historical development in the band structure in solids.<br>4. Explain magnetism in solids. | 1. Understand basics crystal structures.<br>2. Understand and learn the XRD technique to analyze crystal structure.<br>3. Understand energy band in solids.<br>4. Understand magnetism in solid materials. |

**Unit I: Crystalline Structures (9 Hrs.)**

Lattice, basis, translational vectors, primitive unit cell, symmetry operations, different types of lattices: 2d and 3d (bravais lattices) miller indices, inter planer distances, SC, BCC and FCC, HCP structures, packing fraction, crystal structures NaCl, diamond concept of reciprocal lattice and its properties, problems

**Unit 2: X ray Diffraction and Experimental Methods (7 Hrs.)**

Bragg's diffraction, Bragg's Law, experimental X-ray diffraction methods: Laue Method, Bragg's spectrometer, powder crystal method, Analysis of cubic structure by powder method, Ewald's construction, Bragg's diffraction condition in direct and reciprocal lattice, Problems

**Unit 3: Free Electron and Band Theory of Metals (7 Hrs.)**

Assumptions of classical and Sommerfeld free electron model, energy levels and density of states (one and three dimensions), nearly free electron model, fermi energy, fermi level, Hall effect, mobility, Hall angle band theory of solids: origin of energy gap, energy bands in solids, distinction between metal, semiconductor and insulator, problems

**Unit 4: Magnetism (7 Hrs.)**

Diamagnetism, Langevin theory of diamagnetism, paramagnetism, Langevin theory of paramagnetism, ferromagnetism, antiferromagnetism, ferromagnetic domains, hysteresis, Curie temperature, Neel temperature, superconductivity, problems

**Reference books:**


1. Solid State Physics S.O.Pillai, Ed. 6th, New Age International (P) Ltd, Publisher, (2010).
2. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
3. Solid State Physics- A.J.Dekker, Macmillan India Ltd, (1998).
4. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
5. Elementary Solid State Physics Principles and Applications, M Ali Omar, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.(2006)
6. Problems and Solution in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
7. NPTEL Video: https://www.digimat.in/nptel/courses/video/115105099/L03.html Structures of solids by Dr. Amal Kumar Das, Department of Physics, IIT, Kharagpur
8. NPTEL Video: https://www.digimat.in/nptel/courses/video/112106227/L21.html X-ray crystallography by Prof. R.K. Roy, Department of crystal structure, IIT Madras
9. NPTEL Video: https://onlinecourses.nptel.ac.in/noc21_ph34/preview Bonds and Bands in solids, by Prof. S.R. Ramasesha, IISC Bangalore.

| Semester –VI | Paper -II |
|---|---|
| **Course Code:** BSC-PH 602 T | **Title of the Course:** Quantum Mechanics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Describe and learn theoretical aspects at Quantum Level.<br>2. Apply Schrodinger's equation for different cases of potential (V).<br>3. Explain concept of operators and apply it in Quantum mechanics.<br>4. Review Hydrogen atom model and quantum numbers n, l, $m_l$, $m_s$ and degeneracy | 1. Clarify more about the insight of the microscopic world.<br>2. Student can write Schrodinger's equation in spherically symmetric polar co-ordinate system.<br>3. Student can draw wave functions.<br>4. Student can understand dynamics of Rigid Rotator. |

**Unit 1: Origin of Quantum Mechanics (6 Hrs.)**

Historical Background: Black body radiation, photoelectric effects, Matter waves - De Broglie hypothesis, Davisson and Germer experiment, Wave particle duality, Concept of wave function, wave packet, phase velocity, group velocity and relation between them, Heisenberg's uncertainty principle with Electron diffraction experiment, different forms of uncertainty relations, application of uncertainity relation such as electron cannot exist inside nucleus, Problems.

**Unit 2: The Schrodinger equation (9 Hrs.)**

Physical interpretation of wave function, Schrodinger time dependent equation, Schrodinger time independent equation (Steady state equation), Requirements of wave function, Probability current density, equation of continuity, and its physical significance, operators in Quantum mechanics, Eigen function and Eigen values, Expectation value, Ehrenfest's theorem (Only statement), Problems.

**Unit 3: Applications of Schrodinger Steady state equation (11 Hrs.)**

Free particle. Step potential, Potential barrier, (Qualitative discussion), Barrier penetration and tunneling effect, Particle in infinitely deep potential well (one - dimension), Schrodinger's equation in spherical polar co-ordinate system, Problems.

**Unit 4: Operators in Quantum Mechanics (4 Hrs.)**

Hermitian operator: Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian), Commutator brackets- Simultaneous Eigen functions, Commutator Algebra, Commutator bracket using position, momentum and angular momentum operator, Concept of parity according to quantum mechanics, parity operator and its Eigen values, Problems.

**Reference books:**

1. Eisberg, Robert M., and Robert Resnick. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles. Wiley, 1985. ISBN: 9780471873730.
2. Li-Boff, Richard L. Introductory Quantum Mechanics. Addison Wesley, 2002.
3. Griffiths, David J. Introduction to Quantum Mechanics. Upper Saddle River, Pearson Prentice Hall, 2005.
4. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication.
5. N. Zettili, Quantum Mechanics- Concepts and applications, Wiley publication, ISBN: 978-0-470- 02679- 7. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer Publication.
6. NPTEL Video: https://www.youtube.com/watch?v=pGerRhxNQJE , Introduction to Quantum Mechanics I by Prof. S. Lakshmi Bala, Department of Physics, IIT Madras.
7. NPTEL Video: https://www.youtube.com/watch?v=TcmGYe39XG0 Heisenberg Uncertainity Relation by Prof S.Balakrishnan Department of Physics IIT Madras
8. NPTEL Video: https://www.youtube.com/watch?v=y3ARLfm-52w Introduction to linear Vector Spaces by Prof S.Balakrishnan Department of Physics IIT Madras.

| Semester –VI | Paper - III |
|---|---|
| **Course Code:** BSC-PH 603 T | **Title of the Course:** Thermodynamics and Statistical Physics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Design statistical tools to study thermodynamical interactions in ensembles.<br>2. Comparison of the MB, BE and FD statistics and classify particles<br>3. Explain the quantum statistics and differentiate between classical and quantum statistics | 1. Define thermodynamic quantities and functions.<br>2. Student can estimate the probabilities in statistical processes.<br>3. Apply the knowledge of Entropy and density of states to understand the concept of temperature. |

**Unit 1: Transport phenomenon and Maxwell's Relations (6 Hrs.)**

Mean free path, Transport phenomenon, Viscosity, Thermal conductivity and diffusion. Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function, Derivation of Maxwell Relations, Specific heat and latent heat equations, Adiabatic demagnetization, Problems

**Unit 2: Elementary Concepts of Statistics (6 Hrs.)**

Probability, distribution functions, Random Walk and Binomial distribution, Simple random walk problem, Calculation of mean values, Probability distribution for large-scale N, Gaussian probability distributions, Problems

**Unit 3: Statistical Distribution of System of Particles and Ensembles: (13 Hrs.)**

Specification of state of system, Statistical ensembles, Basic Postulates, Probability calculations, Behaviors of density of states, Thermal, Mechanical and general interactions Micro Canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble, Molecules in Ideal gas, Calculation of mean values in canonical ensemble. Problems.

**Unit 4: Introduction to Quantum Statistics (5 Hrs.)**

Quantum distribution function, Maxwell-Boltzmann's statistics, Classical statistical mechanics Maxwell-Boltzmann distribution law, calculation of thermodynamic quantities for ideal monoatomic gases. Bose-Einstein Statistics, Fermi-Dirac Statistics, Comparison of the distributions. Applications of Quantum Statistics, Problems

**Reference books:**


1. Statistical and Thermal physics, Lokanathan, R.S. Gambhir,
2. Fundamentals of statistical and thermal physics, F. Reif,
3. Perspectives of modern physics, A. Beiser
4. Fundamental of Statistical Mechanics, B.B. Laud
5. Heat and thermodynamics - Zemansky and Ditman (Mc Graw Hill, Kugakusha).
6. Kinetic theory of gases - Loeb (Radha Publ. House).
7. A Treatise on Heat - Saha and Sribastava (The Indian Press Ltd).
8. Thermal Physics – S. Garg, R. M. Bansal, C. K. Ghosh (Tata Mc Graw Hill).
9. Heat and Thermodynamics – H. P. Roy and A. B. Gupta (New Central Book Agency).
10. NPTEL Video: https://www.youtube.com/watch?v=iud7fzXPJUs Introduction to statistical Mechanics NPTEL IIT Guwahati Prof. Girish S. Setlur Department of Physics IIT Guwahati.
11. NPTEL Video: https://www.youtube.com/watch?v=UBwiqa8yB7Q Thermodynamic potentials Prof. Girish S. Setlur Department of Physics IIT Guwahati.
12. NPTEL Video: https://www.youtube.com/watch?v=GNmsXLwalCU Relations between ensembles and Theory of Paramagnetism – YouTube Prof. Girish S. Seltur Department of Physics IIT Guwahati.

| Semester –VI | Paper - IV |
|---|---|
| **Course Code:** BSC-PH 604 T | **Title of the Course:** Nuclear Physics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain various properties of radioactive particles.<br>2. Introduce physics behind the radiation detectors.<br>3. Discuss various nuclear models to understand nuclear configuration.<br>4. Explain nuclear reactors and Accelerators.<br>5. Introduce Nuclear Interactions and Particle Physics. | 1. Learn radioactive properties and uses in various fields.<br>2. Understand the working of radiation detectors.<br>3. Determine nuclear configuration of various nuclei.<br>4. Understand working of nuclear reactors and Accelerators and their uses.<br>5. Classify Elementary Particles through nuclear reactions. |

**Unit 1: Basics of Nucleus: (05 Hrs.)**

Basic Concept of Nucleus: charge, size, density of nucleus (Revision), Nuclear Angular momentum, Nuclear magnetic dipole moment, Parity & symmetry, Mass defect and Binding energy, packing fraction, Classification of nuclei, Stability of nuclei (N Vs Z Curve) and problems.

**Unit 2: Radioactivity: (05 Hrs.)**

Radioactivity: Radioactivity disintegration (concept of natural and artificial radioactivity), Properties of α, β, γ-rays, Laws of radioactive decay, half-life, mean life, Specific activity and its units (Revision). Carbon dating, Application of radioactivity, Problems.

**Unit 3: Particle Accelerator and Radiation Detectors: (05 Hrs.)**

Particle Accelerators: Introduction and Classification, Linear Accelerator (electron/proton LINAC), Cyclic Accelerator (Cyclotron), Particle Accelerators in India (Discussion only) Nuclear Detector: Classification of Nuclear Detectors, Gas filled Detectors (G. M. counter), Solid state detectors (scintillation counter), Problems

**Unit 4: Nuclear forces and Nuclear Models: (8 Hrs.)**

Nuclear Forces: Classification of Nuclear Forces, Meson theory of nuclear forces, Properties Of nuclear forces, properties of deuteron system, Elementary particles, Quarks model for elementary particles, Shell Model: Assumptions, Evidences, and Spin and Parity limitations. Liquid drop model: Assumptions, Semi-empirical mass formula, Problems.

**Unit 5: Nuclear Reactions and Reactor Theory: (7 Hrs.)**

Introduction to Nuclear reactions: Nuclear Reaction, Conservation laws (Revision), The Q-value equation, Exothermic and Endothermic reaction, Compound nucleus, Threshold energy, Nuclear cross-section, Nuclear fission , nuclear fusion stellar energy, chain reaction and critical mass, Nuclear reactor and its basic components, homogeneous and heterogeneous reactors, power reactor, fast breeders, Nuclear Reactors In India (Discussion only), Problems.

**Suggested Readings:**

1. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House.
2. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989
3. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991
4. G.F. Knoll, Radiation Detection and Measurement, 3rd Edition, Wiley India, 2010
5. S.S. Kapoor and V.S. Ramamurthy, Nuclear Radiation Detectors, Wiley Eastern Limited, 2005
6. NPTEL Video: https://nptel.ac.in/courses/115/106/115106087/ Nuclear Reactors and Safety- An Introduction, Dr. G. Vaidyanathan, Department of Nuclear Engg, SRM University, 2015.
7. NPTEL Video: https://nptel.ac.in/courses/115/104/115104043/ Nuclear Physics: Fundamentals and Applications, Prof. H.C. Verma, Department of Physics, IIT, Kanpur, 2012.
8. NPTEL Video: https://nptel.ac.in/courses/115/103/115103101/ Nuclear and Particle Physics, Prof. Poulose, Department of Physics, IIT, Guwahati, 2021

| Semester –VI | Paper - V |
|---|---|
| **Course Code:** BSC-PH 605 T (A) | **Title of the Course:** Electronics II |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Introduction to semiconductor Devices.<br>2. Introduction to Integrated circuits.<br>3. Building blocks of digital electronics.<br>4. Understands mechanism of power supplies. | 1. Recall the basic digital gates.<br>2. Understand internal block and working of the Digital Integrated circuits.<br>3. Understand working of flip flops, counters, and registers.<br>4. Design digital circuits for dedicated applications. |

**Unit 1: Semiconductor Devices (8 Hrs.)**

LED and Photodiode, Optocoupler (working principles), Problems. BJT: Transistor amplifier classifications - Class A, B, C, (Introduction, working and Designing), Differential amplifier (transistorized), Problems.

Field Effect Transistor: JFET (Introduction, classification, principle, working and IV characteristics), MOSFETs (DE-MOSFET and E only MOSFET). Problems.

**Unit 2: Integrated Circuits (08 Hrs.)**

Integrated Circuits: Introduction, Scale of Integration, Advantages and drawbacks of IC, OP-AMP: Applications as Integrator, Differentiator, Comparator.

Timer IC-555: Block diagram, Astable, Monostable multivibrator (working and design). Problems.

IC723: Block diagram of IC723, circuits and design of basic low voltage (2 to 7 volt), Problems.

**Unit 3: Regulators Circuits (06 Hrs.)**

Three Pin Regulators: Block diagram of 3-pin IC regulator, study of IC-78XX, 79XX. Dual Power Supply using IC-78XX, 79XX.

Switching Regulators (SMPS): Introduction, Block diagram, Advantages and Disadvantages.

**Unit 4: Combinational Circuits (4 Hrs.)**

Combinational Circuits: Introduction to SOP and POS equation. Concept of Standard SOP and POS equation. Concept of K-map and their use in reduction of Boolean expressions, design of half adder, full adder, half subtractor, Problems.

**Unit 5: Sequential Circuits (4 Hrs.)**

Sequential Circuits: RS flip flop using NAND/NOR, clocked RS, D, JK and T-flip flops, Asynchronous and Synchronous Counters (3-bit Counter), Shift Registers and their types of operation -SISO, SIPO, PISO, PIPO (Concepts only).

**Suggested Readings:**

1. Malvino, Electronic Principles (6th Ed.), Tata McGraw Hill, New Delhi (Year)
2. OPAMP and Linear Integrated Circuits: Ramakanat Gaikwad
3. Power Supplies by B.S. Sonde
4. Linear Integrated Circuits by Roy and Chaudhari (4th Edition)
5. K. R. Botkar, Integrated Circuits, Khanna Publishers, Delhi
6. NPTEL Video: https://youtu.be/wo2S_G4ugz8 Basic Electronics and Lab, IIT Madras Prof. T.S. Natarajan , Semi-Conductor Diodes
7. NPTEL Video: https://youtu.be/hOT72IdQBbw Basic Electronics and Lab, IIT Madras Prof. T.S. Natarajan.

| Semester –VI | Paper - V |
|---|---|
| **Course Code:** BSC-PH 605 T (B) | **Title of the Course:** Advanced Electronics |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Introduction to sensors and Transducers.<br>2. Introduction to Signal Conditioning.<br>3. Building blocks of Data conversion.<br>4. Understands mechanism of process Control. | 1. On completion of the course, the students will be able to convert data from ADC to DAC and Vice versa.<br>2. Explain signal conditioning.<br>3. Explain working of process control.<br>4. Design of Instrumentation amplifier. |

**(Important Note: This course designed for the student who has offered Electronics as one of the subjects at S.Y.B.Sc. level)**

**Unit 1: Sensors (7 Hrs.)**

Introduction to Sensors: Revision of temperature measurement and Pressure Measurement. Motion sensors: Types of motions, Accelerometers' principles, Types of accelerometers, applications. Optical sensors: Photo detectors, Photo detector characteristics, photoconductive detectors, photo voltaic detectors, Photodiode detectors, photo emissive detectors.

Pyrometry: Thermal radiation, Broadband pyrometers, Narrowband pyrometers. Optical sources: Conventional light sources, Laser light sources and principles. Applications: Label inspection, Turbidity, Ranging.

**Unit 2: Analog Signal Conditioning (10 Hrs.)**

Introduction to analog and digital signals: Analog Multiplexer and De-Multiplexer using Ic-4051, Ideal & Practical characteristics of Low Pass, High Pass, band pass and band reject filters. 2nd order active low pass and high pass filter using op-amp. Instrumentation amplifier using 3-OP-AMP, Application of Instrumentation Amplifier for thermocouple signal conditioning. Interpretation of integrator and differentiator as low pass and high pass filters.

**Unit 3: Digital signal conditioning (9 Hrs.)**

Digital Multiplexer and De-Multiplexer, Priority encoder using Ic-74148, Decoders: 2 to 4 decoder and 3 to 8 Decoder. Signal Converters: DAC: R-2R ladder type DAC, Binary weighted DAC.ADC: Single slope ADC, Successive Approximation ADC, Flash ADC. Data Acquisition System using 3-channels

**Unit 4: Introduction to Process Control (4 Hrs.)**

Block diagram of Process control, Process control using ON-OFF controller, Op-amp and temperature sensor, Process control using Proportional Control Logic, Definition of Process LAG, and Problems.

**Suggested Readings:**


1. Process Control Instrumentation Technology, C.D. Johnson, Pearson Education, Ed. 8th.
2. Instrument of Device System, Rangan, Mani, Sharma.
3. Instrument measurement and analysis, B. C. Nakra, K. K. Chaudhari
4. Digital Principles and Applications (SIE), Ed.8th, Leach, Malvino , Saha , Mac Graw Hill
5. Electronic Instrumentation, H. S. Kalsi, 3rd edition
6. NPTEL Video: https://www.youtube.com/watch?v=nE1C4ghfvac Sensors and Actuators, IISc Bangalore, Prof. Hardik Jeetendra Pandya
7. NPTEL Video: https://youtu.be/8ybxGhhkr20 Electronics for Analog Signal Processing - I, IIT Madras , Prof. K. Radhakrishna Rao.
8. NPTEL Video: https://youtu.be/6dFnpz_AEyA Digital Signal Processing, IIT Delhi , Prof. S.C. Dutta Roy.
9. NPTEL Video: https://youtu.be/sj0PsMFpTKY Process Control and Instrumentation, IIT Kharagpur, Dr. A.K. Jana, Dr. D. Sarkar.

| Semester –VI | Paper - VI |
|---|---|
| **Course Code:** BSC-PH 606 T | **Title of the Course:** Astronomy and Astrophysics - II |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. This course develops an interest about stellar phenomenon.<br>2. Introduce astronomical time system.<br>3. Introduce instruments used for observations in non-optical astronomy.<br>4. Explain internal structure of sun. | 1. Student will be able to Locate, classify celestial objects, and understand the vastness of Space.<br>2. Students gains knowledge about Milky way.<br>3. Understands about space based telescope.<br>4. Students will be able to classify galaxies. |

**Unit 1: Astronomical Scales (9 Hrs.)**

Measurement of Astronomical Quantities: Astronomical Distances, Stellar Radii, Stellar Temperature, Magnitudes (Brightness): apparent and absolute, Radiant Flux and Luminosity, Measurement of Time: Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Astronomical Coordinate system (only introduction), Celestial Hemisphere (only introduction).

**Unit 2: The Milky Way and Universe (6 Hrs.)**

Basic Structure of Milky Way, Properties of the Milky Way, Types of Galaxies: Active Galaxies, Quasars, Radio Galaxies. Hubble's law with equation, its significance, Concept of space time, fate of our universe, Multiverse (only introduction).

**Unit 3: The Stellar Phenomenon (9 Hrs.)**

Basic Composition of Interstellar Medium, Sun**:** Atmosphere, Solar Cycle, (Butterfly diagram), Solar Flares, Photospheric phenomenon, Solar Magnetic field and sunspot. Stars as distance estimators, Hydrostatic equilibrium of a star, Stellar models (only introduction).

**Unit 4: Non-optical Astronomy and Astrobiology (6Hrs.)**

Non optical Astronomy: Antenna and its basic parameters (only introduction), UV, IR, X-ray and Gamma Ray Telescopes, Detectors for optical and infrared regions. Orbiting space based Telescopes: HST, Chandra., Astrobiology: What is Life, Chemistry of life, Prerequisites of life.

**Suggested Readings:**


1. Astronomy structure of the Universe, A. E. Roy and D. Clarke, Adam Hilger Pub., 1989
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Astrophysics, Baidyanath Basu.
6. Astrophysical Techniques, third Edition, C. R. Kitchin
7. Telescopes and techniques, C. R. Kitchin (Springer)
8. Fundamental Astronomy , Sixth edition,H. Karttunen, Pekka Kroger, Heikki Oja., (Springer)
9. Introduction to Astronomy and Cosmology , Ian Morison, Willey.
10. A Textbook of Astronomy and Astrophysics, Mohit Kumar Sharma And Suresh Chandra , Willey
11. An Introduction to Astronomy and Astrophysics, Pankaj Jain , CRC Press, T and F. Group
12. NPTEL Video : https://youtu.be/5M4l0Ylh3L8 Astrophysics & Cosmology, IIT Kharagpur Prof. S. Bharadwaj Hydrostatics and the Solar Wind
13. NPTEL Video: https://youtu.be/aizFTBfbn6k Astrophysics & Cosmology, IIT Kharagpur Prof. S. Bharadwaj , Stellar Physics – I ,
14. NPTEL Video : https://www.youtube.com/watch?v=6zUsYkRfhiM Astrophysics & Cosmology, IIT Kharagpur Prof. S. Bharadwaj , Stellar Physics – II.
15. NPTEL Video: https://www.youtube.com/watch?v=VG-MNB6i1cs Astrophysics & Cosmology, IIT Kharagpur Prof. S. Bharadwaj , Stellar Physics – III.

| Semester –VI | Paper -VII |
|---|---|
| **Course Code:** BSC-PH 607 P | **Title of the Course:** Physics Laboratory-4A |
| **Credits: 2** | **Total Hours: 60 Hrs. (12 Experiments)** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Hands on experience to handle various nuclear detectors.<br>2. Explain thermal, electrical and magnetic properties of material.<br>3. Explain modulus of elasticity<br>4. Explain working nuclear detectors and GM counter. | 1. Handle various nuclear detectors.<br>2. Analyze thermal, electrical and magnetic properties of material by various methods.<br>3. Handling of various radioactive sources.<br>4. Determine young's modulus through experiment.<br>5. Understand working of G.M. counter |

**Section I- General Physics (Any Five)**

| Sr. No. | Title of the experiment |
|---|---|
| 1) | Surface Tension of Mercury by method of Ripples |
| 2) | Viscosity of Liquid by rotating cylinder method |
| 3) | Coefficient of sound absorption |
| 4) | 'Y' by Cornu's Method |
| 5) | Hall Effect: To measure the Hall coefficient |
| 6) | Energy gap of a semiconductor |
| 7) | Study of XRD spectrum of any material |
| 8) | Resistivity by Four probe method |
| 9) | Platinum resistance thermometer |

**Section II- Thermodynamics, Statistical Physics, Nuclear Physics and Quantum Mechanics (Any Five)**

| Sr. No. | Title of the experiment |
|---|---|
| 1) | Determination of pressure coefficient of air by constant volume thermometer |
| 2) | Verification of Stefan's fourth power law by bulb filament |
| 3) | Thermal conductivity by Forbes Method |
| 4) | Thermal conductivity of rubber tube |
| 5) | Thermal diffusivity of Brass. |
| 6) | Thermal and Electrical conductivity of Cu |
| 7) | Characteristics of G.M. tube |
| 8) | Inverse square law (γ-rays) |
| 9) | e/m by Thomson method |
| 10) | Determination of Planck's constant |
| 11) | Study of Gaussian distribution by G. M. tube |

- Draw graphs for any 4 experiments from Section I and II using Microsoft Excel/ GNU Plot/MAXIMA/Wolfram Cloud/Origin or any other equivalent software activity equivalent to **Two** practical.
- Study tour visit report / mini project / demonstration / science exhibition participation or any other activity related to this course is equivalent to **Two** practical.

| Semester –VI | Paper -VIII |
|---|---|
| **Course Code:** BSC-PH 608 P | **Title of the Course:** Physics Laboratory-4B |
| **Credits: 2** | **Total Hours: 60 Hrs. (12 Experiments)** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Introduction to experimental techniques.<br>2. Arrange the apparatus as per the requirements of the aims and objectives of the experiment.<br>3. Demonstrate the procedure to perform the experiments and the skills required for the particular experiment.<br>4. Perform the experiment, tabulate the data and obtain the result. | 1. Describe different experimental techniques to determine values of various constants, coefficients, parameters.<br>2. Explain the theory behind the formulae used.<br>3. Standardize the entire procedure to obtain reliable, repeatable results.<br>4. Student can hypothesize the result. |

**Section I: Electronics (Any Eight)**

| Sr. No | Title of the experiment |
|---|---|
| 1. | Characteristics of JFET |
| 2. | Design and built astable multivibrator using IC 741/ IC 555 |
| 3. | Half adder/Full adder |
| 4. | Integrator and differentiator using IC 741 |
| 5. | IC 723 as regulated power supply |
| 6. | RS and JK Flip – Flops |
| 7. | Study of diffraction using a transmission/reflection grating (metal ruler) |
| 8. | Instrumental amplifier using three op-amps |

| | |
|---|---|
| **9.** | Schmitt trigger |
| **10.** | LVDT Characteristics. |
| **11.** | Frequency response of loudspeaker (twitter, woofer, mid-range) |
| **12.** | Distance measurement by Ultra Sonic waves. |

**Section II: Astronomy and Astrophysics II (Any Two)**

| Sr. No | Title of the experiment |
|---|---|
| **1.** | Determine the temperature of an artificial star. |
| **2.** | Locate and observe the various stars (At least 2 observation) |
| **3.** | Polar Align an astronomical telescope. |
| **4.** | Study the solar limb darkening effect. |
| **5.** | Study of phases of Moon. |
| **6.** | Study of Planets Jupiter, Saturn and Venus. |

**Additional Activities:**

- Draw graphs for any 4 experiments from Section I and II using Microsoft Excel/ GNU Plot/MAXIMA/Wolfram Cloud/Origin or any other equivalent software activity equivalent to **Two** practical.
- Study tour visit report / mini project / demonstration / science exhibition participation or any other activity related to this course is equivalent to **Two** practical.

| Semester –VI | Paper –IX |
|---|---|
| **Course Code:** BSC-PH 609 P | **Title of the Course:** Project II |
| **Credits: 2** | **Total Hours: 60 Hrs.** |

**Guidelines:**

It is expected that,

1. The student does work equivalent to about twelve (12) laboratory experiments throughout the semester in the third year.
2. Project work is a practical course and it introduced to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the presentation of the final report at the time of viva voce.
6. The viva voce must conduct at the time of evaluation of project work at least for twenty minutes per student. Extra care must be taken in the evaluation of projects done in a pair or group.
7. Plagiarism report is compulsory.
8. It also recommended that a teacher will look after Four (4) projects at one time.
9. Any non-adherence to this norm should attract a penalty by way of deduction in the marks awarded to a student.

The Project work shall consist of the following Criterions.

1. Working model (Experimental or Concept based simulation/Demonstration Related to Physics).
2. Understanding of the project.
3. Experimental Details.
4. Data collection and Data Analysis.
5. Innovation.

6. Outcomes/Result.
7. Conclusion.

**NOTE:**

At the time of project practical examination, the candidate must submit the certified project report by the project in-charge and HOD. A candidate will be allowed to appear for the Project practical examination only if the candidate submits a project completion report duly certified by the project in-charge and Head of the department.

**The Project work shall include:**

Models based / Demonstrated Applications / Review articles / Simulation on PC on any concept in Physics / Comparative & differentiate study / Improvement in the existing experiment (Design and fabrication concept) / Extension of any regular experiments / Attempt to make experiment open-ended / Thorough survey of existing active components / devices, ICs, methods, means, technologies, generations, applications etc. / any innovative projects using the concept of Physics / Interdisciplinary areas.

**Evaluation weightage:**

Project-I:

Semester End Examination: 35 Marks

Internal Examination: 15 Marks

| **Semester –VI** | **Paper - X** |
|---|---|
| **Course Code:** BSC-PH 610 T | **Title of the Course:** Python (Skill Enhancement Course I) |
| **Credits: 2** | **Total Hours: 30 Hrs.** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain all basic things related to Python language.<br>2. Explain the concept of String, Tuples and Sets.<br>3. Explain terms like Dictionary and files.<br>4. Explain importance of Function and Python Classes. | 1. Understand the basic concept of Python language.<br>2. Understand the concept of String, Tuples and Sets.<br>3. Understand importance of Dictionary and files<br>4. Understand importance of the Function and Python Classes and their use. |

**Unit 1: Basic Python (6 Hrs.)**

Python identifiers and reserve words, Lines and Indentation, multiline statements, Comments, Input / Output with print and input functions, Command line arguments and Processing command line argument, Standard data type – Basic, None, Boolean, Numbers, Python strings, Data type conversion, Python basic operators (Arithmetic, Comparison, Assignment, Bitwise, Logical), Python Membership operators (in and not in), Python Identity operators (is and is not), Operator Precedence, Control statements, Python Loops, Interacting by subsequence index loop control statements (break, continue, pass).

**Unit 2: Python Strings (6 Hrs.)**

Concept escape characters, String special operations, String formatting operator, Single quotes, double quotes triple quotes, Raw string, Unicode string built in string methods, Python lists- concept creating and accessing elements, updating and deleting list, basic list operators, reverse, Indexing, slicing and matrices, Built in functions.

**Unit 3: Python Tuples and Sets (4 Hrs.)**

Creating and Deleting tuples, accessing values in a tuple, updating tuples deleting tuple elements, Basic tuple operations, Indexing, slicing and matrices built-in functions, Sets- concept, operations.

**Unit 4: Python Files and Dictionary (4 Hrs.)**

Creating files, Operations on files (open, close, read, write), File object attributes file positions, Testing file types, removing files, copying and renaming files, Concept mutable, Creating and accessing values in a dictionary, Update in dictionary, deleting dictionary elements, Properties of dictionary keys, Built in dictionary functions and methods.

**Unit 5: Functions (6 Hrs.)**

Defining a functions def., Calling a function, Function arguments- pass by value keyword arguments default argument, Scope and variable basic rules, Documentation string, Variable number of arguments, Call by reference, Order by arguments (positional, extra and keyword), Anonymous functions, Recursion, Treatment of input and output arguments, Unpacking, argument list, Lambda forms, Function objects, Function ducktyping and polymorphism , Generators (function and expression) and iterators, list comprehensions.

**Unit 6: Python Classes/Objects (5 Hrs.)**

Object oriented programming and classes in Python- creating classes instances objects accessing members, Data hiding (the double underscore prefix), Built-in class attributes, Garbage collection: the constructor, Overloading methods and operators, Inheritance- implementing subclass overriding methods, Recursive calls of methods, Class variables, class methods and static methods

**Suggested Readings:**

1. Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010.
2. Dive into Python, Mike.
3. Learning Python, 4th Edition by Mark Lutz.
4. Programming Python, 4th Edition by Mark Lutz.

5. Python Programming: An introduction to computer, John Zelle,3rd Edition
6. NPTEL Video: https://onlinecourses.nptel.ac.in/noc22_cs32/preview , Python for Data Science, Prof. Ragunathan Rengasamy, IIT Madras.
7. NPTEL Video: https://onlinecourses.nptel.ac.in/noc22_cs31/preview , The Joy of Computing using Python, Prof. Sudarshan Iyengar, IIT Ropar

| **Semester –VI** | **Paper - XI** |
|---|---|
| **Course Code:** BSC-PH 611 P | **Title of the Course:** Python Lab (Skill Enhancement Course I) |
| **Credits: 2** | **Total Hours: 60 Hrs. (12 Experiemtns)** |

| Course Objectives | Course Outcomes |
|---|---|
| 1. Explain the importance of the Python in Physics.<br>2. Introduced code preparation in python.<br>3. Explain structure, statement, etc. in Python. | 1. Understand importance of the Python and use it for problem solving.<br>2. Learn coding using Python.<br>3. Use structure, statement, etc. in Python. |

| **Sr. No** | **Title of the experiment** |
|---|---|
| **1.** | Find the real roots of quadratic equation. |
| **2.** | Find the GCD of integers. |
| **3.** | Display the Fibonacci sequence up $n^{th}$ terms where n is provided by the user. |
| **4.** | Print different patterns. |
| **5.** | Ascending and descending orders of factorials. |
| **6.** | Remove the $i^{th}$ occurrence of the given word in the list where words can be repeat. |
| **7.** | Create a simple calculator that can add, subtract, multiply or divide depending up on the input from the user. |
| **8.** | Create a class which perform Basic Calculator Operations. |
| **9.** | Find area of the Rectangle and Triangle using classes. |
| **10.** | Accept the total score of the exam (05 subjects) and print the class obtained by student. |

| | |
|---|---|
| **11.** | Print greatest number from given three numbers by user (AND operator and if else condition) |
| **12.** | Create a list of employees and perform the following:<br>a) Display names of employees in the list. b) Add an employee at the end of the list.<br>c) Remove the third element of the list. |
| **13.** | Reverse a number and also calculate the sum of digits of that number. |
| **14.** | Sort a list of strings in ascending and descending order. |

**Additional Activity**

- Study tour visit report / mini project / demonstration / science exhibition participation or any other activity related to this course is equivalent to **Two** practical.