Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

Syllabus for B. Sc. III (SEM- V) w.e.f. 2025-26

PHYSICS MAJOR DSC V: MODERN PHYSICS (UPH350T)

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Course Description:

This course is designed for students of undergraduate course. This duration of the course is 60 hours for theory and 60 hours practical. 4 credits are allotted to the theory course whereas 2 credits are allotted for laboratory course.

Course Objectives:

The course aims to provide students with a comprehensive understanding of various elements of Modern Physics. The basic objective of this course is to develop the knowledge and understanding about the topics like Quantum Mechanics, Relativity, Atomic Physics and X-rays among the students. The course will cover theoretical concepts and practical experiments to help students develop a strong foundation in the subject. The objectives of this course are:

- To understand the origin and the concepts of Quantum Mechanics and its applications.
- To learn about Relativity and the associated effects.
- To learn about various Phenomenon in Atomic Physics.
- To understand the X-rays and its various applications.
- To perform experiments to understand the theoretical concepts.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- CO1: Understand the concepts and phenomenon related to Quantum Mechanics, know about the failure of Classical Mechanics and how Quantum Mechanics can address those failures.
- CO2: Apply the theories and concepts in Quantum Mechanics to real Physical Problems and obtain a solution for it, determine the energy eigen values.
- CO3: Develop understanding about the concept of relative motion and its effect on length, time, velocity and energy of bodies moving with relativistic speed.
- CO4: Know about various effects that take place at atomic levels due to motion of particles through electric and magnetic fields.
- CO5: Develop understanding about X-rays, various effects and laws related to X-rays and its importance in development of periodic table.
- CO6: Learn and use X-ray diffraction techniques for material characterization.

Syllabus:

Unit I: Quantum Mechanics I [10h]

Failure of Classical Physics, black body radiation spectrum, photoelectric effect, Quantum explanation of photoelectric effect, Compton Effect, Wave Particle Duality, de Broglie Hypothesis, Davisson and Germer experiment, wave packet, concept of phase velocity and group velocity and relation between them.
Heisenberg's Uncertainty Principle, canonically conjugate variables, application: non-existence of electron inside the nucleus. Gamma Ray Microscope: Thought Experiment:

Unit II: Quantum II [10h]
Schrodinger's Equation: Time dependent and time independent equations, wave function Ψ and its physical significance, normalised wave function, orthonormal wave function, Operators: operator for position, momentum, kinetic energy, total energy, angular momentum Expectation values of dynamical quantities, Ehrenfest theorem, Eigen values and Eigen functions, Free particle, Free Particle in a one-dimensional box and three dimensional box.

Unit III: Relativity [10h]

Frame of references, Inertial and Non-Inertial frames, Galilean transformation equations, Galilean invariance and conservation laws, Michelson-Morley experiment and its negative result.
Postulates of special theory of relativity, Lorentz transformation, Length contraction, Time dilation, velocity addition theorem, variation of mass with velocity, Mass Energy equivalence, rest mass of photon, Doppler effect.

Unit IV: Atomic Physics [10h]
Introduction: Bohr's model, Sommerfeld and Chadwick Model, Vector Atomic model, Larmor Precession, Stern-Gerlach experiment, spinning of electron, space quantization, selection rules, quantum numbers, L-S and J-J coupling, Pauli's exclusion principle, Hund's rule, Zeeman Effect: Normal Zeeman effect and Anomalous Zeeman effect.

Unit V: Raman Spectroscopy [10 h]

Raman effect, Classical and Quantum explanation, Experimental set up, Raman spectra and molecular spectra, Applications of Raman effect, electronic spectra, Dissociation energy, Frank- Condon principle, Elementary ideas of NMR and ESR and their applications in spectroscopy.

Unit VI: X-ray [10 h]

Introduction, production of X-rays, discrete and continuous X-ray spectra, main features of continuous X-ray spectra, characteristics X-ray spectra, Duane-Hunt law, X-ray emission spectra, Moseley's law, its importance and applications, Detection of X-ray, Absorption of X-ray, Auger effect, Application of X-rays in various fields. Bragg's

Law, X-ray diffraction methods, Bragg's X-ray spectrometer, determination of wavelength of X-rays.

List of Experiments (Any 10) [60h]

1. To determine the Rydberg's constant by hydrogen spectra.
2. To study the absorption spectra of iodine vapours.
3. To determine the e/m ratio by Thomson method.
4. To determine e/m by Helical method.
5. To determine the Planck's constant by using photocell/solar cell.
6. To determine the Planck's constant by using LED.
7. To determine the electric charge of an electron by Millikan's oil drop method.
8. To determine the electronic charge and work function of a cathode material using photocell.
9. To study inverse square law using static characteristics of photocell.
10. To analyse the image of SEM/TEM of nanoparticles.
11. To calculate the optical band gap of nanomaterial by UV visible spectrum.
12. Determination of bandgap of semiconductor using PN junction diode in reverse bias.
13. To determine the lattice parameter of a crystalline material from given XRD pattern.
14. Identification of unknown element from line emission spectra.
15. To determine the Boltzmann constant using power transistor (2N3055)
16. To determine the unknown ac voltage using CRO and to calculate its deflection sensitivity and figure of merit.

Reference Books for Theory:

1. Atomic Physics by J.B. Rajam.
2. Concepts of Modern Physics: Arthur Beiser (Tata Mc Graw Hill)
3. Physics for Degree Students BSc-III by C.L. Arora and P.S. Hemne. (S. Chand)
4. Elements of Special Theory of Relativity by M.K. Bagde and S.P. Singh (S. Chand)
5. Introduction to theory of Relativity by P.G. Bergmann
6. Introduction to Special Theory of Relativity by Shrivastava.
7. Material Science and Engineering, William Callister, Wiley.
8. Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education.
9. Quantum Mechanics, G. Aruldhas, 2 nd Edition. 2002, PHI Learning of India.
10. Quantum Mechanics by Chatwal and Anand (Himalaya Publications)
11. Quantum Mechanics, H.C. Verma, Surya Publications.

Reference Books for Practical:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971,Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S. Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4 th Edition, reprinted 1985, Heinemann Educational Publishers.
5. Physics through experiments, B Saraf *et al*,Vikas Publications 1987.

6. Advanced practical physics, Chauhan & Singh, Pragathi Publications 1st Ed.
7. B.Sc. Practical Physics, P.S. Hemne, Harnam Singh, S.Chand

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Proposed Syllabus for Four Year Multidisciplinary UG Program with Physics as Major
(e.g. Four Year B.Sc. Honors/Research Program)

Program: B.Sc.
(Academic Session 2025-26)
Syllabus

SOLID-STATE PHYSICS (DSC-VI)

Semester V courses in
Physics
Syllabus under Autonomy

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)
Syllabus for B. Sc. III (SEM- V) w.e.f. 2025-26
PHYSICS MAJOR DSC VI: SOLID STATE PHYSICS (UPH355T)
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Course Description:

This course provides an in-depth exploration of the fundamental principles of solid state physics, focusing on the structure, properties, and behavior of solid materials is designed for undergraduate students with Physics as a major subject.

Course Objectives:

Students will gain an understanding of crystalline and amorphous materials, lattice dynamics, magnetic properties, superconductivity, band theory, and dielectric properties. Through theoretical concepts and practical applications, the course aims to equip students with the knowledge necessary to analyse and interpret various phenomena in solid state systems.

Course learning outcomes:

CO1: Understand the fundamental principles and concepts of solid state physics, including crystal structures, lattice vibrations, electronic band structure, and magnetic and optical properties of solids.

CO2: Analyse the behaviour of electrons in solids, including energy bands, Fermi surfaces, and carrier transport.

CO3: Explain the principles of semiconductor physics, including intrinsic and extrinsic semiconductors, carrier transport, and recombination.

CO4: Develop problem-solving skills in solid state physics, including analytical and numerical methods.

CO5: Understand the relevance of solid state physics to modern technology, including electronic devices and magnetic storage.

CO6: Synthesize knowledge from multiple areas of solid state physics to understand complex phenomena.

Theory (04 Credit) **60Hrs**

Unit-I **(10 Hrs)**

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Unit-II **(10 Hrs)**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law

Unit-III **(10 Hrs)**

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient.

Unit-IV **(10 Hrs)**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Unit-V **(10 Hrs)**

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mossotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.

Unit-VI **(10 Hrs)**

Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)

LABORATORY (2 Credits) **60 Hrs**

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 o C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

11. Study of Thermocouple.
12. Energy bandgap of semiconductor using P-N Junction diode.

Reference Books for Theory:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Reference Books for Practical:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971,Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S. Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
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Physics through experiments, B Saraf *et al*,Vikas Publications 1987

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Programme: B.Sc.
(Academic Session 2025-26)
Syllabus

DSE I

Semester V courses in
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Bajaj College of Science, Wardha (Autonomous)

Syllabus for B. Sc. III (SEM-V) w.e.f. 2025-26

DSE I (UPH354T)

Course: ASTRONOMY AND INDIAN SPACE MISSION

(Credits: 04)
Theory: 60 Lectures

Course Description:

This course provides an in-depth exploration of astronomy and space science, covering fundamental concepts and contemporary advancements. Students will investigate the history and structure of the universe, including cosmological theories and galaxy formation. The course delves into the solar system's components, examining the Sun, planets, moons, and other celestial objects. It also addresses astronomical measurement techniques for determining the size, distance, and mass of celestial bodies. Key topics include the life cycle of stars, from formation to various end states like black holes. Additionally, students will learn about modern astronomical tools and observatories. The course highlights the significant contributions of the Indian Space Research Organisation (ISRO) and its impact on space exploration. Through lectures and practical insights, students will gain a comprehensive understanding of the cosmos and the methods used to study it.

Learning Objective:
Astronomy And Indian Space Mission will facilitate under graduate students to know following ideas.

- Understand Cosmological Theories and Galactic Formation
- Analyse the Structure and Dynamics of the Solar System
- Apply Methods for Astronomical Measurements and Calculations
- Explore Stellar Evolution and Life Cycles
- Evaluate Astronomical Tools and Techniques
- Investigate the Contributions of Indian Space Research Organisation (ISRO)

Course Learning Outcome: Upon completion of this course students will be able to

CO1: Describe and Compare Cosmological Models.
CO2: Analyse the Solar System's Components.
CO3: Apply Measurement Techniques in Astronomy.
CO4: Understand Stellar Evolution.
CO5: Evaluate and Utilize Astronomical Instruments.
CO6: Recognize ISRO's Impact on Space Exploration.

Theory Sessions (04 Credit, 60 Lectures)

Unit I (10 Lectures)
History of Universe: Cosmological theories of the universe (Concept only), Big Bang Theory, time line of Universe, formation of galaxies, Types of Galaxies, The Milky Way and Andromeda.
(10 Lectures)

Unit II (10 Lectures)

Solar System: Structure of Sun and Solar interior, Sun spots and Magnetic field on the sun and Solar activity, planets and their natural satellites, dwarf planets and their natural satellites, prominent artificial satellites revolving different planets and their findings, asteroids belt and comets. **(10 Lectures)**

Unit III (10 Lectures)

Terrestrial and extraterrestrial measurements and findings: Meteor and meteorites, size of a planet (d=D.α), distance of a planet by parallax method (D=b/θ), Mass of the sun and the planets (M=4π2r3/GT2), surface temperature of sun (T=[R/r]1/2*[S/σ]1/4) and Solar luminosity, Stellar spectra, spectral classification of Stars O, B, A, F, G, K, M. **(10 Lectures)**

Unit IV (10 Lectures)

Life cycle of a star: Nebula and Formation of stars, life span of star, death of star. Red Giant, Super Red Giant, Nova, Super Nova, White dwarf; C-O core, Hydrogen shell, Helium Shell, Neutron Star; surface, outer crust, inner crust outer core, inner core, magnetic field lines, pulsers, Black hole; Singularity, event horizon, photon sphere, accretion disc, relativistic jets. **(10 Lectures)**

Unit V (10 Lectures)

Tools of the astronomer: Optical telescopes, (Galielian, Newtonian, Cassegrainian & Hubble Space Telescope), Magnifying power & Resolving power of telescopes, UV, x-ray, IR, Radio & gravitational Astronomy, Spectroscope. Designs of few upcoming large telescopes (eg. EVLT, TMT). **(10 Lectures)**

Unit VI (10 Lectures)

Indian Space Research Organisation (ISRO): About ISRO and its Goals, History of Creation. General Satellite Programmes: The IRS series, The INSAT series. Gagan Satellite Navigation System, Navigation with Indian Constellation (NavIC), Other satellites. Launch vehicles: Satellite Launch Vehicle (SLV), Augmented Satellite Launch Vehicle (ASLV), Polar Satellite Launch Vehicle (PSLV), Geosynchronous Satellite Launch Vehicle (GSLV). **(10 Lectures)**

Reference Books:

- The Amateur Astronomer Sir Patrick Moore Springer 2006
- Handbook of Practical Astronomy Gunter D. Routh Springer 2009
- Fundamental Astronomy Hannu Karttunen Springer 2007
- Guide to Night Sky P. Shankar KRVP 2007
- The Complete Idiot's Guide to Astronomy Christopher De Pree and Alan Axelrod Pearson 2001
- The story of Astronomy In India Chander mohan Research Gate 2015
- A Skywatcher's Year Jeff Kanipe Cambridge University Press 1999 10. The Casual Sky Observer's Guide Rony De Laet Springer 2012.
- Astrophysical Techniques - C. R. Kitchin:
- Astronomical Observations - an Optical Perspective - Gordon Walker: (Cambridge University press).
- Astronomical Photometry- Henden and Kaitchuck:
- Astrophysics-Stars and galaxies - K.D.Abhyankar.
- Tools of the Astronomers - C. R. Miczaika and W. M. Sinton:
- Astronomical Techniques- W. A. Hiltner (Ed):

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(e.g. Four-Year B.Sc. Honours/Research Program)

Programme: B.Sc.
(Academic Session 2025-26)
Syllabus

DSE II

Semester V courses in
Physics
Syllabus under Autonomy

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Bajaj College of Science, Wardha (Autonomous)

Syllabus for B. Sc. III (SEM-V) w.e.f. 2025-26

DSE II (UPH354T)

Course: NON-CONVENTIONAL SOURCES OF ENERGY

(Credits: 04)
Theory: 60 Lectures

Course Description:

This course provides a comprehensive overview of various energy sources, with a focus on renewable and alternative energy technologies. Students will explore the principles, technologies, and applications of solar, wind, geothermal, biomass, and ocean energy, as well as chemical energy sources like fuel cells. The course also covers advanced topics in energy storage systems, hybrid configurations, and emerging power generation methods such as Magneto Hydro Dynamic (MHD), thermo-electric, and thermo-ionic power generation.

Learning Objective:
Non-conventional sources of energy will facilitate undergraduate students to know following ideas.

- describe various sources of renewable energy and their working principals.
- explain the working of flat plate and concentrating solar collectors, different geothermal energy resources, biomass gasifiers, of open cycle and closed cycle OTEC systems, tidal power systems, open and closed cycle MHD power generation systems.
- discuss methods of storing solar energy and applications of solar energy.
- discuss different wind energy conversion technologies.
- discuss various factors affecting the selection of biogas plants.
- discuss different ways to reduce energy consumption and explain energy conservation systems.

Course Learning Outcome: Upon completion of this course students will be able to

CO1: Discuss non-conventional sources of energy and explain the working of different solar energy applications
CO2: Discuss wind energy conversion systems and explain sources of geothermal energy
CO3: Describe different biogas plants and working of different gasifiers
CO4: Explain the working principle of different fuel cells and ocean thermal energy conversion systems
CO5: Explain the working of Energy storage and hybrid system configurations.
CO6: Describe the working of magneto hydro dynamic power systems and principles of energy conservation

Theory Sessions (04 Credit, 60 Lectures)

Unit I (10 Lectures)
Introduction to Energy Sources: Energy sources and their availability, non-conventional sources, advantages of renewable energy sources, prospects of renewable energy sources.
Solar Energy: Solar energy collectors – flat plate collectors and concentrating collectors, solar energy storage systems – mechanical, electrical, chemical and electro-magnetic, solar pond, applications of solar energy – solar water heating, solar distillation, solar cooking. **(10 Lectures)**

Unit II (10 Lectures)
Wind Energy: Basic principles of wind energy conversion, site selection considerations, basic components of Wind Energy Conversion System (WECS), classification of WEC systems, wind energy collectors – horizontal axis machines and vertical axis machines, generating systems, applications of wind energy. **(10 Lectures)**
Geothermal Energy: Geothermal sources, hydrothermal resources – vapor dominated and liquid dominated systems, hybrid plants – geothermal preheat and fossil superheat; applications of geothermal energy, advantages and disadvantages of geothermal energy. **(10 Lectures)**

Unit III (10 Lectures)
Energy from Biomass: Biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, classification of biogas plants – floating drum plants and fixed dome plants, selection of site for biogas plant, utilization of biogas; Methods for obtaining energy from biomass, biomass gasification, classification of biomass gasifiers, fixed bed gasifiers and fluidized bed gasifiers, applications of gasifiers, advantages and limitations of gasifiers.
(10 Lectures)

Unit IV (10 Lectures)
Chemical Energy sources: Fuel cells -principle of operation of fuel cell, types of fuel cells – hydrogen-oxygen, solid-oxide, alkaline, polymer electrolyte membrane fuel cells, advantages, disadvantages and conversion efficiency of fuel cells, applications of fuel cells.
Energy from the oceans: Ocean thermal energy conversion-open cycle and closed cycle systems, energy from tides – basic principle of tidal power, components of tidal power plants, single basin and double basin systems, ocean waves – wave energy conversion systems. **(10 Lectures)**

Unit V (10 Lectures)
Energy storage and hybrid system configurations: Energy storage, Battery – types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Flywheel-energy relations, components, benefits over battery. **(10 Lectures)**

Unit VI (10 Lectures)
Magneto Hydro Dynamic (MHD), Thermo-electric and Thermo-ionic Power Generations: Principles of MHD power generation – open cycle and closed cycle – advantages and limitations. Basic principles of thermo-electric and thermo-ionic power generation – advantages and limitations.
Energy Conservation: Economic concept of energy, principles of energy conservation and energy audit, energy conservation technologies, co-generation, waste heat utilization, combined cycle power generation.
(10 Lectures)

Reference Books:

- Non- Conventional Energy Sources and Utilisation by R. K. Rajput, S. Chand Publishers.
- G.D. Rai, *Non-Conventional energy sources*, 5th Edition, Khanna Publishers, 2011.

- D.P. Kothari, R. Rakesh and K.C. Singal, Renewable Energy Resources and Emerging Technologies, 2nd Edition, Prentice India Pvt. Ltd, 2011.
- G.S. Sawhney, Non-Conventional Energy Sources, 1st Edition, Prentice India Pvt. Ltd, 2012.
- G.N. Tiwari and M.K. Ghosal, Renewable Energy Resources: Basic Principles and Applications, 1st Edition, Alpha Science International Ltd, 2004.
- Solar Energy Fundamentals and application by H.P. Garg and J. Prakash, Tata McGraw-Hill Publishing company Ltd, 1997.
- Solar Energy by S. P. Sukhatme, Tata McGraw- Hill Publishing company ltd,1997.
- Solar Energy Utilization by G.D. Rai, Khanna Publishers, 1995.

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Programme: B.Sc.
(Academic Session 2024-25)
Syllabus

VOCATIONAL SKILL COURSE (VSC)

Semester-V course in
Physics
Syllabus under Autonomy

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Syllabus for B. Sc. III (SEM-V) w.e.f. 2025-26

Vocational Skill Course (VSC-III)

Course: Digital Physics Lab

(Only Practical Component)

Credits: 02 **60 Hours**

Course Description:

The course is designed for undergraduate students to provide them with hands-on experience of various sensors, kits, and software applications. The course content focuses on learning by doing. This course is intended for students belonging to physics and allied subjects but can also be taken by other disciplines.

Course Objectives:

The Course Objectives of this course are as follows:

- Experimental data acquisition using sensors and data acquisition platforms.
- Analysing data with the various software and interpreting.
- Providing digital experience to the students by giving hands on experience.
- Making a fully functional digital physics lab.
- To prepare students to work as part of teams on multi-disciplinary projects.

Course Outcome:

On completion of this course students will be able to

CO1: Students will be able to use various sensors and kits to perform experiments and acquire data digitally.

CO2: Students will be able to analyse the data using software to connect with theoretical understanding.

CO3: Students will be able to design and implement hardware interface for various experiment.

CO4: Students will be able to acquire, plot and analyse data.

CO5: Increased Scientific understanding.

Practical Sessions (02 Credit, 60 Hours)

Experiments Using Arduino:

1. Basic Arduino operations
2. Interfacing real time clock with Arduino for timer switching.
3. Temperature, humidity sensing using sensors.
4. Distance measurement using ultrasonic sensor.

Experiment Using ExpEYES kit:

5. Application of ultrasonic sensor for mass spring analysis.
6. Study of free oscillation, forced oscillation and damped oscillation using DC motor.
7. Acceleration due to gravity using bar pendulum.

8. Study of diodes (Diode, LEDS, Zener Diode, etc.)
9. Study of polariser.
10. Determination of velocity of sound.

Experiment Using Tracker Software:

11. Study of diffraction pattern of hair, single slit, double slit.
12. Determination of wavelength of LASER using diffraction grating.
13. Determination of thickness of hair using LASER.
14. Study of coupled oscillator.
15. Determination of acceleration of falling object under gravity.

Reference:

1. **https://docs.arduino.cc/learn/starting-guide/getting-started-arduino/**
2. **https://github.com/**
3. **https://expeyes.in/**
4. **https://physlets.org/tracker/**

Note: Mode of evaluation:
End Semester Exam + Continuous Internal Assessment (Poster presentation / Project/ Presentation/ Assignment/ quiz)
Total Mark: 50

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Syllabus for B. Sc. III (SEM-VI) w.e.f. 2025-26

DSE III (UPH364T)

Course: NANOSCIENCE AND NANOTECHNOLOGY

(Credits: 04)
Theory: 60 Hours

Course Description:

This course provides an introduction to the fundamental concepts of nanoscience and nanotechnology. It covers the definition, types, synthesis, characterization, and applications of nanomaterials. The course aims to equip students with a comprehensive understanding of the unique properties and behaviors of materials at the nanoscale.

Course Objectives:

- To define nanoscience and nanotechnology and understand their significance in modern science.
- To explore the various types of nanostructures and their properties.
- To learn about the synthesis and preparation techniques for nanomaterials.
- To study diffraction analysis methods for material characterization.
- To understand surface imaging techniques for studying nanomaterials.
- To familiarize with spectroscopic techniques used in nanomaterial analysis.

Course Learning Outcomes: Upon completion of this course, students will be able to:

- **CO1**: Define nanoscience and nanotechnology and discuss their impact.
- **CO2:** Identify and describe various types of nanostructured materials.
- **CO3:** Compare and contrast top-down and bottom-up synthesis techniques.
- **CO4**: Analyze diffraction data for phase identification and particle size determination.
- **CO5:** Utilize surface imaging techniques for nanomaterial characterization.
- **CO6:** Apply spectroscopic techniques to analyze the properties of nanomaterials.

Course Contents [Theory Credits:04, 60 Hrs.]

Unit I: Introduction to Nanoscience and Nanotechnology

Definition, scientific revolution, atomic structure, and size; emergence and challenges; carbon age (CNT to Graphene); influence of nano over micro/macro; size effects and crystals; large surface-to-volume ratio; surface effects on physical properties. Applications of nanotechnology in various fields. **(10 Hours).**

Unit II: Types of Nanostructures and Properties of Nanomaterials

One-dimensional, two-dimensional, and three-dimensional nanostructured materials; quantum dots and shell structures; metal oxides; semiconductors; composites; mechanical, physical, and chemical properties; surface plasmon resonance; super paramagnetism. **(10 Hours)**

Unit III: Synthesis and Preparation of Nanomaterials

Top-down and bottom-up techniques; high-energy ball milling; injection molding; extrusion; melt quenching and annealing; Langmuir-Blodgett films; sol-gel processing; chemical vapor deposition (CVD); spin coating; templated self-assembly; electrochemical approach. **(10 Hours)**

Unit IV: Characterization Techniques of nanomaterials and devices

X-ray diffraction; powder diffraction; lattice parameters; structure analyses; strain analyses; phase identification; particle size analysis using Scherer's formula; X-ray photoelectron spectroscopy (XPS); Auger electron spectroscopy (AES). **(10 Hours)**

Unit V: Surface Imaging Techniques for nanomaterials and devices

Scanning Electron Microscope (SEM); Field Emission Scanning Electron Microscope (FESEM); Atomic Force Microscopy (AFM); Scanning Tunneling Microscopy (STM); Transmission Electron Microscopy (TEM). **(10 Hours)**

Unit VI: Spectroscopic Techniques for nanomaterials and devices

Infrared spectroscopy (IR) - rotational & vibrational; UV-visible spectroscopy; Raman spectroscopy; photoluminescence (PL); particle size analyzer. **(10 Hours)**

Reference Books:

- Introduction to Nanotechnology, by Charles P. Poole Jr. and Frank J. Owens.
- Nanoscience: Principles and Practices, by Sulabha K. Kulkarni.
- Nanotechnology: A Guide to Synthesis, Properties, and Applications, by S. M. Sze.
- Nanomaterials: Synthesis, Properties and Applications, by A. K. Geim and K. S. Novoselov.

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

BOARD OF STUDIES MEETING
APPROVED
PHYSICS
10.03.2025
BAJAJ COLLEGE OF SCIENCE, WARDHA

Proposed Syllabus for Four Year Multidisciplinary UG Program with Physics as Major
(e.g. Four Year B.Sc. Honors/Research Program)

Program: B.Sc.
(Academic Session 2025-26)
Syllabus

MEDICAL PHYSICS (DSE-IV)

Semester VI courses in
Physics
Syllabus under Autonomy

BOARD OF STUDIES MEETING APPROVED PHYSICS 10.3.2025 BAJAJ COLLEGE OF SCIENCE, WARDHA

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

Syllabus for B. Sc. III (SEM-VI) w.e.f. 2025-26

DSE IV (UPH364T)

Course: MEDICAL PHYSICS

(Credits: 04)

Theory: 60 Lectures

Course description:

The course is designed for the students of science faculty who choose Physics as major in their B.Sc. Programme. This course introduces the fundamental principles and applications of medical physics, bridging the gap between physics and medicine.

Course Objectives:

The aim of this course is to give comprehensive introduction to medical physics, preparing students for advanced studies or careers in this exciting field. Student should be able to incorporate the concepts of Physics in the field of Medicine.

Course learning outcomes: Upon completion of the course, student will be able to:

CO1: Understand the fundamental principles of physics and their application in medicine.

CO2: Learn about medical imaging modalities, such as X-ray, CT, MRI, and PET.

CO3: Develop knowledge of radiation physics, including radiation production, interactions, and detection.

CO4: Understand the biological effects of radiation on living tissues.

CO5: Understand the principles of radiation therapy, including treatment planning and delivery.

CO6: Develop skills in radiation safety and protection. Apply physics principles to medical instrumentation, such as dosimetry and imaging equipment.

Theory (04 Credit) **60Hrs**

Unit-I **(10 Hrs)**

PHYSICS OF THE BODY-I

Mechanics of the body: Skeleton, forces, and body stability. Muscles and the dynamics of body movement, Physics of body crashing. Energy household of the body: Energy balance in the body, Energy consumption of the body, Heat losses of the body, Pressure system of the body: Physics of breathing, Physics of cardiovascular system.

Unit-II **(10 Hrs)**

PHYSICS OF THE BODY-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound.

Optical system of the body: Physics of the eye. Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer.

Unit-III **(10 Hrs)**

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I

X-RAYS: Electromagnetic spectrum – production of x-rays – x-ray spectra, Bremsstrahlung-Characteristic x-ray – X-ray tubes – Coolidge tube – x-ray tube design – tube cooling stationary mode – Rotating anode x-ray tube – Tube rating – quality and intensity of x-ray. X-ray generator circuits – half wave and full wave rectification – filament circuit – kilo voltage circuit – high frequency generator – exposure timer – HT cables.

RADIATION PHYSICS: Radiation units - exposure - absorbed dose – units: rad, gray - relative biological effectiveness - effective dose - inverse square law - interaction of radiation with matter - linear attenuation coefficient.

Unit-IV **(10 Hrs)**

Radiation Detectors -Thimble chamber- condenser chambers – Geiger counter – Scintillation counter – ionization chamber – Dosimeters – survey methods – area monitors – TLD and semiconductor detectors

RADIATION THERAPY PHYSICS: Radiotherapy – kilo voltage machines – deep therapy machines – Telecobalt machines – Medical linear accelerator. Basics of Teletherapy units – deep x-ray, Telecobalt units, medical linear accelerator – Radiation protection – external beam characteristics – phantom – dose maximum and build up – bolus – percentage depth dose – tissue – air ratio – back scatter factor.

Unit-V **(10 Hrs)**

MEDICAL IMAGING PHYSICS: X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR) – NMR imaging – MRI Radiological imaging – Radiography – Filters – grids – cassette – X-ray film – film processing – fluoroscopy – computed tomography scanner – principle function – display – generations – mammography. Ultrasound imaging – magnetic resonance imaging – thyroid uptake system – Gamma camera (Only Principle, function and display)

Unit-VI **(10 Hrs)**

RADIATION AND RADIATION PROTECTION: Principles of radiation protection – protective materials-radiation effects – somatic, genetic stochastic & deterministic effect, Personal monitoring devices – TLD film badge – pocket dosimeter. Radiation dosimetry, Natural radioactivity, Biological effects of radiation, Radiation monitors.

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-II

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment

Reference Books:

- Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
- Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
- Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
- Physics of the human body, Irving P. Herman, Springer (2007).
- Physics of Radiation Therapy : F M Khan - Williams and Wilkins, 3rd edition (2003)
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
- The Physics of Radiology-H E Johns and Cunningham.

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

Proposed Syllabus for Four Year Multidisciplinary UG Program with Physics as Major
(e.g. Four Year B.Sc. Honors/Research Program)

Program: B.Sc.
(Academic Session 2025-26)
Syllabus

DIGITAL AND SOLID-STATE ELECTRONICS (DSC-VIII)

Semester VI courses in
Physics
Syllabus under Autonomy

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)
Syllabus for B. Sc. III (SEM- VI) w.e.f. 2025-26
PHYSICS MAJOR DSC VIII (UPH365T)
DIGITAL AND SOLID-STATE ELECTRONICS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Course description:

The course is designed for the students of science faculty who choose Physics as major in their B.Sc. Programme. This course provides a comprehensive introduction to digital and solid-state electronics, preparing students for advanced studies or careers in electronics, or related fields.

Course Objectives:

The aim of this course is to provide a solid foundation for advanced studies or research in digital and solid-state electronics. Student should be able to design and fabricate a circuit, operate it and be able to trouble shoot the circuit if necessary.

Course learning outcomes: Upon completion of the course student will be able to:

CO1: Understand and describe the behaviour of semiconductor materials and devices (diodes, transistors, solar cell).

CO2: Analyse and design solid-state electronic circuits for amplification, switching, and control.

CO3: Design and test amplifier circuits, including feedback and stability analysis.

CO4: Use laboratory instruments (oscilloscope, multimeter, etc.) to measure and test electronic circuits.

CO5: Understand and apply number systems, binary arithmetic, and Boolean algebra.

CO6: learn, design and test combinational and sequential logic circuits.

Theory (04 Credit) **(60Hrs)**

Unit-I **(10 Hrs)**

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

Unit-II **(10 Hrs)**

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Unit-III **(10 Hrs)**

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.

Unit-IV **(10 Hrs)**

Coupled Amplifier: multistage amplifiers, RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

Unit-V **(10 Hrs)**

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Unit-VI **(10 Hrs)**

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

LABORATORY (2 Credits) **60 Hrs**

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4. To study the various biasing configurations of BJT for normal class A operation.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response and voltage gain of a RC-coupled transistor amplifier.
7. To design a Wien bridge oscillator for given frequency using an op-amp.
8. To design a phase shift oscillator of given specifications using BJT.
9. To study the Colpitts oscillator.
10. To study the Hartley oscillator.
11. To design an inverting amplifier using Op-amp (741) for dc voltage of given gain
12. To design inverting amplifier using Op-amp (741) and study its frequency response
13. To design non-inverting amplifier using Op-amp (741) & study its frequency response
14. To study the zero-crossing detector and comparator
15. To add two dc voltages using Op-amp in inverting and non-inverting mode
16. To design a precision Differential amplifier of given I/O specification using Op-amp.
17. To investigate the use of an op-amp as an Integrator.
18. To investigate the use of an op-amp as a Differentiator.
19. Study of basic gates.
20. De Morgans theorem

Reference Books:

- A textbook in Electrical Technology - B L Theraja - S Chand & Co.
- A textbook of Electrical Technology - A K Theraja - S Chand & Co.
- Principles of Electronics, V. K. Mehta, Rohit Mehta- S Chand & Co.
- Basics of electronics-Solid State, B. L. Thereja- S Chand & Co.
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
- Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

Reference Books for Practical:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971,Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11Edition, 2011, Kitab Mahal, New Delhi.

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

Syllabus for B. Sc. III (SEM- VI) w.e.f. 2025-26

PHYSICS MAJOR DSC VII (UPH360T)

NUCLEAR PHYSICS, LASER, OPTICAL FIBRE AND BIOINSTRUMENTATION

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Course Description:

This course is designed for students of undergraduate course. This duration of the course is 60 hours for theory and 60 hours practical. 4 credits are allotted to the theory course whereas 2 credits are allotted for laboratory course.

Course Objectives:

The course aims to provide students with a comprehensive understanding and develop the knowledge about the topics like Nuclear Physics, LASER, Optical Fibre and Biophysics. The course will cover theoretical concepts and practical experiments to help students develop a strong foundation in the subject. The objectives of this course are:

- To learn the concepts of Nuclear Physics and various useful instruments for particle acceleration and detection.
- To understand radioactivity and various related phenomenon.
- To learn about LASER, its characteristics and various applications.
- To understand the working mechanism of optical fibre and its relevance in communication.
- To understand the concepts in Biophysics and bio-instruments.
- To perform experiments to understand the theoretical concepts.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- CO1: Understand the concepts and characteristics of nuclei, nuclear models and nuclear reactions.
- CO2: Apply the theories and concepts to radioactive process and understand radioactivity.
- CO3: Develop understanding about particle accelerators and detectors in Nuclear Physics and fission and fusion reactions.
- CO4: Know about various effects and characteristics of different LASER.
- CO5: Develop understanding fibre optics and its applications in communication.
- CO6: Learn concepts in Biophysics and understand the working mechanism of various Bio-instruments.

Syllabus:

Unit I: Nuclear Physics I [10h]

General properties of nucleus: Types of nuclei, nuclear size, mass, charge, density, nuclear magnetic dipole moment, quadrupole moment, mass defect, packing fraction, binding energy, binding energy curve, stability of nucleus (N/Z curve), Discovery of neutron, slow and fast neutron.
Nuclear Models: Liquid drop model, semi-empirical mass formula and significance of various terms, nuclear shell model, magic numbers. Nuclear reactions, Q- value, nuclear transmutations, velocity selector, Bainbridge mass spectrograph.

Unit II: Nuclear Physics II [10h]

Radioactivity: stability of nucleus, Law of radioactive decay, Mean life & half-life, α-decay, Range of alpha particles, Geiger Nuttal law, Magnetic spectrometer for the energy of α particles, Tunnelling, Gamow's theory of α-decay, β-decay, measurement of energy of β-particles, β-decay energy spectrum and end point energy, Neutrino theory of β-decay, Gamma decay, energy of gamma photon, Applications of radioactivity(Agriculture, Medical, Industrial, Archaeological)

Unit III: Nuclear Physics III [10h]

Nuclear fission, nuclear fission on the basis of liquid drop model, chain reaction, nuclear fusion solar cycles, basic idea of nuclear reactors. Nuclear Accelerator: linear accelerator (LINAC), cyclotron. Nuclear Detectors: Ionization chamber, proportional counter, Geiger Muller counter, solid state counter, scintillation counter.
Radiation hazards, effects of nuclear radiation, radiation levels for safety, radiation protection methods. Cosmic rays

Unit IV: LASER [10h]

Spontaneous and stimulated emissions, population inversion, theory of laser action, three and four level Lasing action, Einstein's coefficients, components of LASER system, Characteristics of laser beam, Ruby LASER, He-Ne laser, Semiconductor lasers, CO_2 LASER, Nd: YAG LASER. Comparison of laser systems, Applications of lasers

Unit V: Optical Fibre [10 h]

Fiber Optics- Importance of optical fibre, Propagation of light waves in optical fibre, Basic structure, step index monomode fibre, Graded index fibre, Acceptance angle and acceptance cone, Numerical aperture, optical fibre material, optical fibre losses, Electrical and optical band width, band width - length product, Dispersion in optical fibre, advantages -disadvantages and applications.

Unit VI: Bioinstrumentation [10 h]

Introduction, History of biophysics, Bio Potential: compound action potentials of the human body, Electrocardiogram for heart (ECG), Electroencephalogram for brain (EEG), Electroretinogram for eye retina (ERG), Electromyogram for muscle (EMG), and sonography (working mechanism).

Bio instruments: Basic principle, construction and working of colorimeter, spectrophotometer, PH-meter and centrifuge measurements.

List of Experiments (Any 08) [60h]

1. Study of GM counter and to plot the plateau characteristics.
2. Study of random decay of nuclear disintegration and determination of decay constant using one coloured face dice.
3. To determine the wavelength of LASER bean by plane diffraction grating.
4. To study the divergence of LASER beam.
5. To study the total internal reflection using LASER.
6. Measurement of focal length of a given convex lens using LASER.
7. Determination of grating element of plane transmission grating.
8. Study of V-I & power curves of solar cells and find maximum power point & efficiency
9. To draw the histogram of theoretical Gaussian curve.
10. Recording and analysis of ECG signals.
11. To determine PH value of Amino acids.
12. Verification of Beer-Lambert's Law
13. Measurement of BP and recording of Kortov sound.
14. Mechanical Equivalent of Heat – Calendar – Barne's Method.
15. Optical Fibre – Measurement of Numerical Aperture.
16. Y by Koenig's Method.
17. Study of Zeeman Effect.

Reference Books for Theory:

1. Introduction to Nuclear Physics, H A Enge (Addition Wesley Co.)
2. Atomic Physics by J.B. Rajam.
3. Concepts of Modern Physics: Arthur Beiser (Tata Mc Graw Hill)
4. Physics for Degree Students BSc-III by C.L. Arora and P.S. Hemne. (S. Chand)
5. Atomic and Nuclear Physics, N. Subramanyam & Brijlal
6. Laser and Non-Linear Optics, B B Laud
7. LASER: Theory and Applications, Thyagarajan & A K Ghatak
8. Introduction to Fibre Optics, R Allen Shotwell
9. Laboratory Manuals of Bio Physics Instruments, P B Vidyasagar
10. Bio Physics, Vatsala Piramal (Dominant Publications and Distributions, New Delhi)
11. Medical Instrumentation, Khandpur (Tata McGraw Hill)

Reference Books for Practical:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.

2. A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S. Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4 th Edition, reprinted 1985, Heinemann Educational Publishers.
5. Physics through experiments, B Saraf *et al*, Vikas Publications 1987.
6. Advanced practical physics, Chauhan & Singh, Pragathi Publications 1st Ed.
7. B.Sc. Practical Physics, P.S. Hemne, Harnam Singh, S. Chand

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

Proposed Syllabus for Four Year Multidisciplinary UG Program with DSC as Major
(e.g. Four Year B.Sc. Honours/Research Program)

Programme: B.Sc.
(Academic Session 2025-26)
Syllabus

VOCATIONAL SKILL COURSE (VSC)

Semester-VI course in
Physics
Syllabus under Autonomy

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

Syllabus for B. Sc. III (SEM-VI) w.e.f. 2025-26

Vocational Skill Course (VSC-V)

Course: Sophisticated Instrumentation Handling: XRD, UV-Vis Spectroscopy, and FTIR

(Only Practical Component)

Credits: 02 **60 Hours**

Course Description

This course provides hands-on training in the handling and analysis of three sophisticated instruments: X-ray Diffraction (XRD), UV-Visible Spectroscopy, and Fourier Transform Infrared Spectroscopy (FTIR) at undergraduate level. Students will learn the principles, operation, and data analysis techniques for each instrument through a series of practical activities.

Course Objectives:

- To provide a comprehensive understanding of the principles and applications of X-ray Diffraction (XRD), UV-Visible Spectroscopy, and Fourier Transform Infrared Spectroscopy (FTIR).
- To equip students with practical skills in sample preparation, instrument calibration, and data collection for sophisticated analytical techniques.
- To develop proficiency in data analysis and interpretation of results obtained from XRD, UV-Vis, and FTIR instruments.

Course Outcomes (COs)

Upon completion of this course, students will be able to

CO1. Explain the fundamental principles of X-ray diffraction and its applications in material characterization, demonstrating knowledge of the diffraction process and crystal structures.

CO2. Prepare samples and perform calibration and data collection using XRD instruments, showcasing their ability to handle equipment and ensure accurate measurements.

CO3. Apply the principles of UV-Visible spectroscopy to analyse the absorbance of solutions, creating calibration curves and determining unknown concentrations effectively.

CO4. Demonstrate the ability to interpret UV-Vis spectra, identifying key features and correlating them with chemical properties of the analysed compounds.

CO5. Describe the principles of FTIR spectroscopy and prepare samples for analysis, demonstrating competence in using FTIR to identify functional groups in organic compounds.

CO6. Analyze FTIR spectra, identifying characteristic peaks and functional groups, and draw conclusions about the chemical composition of unknown samples based on their spectral data.

Course Contents:

Unit I: X-ray Diffraction (XRD) (20 hours)

- Introduction to the principles of X-ray diffraction and its applications in material characterization.
- Sample preparation techniques for XRD analysis.
- Calibration and data collection procedures for XRD instruments.
- Data analysis methods for interpreting XRD patterns.

Unit II: UV-Visible Spectroscopy (20 hours)

- Overview of the principles and applications of UV-Vis spectroscopy.
- Sample preparation methods for UV-Vis analysis.
- Creating calibration curves and measuring absorbance.
- Data collection and analysis techniques using UV-Vis spectroscopy.

Unit III: Fourier Transform Infrared Spectroscopy (FTIR) (20 hours)

- Introduction to the principles of FTIR spectroscopy and its applications in functional group identification.
- Sample preparation techniques for FTIR analysis.
- Calibration and data collection procedures for FTIR instruments.
- Data analysis methods for interpreting FTIR spectra.

Practicals/Activities that can be conducted for the mentioned topics:

1. XRD Principles Overview: Conduct a lecture and demonstration on the working principles of X-ray diffraction and its significance in materials science.
2. Sample Preparation for XRD: Engage students in preparing powdered samples and mounting them on XRD sample holders for analysis.
3. XRD Calibration Exercise: Guide students through the calibration process of the XRD instrument using a standard sample.
4. XRD Data Collection: Have students run XRD experiments on prepared samples and record the resulting diffraction patterns.
5. XRD Data Analysis: Use software to analyze collected XRD data, identifying phases and calculating lattice parameters.
6. UV-Vis Principles Overview: Provide a lecture on the theory and applications of UV-Vis spectroscopy, including its role in quantitative analysis.

7. Sample Preparation for UV-Vis: Instruct students on preparing solutions of known concentrations of colored compounds for UV-Vis analysis.
8. Calibration Curve Creation: Engage students in measuring the absorbance of standard solutions and plotting a calibration curve for quantitative analysis.
9. UV-Vis Data Collection: Have students measure the absorbance spectra of unknown samples and record the data for further analysis.
10. FTIR Principles Overview: Conduct a lecture on FTIR spectroscopy, focusing on how it is used to identify functional groups in organic compounds.

Reference Books:

1. X-ray Diffraction: A Practical Approach by C. Suryanarayana and M. Grant Norton.
2. Principles of Instrumental Analysis by R. K. Sharma and A. K. Gupta.
3. Infrared Spectroscopy: Fundamentals and Applications by G. R. Mohan and R. K. Jain.
4. UV-Visible Spectroscopy: Principles and Applications by S. Chandrasekaran and M. S. K. Rao.
5. Introduction to X-ray Diffraction by A. K. Ghatak and S. Lokanathan.
6. Spectroscopic Techniques in Organic Chemistry by P. S. Kalsi.
7. Introduction to X-ray Diffraction by Donald E. Cox.

Note: Mode of evaluation:
End Semester Exam + Continuous Internal Assessment (Poster presentation / Project/ Presentation/ Assignment/ quiz)
Total Mark: 50