Vivekanand Education Society's

College of Arts, Science and Commerce

(Autonomous)

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

Accredited by NAAC "A Grade" in 3rd Cycle - 2017

Best College Award – Urban Area, University of Mumbai (2012-13)

Recipient of FIST Grant (DST) and STAR College Grant (DBT)

Affiliated to the

University of Mumbai

Syllabus for

Program: B.Sc. (Physics)

(Program code: VESUSPH)

As per NEP 2020

with effect from Academic Year 2025 - 2026

Program Outcomes (PO):

Upon completion of B.Sc Programme, the graduates will have:

PO1	The required analytical skills to apply appropriate scientific principles and methodologies to solve real world problems.
PO2	The ability to design, carry out experiments and analyze results by accounting uncertainties in different quantities measured using various scientific instruments.
PO3	The ability to communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.
PO4	Understanding of the need for scientific solutions to problems of the environment and society, keeping in mind their sustainable development.
PO5	Imbibed ethical, moral and social values in personal and social life leading to a cultured and civilized personality.

Program Specific Outcomes (PSO)

On completion of B.Sc. Physics program, learners will be enriched with knowledge and be able to

PSO1	Understand applications of physics concepts in different areas.
PSO2	Establish linkages between different areas of physics and other interdisciplinary science subjects.
PSO3	Demonstrate competence in problem-solving skills in different areas of Physics namely Classical Mechanics, Quantum Mechanics, Modern Physics, Electrodynamics, Optics, Thermodynamics, Crystallography and Materials Science.
PSO4	Use analytical skills using appropriate physical principles and methodologies to solve a wide range of problems.
PSO5	Design and carry out experiments by using appropriate scientific instruments.

T.Y.B.Sc. PHYSICS (SEMESTER V)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
	Mathematical, Thermal and Statistical Physics	**2**	**02**
	Unit I: Mathematical Physics and Thermodynamics	**15 Lectures**	
	Unit II: Probability, Classical and Quantum Statistics	**15 Lectures**	
	Solid State Physics	**2**	**02**
	Unit I: Free electron and Band theory	**15 Lectures**	
	Unit II: Semiconductor and superconductivity	**15 Lectures**	
	Electrodynamics	**2**	**02**
	Unit I: Electrostatics and magnetostatics	**15 Lectures**	
	Unit II: Electrodynamics and Electromagnetic Waves	**15 Lectures**	

Elective:

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
1	**Atomic and Molecular Physics**	**2.**	**02**
	Unit I: Quantum Theory of Hydrogen Atom and Spin and Magnetic Interactions	**15 Lectures**	
	Unit II: Molecular Spectra and its Applications: Raman Spectroscopy, ESR and NMR	**15 Lectures**	
2	**Special Theory of Relativity**	**2**	**02**
	Unit I: Introduction to Special Theory of Relativity and Relativistic Kinematics	**15 Lectures**	
	Unit II: Relativistic dynamics and Electromagnetism	**15 Lectures**	
3	**Introduction to Characterization techniques**	**2**	**02**
	Unit I: characterization techniques -I	**15 Lectures**	
	Unit II: characterization techniques -II	**15 Lectures**	

Labs:

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
	Practicals of Major	**4**	**08**
	Practicals of Elective	**2**	**04**

VSC: Microprocessor, Microcontroller and Python programming

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
	Microprocessor, Microcontroller and Python programming	**2**	**04**

Minor:

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
	Nuclear Physics and Digital electronics	**2**	**02**
	Unit 1: Nuclear Physics	**15 Lectures**	
	Unit 2: Digital Electronics	**15 Lectures**	
	Lab of Minor	**2**	**04**

Detailed Syllabus: Unit wise / Module wise with number of lectures:

Course title: Mathematical, Thermal and Statistical Physics

Course code:

Objective: To understand some probability distributions, mathematical techniques like Laplace transform, Fourier transform required to understand the physical phenomena at the undergraduate level and get exposure to important ideas of thermal physics and statistical mechanics. It is also expected that the student will understand the difference between different statistics, classical as well as quantum.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	The students will have an idea of the partial differential equations using simple methods.
LO2	To demonstrate probability distributions and applications.
LO3	Solve problems in probability, understand the concept of independent events and work with standard continuous distributions.
LO4	Apply Laplace Transformation in real life application.
LO5	Analyze Fourier transform and solve problems based on it.
LO6	Understand concepts of microstates, Boltzmann distribution and statistical origins of entropy.
LO7	Analyse the difference between different statistics, classical as well as quantum.
LO8	Demonstrate problems solving skills based on all the topics covered.

<table>
<tr><th>Unit no.</th><th>Details of topics</th><th>No of lectures</th></tr>
<tr><td>1</td><td>1.Partial Differential Equations:

Partial differential equations, some important partial differential equations in physics, method of separation of variables.

Ref : CH :5.3.1 to 5.3.4

2. Fourier series :

Introduction, Fourier cosine and sine series, generalized fourier series.

CH : 7.1, 7.1.1, 7.1.2.

3. Fourier transforms: Introduction, Formal development of the complex Fourier transform, Cosine and Sine transforms.

CH : 8.1, 8.2.1, 8.2.2

4.Statistical Thermodynamics:

Microstates and configurations, derivation of Boltzmann distribution, dominance of Boltzmann distribution, physical meaning of the Boltzmann distribution law, definition of, the canonical ensemble, relating Q to q for an ideal gas, translational partition function, equipartition theorem, energy, entropy

ER: 13.1 to 13.5, 14.1, 14.2, 14.4, 14.8, 15.1, 15.4</td><td>15 Lectures</td></tr>
<tr><td>2</td><td>1.Probability: Review of basic concepts, introduction, sample space, events, independent events, conditional probability, probability theorems, methods of counting (derivation of formulae not expected), random variables, continuous distributions (omit joint distributions), binomial distribution, the normal distribution, the Poisson distribution.

Ref: MB – 15.1-15.9

2.Classical and Quantum Statistics:

The probability of a distribution, The most probable distribution, Maxwell Boltzmann statistics, Molecular speeds. Bose-Einstein statistics, Black-body radiation, The Rayleigh-Jeans formula, The Planck radiation formula, Fermi-Dirac statistics, Comparison of results.</td><td>15 Lectures</td></tr>
</table>

	AB : 15.2 to 15.5, 16.1 to 16.6	

References:

1. MB: Mathematical Methods in the Physical sciences: Mary L. Boas Wiley India, 3rd ed.

2. ER: Thermodynamics, Statistical Thermodynamics and Kinetics: T. Engel and P. Reid (Pearson).

3. AB: Perspectives of Modern Physics: Arthur Beiser, (Mc Graw Hill International).

4. CH: Introduction to Mathematical Methods: Charlie Harper (PHI Learning).

Additional References:

1. Mathematical Physics: A K Ghatak, Chua – 1995 Macmillian India Ltd.
2. Mathematical Method of Physics: Riley, Hobson and Bence, Cambridge (Indian edition).
3. Mathematical Physics: H. K. Das, S. Chand & Co.
4. Mathematical Methods of Physics: Jon Mathews & R. L. Walker, W A Benjamin inc.

5. A Treatise on heat: Saha and Srivastava (Indian press, Allahabad)
6. Statistical Physics: F. Reif (Berkeley Physics Course, McGraw Hill)
7. Introductory Statistical Mechanics: R. Bowley and M. Sanchez (Oxford Science Publications).
8. An Introduction to Thermal Physics: D. V. Schroeder (Pearson).
9. PROBABILITY: Schaum's Outlines Series by S. Lipschutz and M. L. Lipson (Mc Graw Hill International).

Course title: Solid State Physics

Course code:

Objective: To understand the theoretical and experimental foundation of Solid state Physics.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand progress in theory of metals.
LO2	Demonstrate problem solving skills in all the topics covered.
LO3	Analyze postulates and outcomes, drawbacks of classical and Quantum free theory of metals.
LO4	Analyze band theory of solids leading to differentiation among the types of materials.
LO5	Understand the basic concepts of Brillounin zones , reciprocal space.
LO6	Understand the phenomenon and characteristics of superconductivity.

Unit no.	**Details of topics**	**No of lectures**
1	**Free electron theory:** Classical free electron theory of metals, Drawbacks of classical theory. **Sommerfeld Free electron theory :** Quantum theory of free electrons, Density of energy states and Fermi energy, The Fermi distribution function, Heat capacity of the Electron gas, Mean energy of electron gas at 0 K, Electrical conductivity from quantum mechanical considerations, Failure of Sommerfeld's free electron Theory. Thermionic Emission phenomenon. **Band Theory of Solids:** Band theory of solids, Kronig- Penney model (qualitative model and conclusions), Brillouin zones, Number of wave functions in a band, Motion of electrons in a one-dimensional periodic potential, Distinction between metals, insulators, and intrinsic semiconductors. Ref.: SOP: Chapter 6: V, XIV, XV, XVI, XVII, XVIII, XX, XXXV, XXXI, XXXVI, XXXVII, XXXVIII, XXXIX, XXXX, XXXXI	15 Lectures

4.	**Semiconductor Theory and Superconductivity:** **Conduction in Semiconductors:** Electrons and Holes in an Intrinsic Semiconductor, Conductivity of a Semiconductor, Carrier concentrations in an intrinsic semiconductor, Donor, and Acceptor impurities, Charge densities in a semiconductor, Fermi level in extrinsic semiconductors, Diffusion, Carrier lifetime, The continuity equation, and Hall Effect. **Diode Theory:** Semiconductor-diode Characteristics: Qualitative theory of the p-n junction, The p-n junction as a diode, Band structure of an open-circuit p-n junction, The current components in a p-n junction diode, Qualitative theory of p-n diode currents, The Volt-Ampere characteristics, The temperature dependence of p-n characteristics. **Superconductivity:** Experimental Survey, Occurrence of Superconductivity, destruction of superconductivity by magnetic field, The Meissner effect, London equation, Qualitative introduction to BCS theory of superconductivity, Type I and Type II Superconductors Ref.: EDC: 4.1 to 4.10, EDC: 5.1 to 5.8 CK: Topics from Chapter 12.	15 Lectures

References:

1. SOP : Solid State Physics: S. O. Pillai, New Age International, 6th Ed.

2. EDC: Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3rd Ed.) Tata McGraw Hill.

3.CK: Introduction to Solid State Physics - Charles Kittel, 7th Ed. John Wiley &Sons.

Additional References:

1. Solid State Physics: A. J. Dekker, Prentice Hall.

2. Electronic Properties of Materials: Rolf Hummel, 3rd Ed. Springer.

3. Semiconductor Devices: Physics and Technology, 2nd Ed. John Wiley & Sons.

4. Solid State Physics: Ashcroft & Mermin, Harcourt College Publisher.

5. Elementary Solid State Physics-Principles and Applications: M.Ali Omar, Pearson Education, 2012.

6. Modern Physics and Solid State Physics: Problems and solutions New Age International.

7. Elements of X-ray diffraction by B.D. Cullity, Addison-Wesley pub.

Course title: Electrodynamics

Course code:

Objective: To understand the laws of electromagnetism and the theoretical approaches that led to the relation between electromagnetism and optics.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand the laws of electrostatics and be able to perform calculations using them.
LO2	Understand the laws of magnetostatics and be able to perform calculations using them.
LO3	Understand Maxwell's electrodynamics and its relation to relativity
LO4	Understand how laws of optics can be derived from electromagnetic principles.
LO5	Develop quantitative problem solving skills in Electrodynamics

Unit no.	**Details of topics**	**No of lectures**
1	**Electrostatics and magnetostatics** 1. Statements of Coulomb & Gauss law.The divergence of E, Applications of Gauss' law, The curl of E. Introduction to potential, The potential of a localized charge distribution (Qualitative) 2. Dielectrics, Induced Dipoles, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics (no derivation), Susceptibility, Permittivity, Dielectric constant and relation between them, Energy in dielectric systems. 3. Statements of Biot-Savart's law and Ampere's law, Straight-line currents, The Divergence and Curl of B, Applications of Ampere's Law in the case of a long straight wire and a long solenoid. 4. Magnetization, Bound currents and their physical interpretation, Magnetic susceptibility and permeability. DG: 2.1.1 to 2.1.3, 2.2.2 to 2.2.4, 2.3.1 to 2.3.4 DG: 4.1.1 to 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.4.1, 4.4.3 DG: 5.2.1, 5.3.1 to 5.3.4, 5.4.1	15

	DG: 6.1.1, 6.1.4, 6.2.1, 6.2.2, 6.2.3, 6.3.1, 6.3.2, 6.4.1	
2	**Electrodynamics and Electromagnetic Waves** 1. Energy in magnetic fields, Electrodynamics before Maxwell, Maxwell's correction to Ampere's law, Maxwell's equations, Maxwell's equations in matter, Boundary conditions. 2. The continuity equation, Poynting's theorem 3. The wave equation for E and B, Monochromatic Plane waves, Propagation in linear media, Reflection and transmission of EM waves (Brief Discussion) DG: 7.2.4, 7.3.1 to 7.3.6 DG : 8.1.1, 8.1.2 DG : 9.2.1 to 9.2.3, 9.3.1 to 9.3.3	**15**

References:

1. DG: Introduction to Electrodynamics, David J. Griffiths (3rd Ed) Prentice Hall of India.

Additional References:

1. Introduction to Electrodynamics: A. Z. Capria and P. V. Panat, Narosa Publishing House.

2. Engineering Electrodynamics: William Hayt Jr. & John H. Buck (TMH).

3. Foundations of Electromagnetic Theory: Reitz, Milford and Christy.

4. Solutions to Introduction to Electrodynamics: David J. Griffiths (3rd Ed) Prentice Hall of India.

Elective Course:

Course title: Atomic and Molecular Physics

Course code: VESUSPH503

Objective: To understand the applications of Quantum mechanics in atomic physics. To understand different concepts namely, electron spin, symmetric and antisymmetric waves, effect of magnetic field on atoms, Molecular physics and its applications. This course will be useful to get an insight into spectroscopy.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand basic structure of atom
LO2	Provide electronic configuration
LO3	Status of energy levels
LO4	Explain basic electronic spectra
LO5	Explain effect of magnetic field on the electronic spectra
LO6	Analyse and explain molecular structure
LO7	Explain molecular spectra

Unit no.	Details of topics	No of lectures
1	**Quantum Theory of Hydrogen Atom** 1. Schrodinger equation for Harmonic oscillator, its solution. Schrödinger's equation for Hydrogen atom, Separation of variables, Quantum Numbers: Total quantum number, Orbital quantum number, Magnetic quantum number. Angular momentum, 2. Electron spin: The Stern-Gerlach experiment, Pauli's Exclusion Principle Symmetric and Antisymmetric wave functions. Ref : B: 9.1 to 9.9, B: 10.1, 10.3. 2, DG: 2.3	15 Lectures

	Spin and Magnetic Interactions Spin orbit coupling, Total angular momentum, Vector atom model, L-S and j-j coupling. Origin of spectral lines, Selection rules (only statements). B: 10.2, 10.6, 10.7, 10.8, 10.9.	
2	**Zeeman effect** Effect of Magnetic field on atoms, the normal Zeeman effect and its explanation (Classical and Quantum), The Lande g - factor, Anomalous Zeeman effect. B : 11.1 and 11.2 **Molecular Spectra and its Applications** Molecular spectra (Diatomic Molecules): Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational-Rotational spectra. Application Infrared spectrometer & Microwave spectrometer. (Self Study) **Raman Spectroscopy, ESR and NMR** Raman effect: Quantum Theory of Raman effect, Pure Rotational Raman spectra: Linear molecules, symmetric top molecules, Asymmetric top molecules, Vibrational Raman spectra: Raman activity of vibrations, Experimental set up of Raman Effect. Ref: B: 14.1, 14.3, 14.5, 14.7 BM: 6.11, 6.1.3. 2. BM: 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.2.3, 4.3.1.	15 Lectures

References:

1. DG: Introduction to Quantum Mechanics by D. Griffiths

2. B: Perspectives of Modern Physics : Arthur Beiser McGraw Hill.

3. BM: Fundamentals of Molecular Spectroscopy : C. N. Banwell & E. M. McCash (TMH).(4th Ed.)

4. GA: Molecular structure and spectroscopy : G Aruldhas (2nd Ed) PHI learning Pvt Ltd.

Additional references:

1. Atomic Physics (Modern Physics): S.N.Ghoshal. S.Chand Publication (for problems on atomic Physics).

2. Atomic Physics by J.B. Rajam

Course title: Special Theory of Relativity

Course code:

Objective: This course introduces students to the essence of special relativity which revolutionized the concept of physics in the last century by unifying space and time, mass and energy, electricity and magnetism. This course also gives a very brief introduction of general relativity.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand and appreciate development of relativity theory
LO2	Understand the significance of Michelson Morley experiment and failure of the existing theories to explain the null result.
LO3	Demonstrate how a series of theories proposed to preserve ether failed.
LO4	Demonstrate correct reasoning in explanation of Michelson and Morley experiment
LO5	Understand the importance of postulates of special relativity, Lorentz transformation equations
LO6	Demonstrate use of space-time diagram to understand various concepts of relativity
LO7	Understand the transformation equations for: Space and time, velocity, frequency, mass, momentum, force, Energy, Charge and current density, electric and magnetic fields
LO8	Solve problems based on length contraction, time dilation, velocity addition, Doppler effect, mass energy relation and resolve paradoxes in relativity like twin paradox etc.

Unit no.	**Details of topics**	**No of lectures**
1	**Introduction to Special theory of relativity:** Inertial and Non-inertial frames of reference, Galilean transformations, Newtonian relativity, Electromagnetism and Newtonian relativity. Attempts to locate absolute frame: Michelson- Morley experiment (omit derivation part), Attempts to preserve the concept of a preferred ether frame: Lorentz Fitzgerald contraction and Ether drag hypothesis (conceptual), Stellar aberration. **Relativistic Kinematics**: Postulates of the special theory of relativity, Simultaneity, Lorentz transformation equations (No derivations). Some	

	consequences of the Lorentz transformation equations: length contraction, time dilation and meson experiment, The observer in relativity. Qualitative introduction to space-time diagrams and interpretation about length contraction, time dilation, and simultaneity. Supplementary topics A1, A2, A3. The relativistic addition of velocities, acceleration transformation equations, Aberration and Doppler effect in relativity. RR: 1.1 to 1.9, 2.1 to 2.8	
2	**Relativistic Dynamics**: Mechanics and Relativity, The need to redefine momentum, Relativistic momentum, Alternative views of mass in relativity, The relativistic force law and the dynamics of a single particle, The equivalence of mass and energy, The transformation properties of momentum, energy and mass (statements). **Relativity and Electromagnetism:** Introduction, The interdependence of Electric and Magnetic fields, The Transformation for E and B, The field of a uniformly moving point charge, Force and fields near a current-carrying wire, Force between moving charges. RR: 3.1 to 3.7, 4.1 to 4.7	

References:

1. RR: Introduction to Special Relativity: Robert Resnick (Wiley Student Edition).
2. Special theory of Relativity: A. P. French.
3. Very Special Relativity – An illustrated guide: by Sander Bais - Amsterdam University Press.
4. Concepts of Modern Physics by Arthur Beiser.
5. Modern Physics by Kenneth Krane

Course Title: Introduction to Characterization techniques
Course code:

Objective: To understand different characterization techniques.

Learning Outcomes (LO):

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

LO1	Understand different characterization techniques and their importance
LO2	Understand the potential as well as the limitations of different characterization techniques
LO3	Choose an investigating technique as per the required characterization

Unit No.	Details of topics	No of lectures
1	Introduction to materials characterization and different available techniques as per requirement. **Optical Microscopy:** Optical microscope - Basic principles and components, Different examination modes (Bright field illumination, Dark field illumination, Phase contrast, Specimen preparation) **Electron Microscopy:** Interaction of electrons with solids, Scanning electron microscopy Transmission electron microscopy and overview of specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive and wavelength dispersive spectroscopy.	15 Lectures
2	**X-ray and Diffraction methods:** Overview of crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, X-ray photoelectron spectroscopy. Electron diffraction. Selection rules and Indexing of Cubic system. **Atomic force microscopy:** Introduction to Atomic force microscopy, AFM’s different operation modes. **Spectroscopy:** Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy. **Thermal Analysis:** Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis, and dilatometry.	15 Lectures

References:

1) Handbook of Analytical Methods for Materials, Materials Evaluation and Engineering, Inc.
2) Characterization of Materials volume 1 and 2, Wiley Interscience, A john wiley and sons
3) Chemistry and Physics of Surfaces and Interfaces, Thiruvancheril, G. Gopakumar, Chemistry

4) Elements of X-ray diffraction by B.D. Cullity, Addison Wesley Pub.

Lab Courses:
Course code:

Objective: To get familiar with use of basic instruments in Physics and develop deep understanding of concepts in areas studied in theory. To understand correlation between theory and practicals.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Plan experiments and record precise observations, plotting appropriate graphs to draw results.
LO2	Understand the use of different apparatus without fear and hesitation.
LO3	Use CRO and DSO confidently for different analysis
LO4	Use spectrometer and able to do experiments based on spectrometer
LO5	Connect the electric circuits on breadboard.
LO6	Calculate results and estimate possible errors in the results.
LO7	Design constant current source.
LO8	Differentiate between first order filter and second order filter.
LO9	Make appropriate adjustments of the equipments.

SKILL EXPERIMENTS

Name of the Experiment

1. Estimation of errors from actual experimental data.

2. Soldering and testing of electronic circuits

3. Optical Leveling and Schuster's method of spectrometer

5. Laser beam profile

6. Use of electronic balance (density of a solid cylinder)

7. Dual trace CRO: Phase shift measurement

8. C1/C2 by B.G.

9. Internal resistance of voltage and current source

10. Use of DMM to test diode, transistor and β factor

Lab of Major papers:

SET 1 (credit 2)

1. Determination of ‘g’ by Kater’s pendulum
2. Determination of g using Bar Pendulum
3. Searle’s Goniometer
4. Determination of Rydberg’s constant
5. Edser’s ‘A’ pattern
6. Determination of wavelength by Step slit
7. R. I. by total internal reflection
8. Velocity of sound in air using CRO
9. Logarithmic decrement
10. Determination of e/m by Thomson’s method

SET 2 (credit 2)

1. Diode as a temperature sensor
2. Determination of ideality factor using log amplifier
3. Band gap energy of Ge diode
4. Hall effect
5. Determination of dielectric constant
6. Elastic constants of a rubber tube
7. Y by Koneig method
8. Y by bending
9. Thermal conductivity by Lee’s method
10. Solar cell characteristics (determination of Voc, Isc and Pmax)
11. Hysteresis loop by CRO

SET 3 (**Elective**, credit 2)

1. First order Active LP
2. First order Active HP
3. Active Second order LP
4. Active Second order HP
5. Mutual inductance by BG.
6. C by Ballistic Galvanometer
7. C by de-Sauty’s capacitance comparison bridge

8. L by de-Sauty's inductance comparison bridge
9. Capacitance by parallel bridge
10. C by Maxwell's bridge
11. Transistorized astable multivibrator
12. Monostable/Bistable multivibrator
13. Wien bridge oscillator
14. Analysis of XRD, UV-visible, AFM, DSC/DTA and SEM data.

References:

1. Advanced course in Practical Physics: D. Chattopadhya, PC. Rakshit & B. Saha (8th Edition) Book & Allied Pvt. Ltd.

2. BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001.

3. A Text book of Practical Physics: Samir Kumar Ghosh New Central Book Agency (4th edition).

4. B Sc. Practical Physics: C. L. Arora (1st Edition) – 2001 S. Chand & Co. Ltd.

5. Practical Physics: C. L. Squires – (3rd Edition) Cambridge University Press.

6. University Practical Physics: D C Tayal. Himalaya Publication.

7. Advanced Practical Physics: Worsnop & Flint.

Minimum five experiments. A learner will be allowed to appear for the semester and practical examination only if he submits a certified journal of Physics.

Vocational Skill Courses (VSC)

Course Code	Title	Credits	Lectures per Week

	Microprocessor, Microcontroller and Python Programming	**02**	**04**

Course title: Microprocessor, Microcontroller and Python Programming
Course code:

Objective: To equip students with the programming skills in the Microprocessor 8085, Microcontroller 8051 and Python.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand and explain internal architecture of microprocessor 8085
LO2	Differentiate between machine language, assembly language and high level language.
LO3	Develop algorithms to solve given tasks, as a first step towards programming.
LO4	Write flowchart of basic programs.
LO5	Find hex code of the instruction and use it while entering the program.
LO6	Write programs at appropriate locations and execute programs in different make kits by using its manual confidently.
LO7	Understand the architecture of the 8051 microcontrollers.
LO8	Use the different types of instructions (e.g., data transfer, arithmetic, logical, control).
LO9	Write and execute simple programs using the 8051-instruction set.
LO10	Learn the basic syntax of Python
LO11	Write and execute simple programs in python
LO12	Demonstrate basic arithmetic using Python

No.	Experiments
	8085 programming
1	8- bit multiplication (revision)
2	16- bit Addition using DAD
3	16- bit Addition using ADC
4	16- bit Subtraction SUBB
5	Assembly Language Program for equation a*b + c*d using Subroutine
	8051 programming
6	Addition of 2 data bytes
7	8-bit MULTIPLICATION
8	8-bit DIVISION
9	16-bit Addition
10	find the square of a number

	8255A PPI
11	Intro to 8255A - Programmable Peripheral Interface
	Python Programming
12	Introduction to Python
13	Using Python as a Calculator link
14	Prime number generator link
15	Generates arithmetic progressions using for loop
16	LCM, GCD
17	Fibonacci series using while loop link
18	Graph Plotting

References:

1. RG: Microprocessor Architecture, programming and Applications with the 8085 by Ramesh Gaonkar, 5th Edition, Prentice Hall of India.
2. Microprocessor and Applications by Vibhute and Borole, Technova Publications, Pune.
3. Microprocessor, Principles & Applications by Gilmore (2nd Ed) TMHAVD: Microcontrollers (Theory and Applications) by Ajay V Deshmukh, The Tata-McGraw-Hill Companies
4. MMM: The 8051 Microcontroller & Embedded Systems by M.A. Mazidi, J.G. Mazidiand R. D. Mckinlay, Second Edition, Pearson.
5. Intel's 8031/8051 Data sheet
6. Microprocessor and Applications by Vibhute and Borole, Techmax Publications.
7. Microprocessor, Principles & Applications by Gilmore (2nd Ed) TMH
8. https://wiki.python.org/moin/BeginnersGuide
9. https://docs.python.org/3/tutorial/index.html

The students are required to maintain a lab journal containing all performed experiments, at least ten experiments, to appear for the exam.

Minor

Course Code	Title: Nuclear Physics and digital electronics	Credits	Lectures per Week
	Unit 1: Nuclear Physics	**02**	**2**
	Unit 2: Digital Electronics		
	Practical based on UMNPHS5-216	**02**	**04**

Course Title: Nuclear Physics and digital electronics

Course code:

Objective: To understand the foundation of Nuclear Physics and Digital Electronics.

earning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand nuclear properties and nuclear behavior.
LO2	Understand the type of isotopes and their applications.
LO3	Differentiate between different nuclear reaction.
LO4	Convert numbers from one system to other numbering system.
LO5	Do binary and hexadecimal addition, subtraction.
LO6	Differentiate between different flip-flops.
LO7	Differentiate between different registers.

Unit no.	Details of topics	No of lectures
1	Nuclear Physics Structure of Nuclei: Nuclear Composition, Basic properties of nuclei, nuclear radii, density of nucleus, Charge, Spin and Magnetic Moment Rutherford's experiment and estimation of nuclear size(Patel: 4.I.2) , Binding energy, BE/A vs A plot and its interpretation , Stability of Nuclei (N vs Z plot) Concepts of Modern Physics -Beiser - 6th edition (11.1,11.2,11.3, 11.4) 2. Radioactivity: Review : Properties of α, β, γ-rays (AB12.1), half-life, Law of Radioactive decay , mean life (derivation not required), statistical nature of radioactivity, , units of radioactivity, laws of radioactive decay, Radioactive growth and decay (successive disintegration ; A to B to C where C is the stable product) and equilibriums, Natural Radioactive series , Natural and artificial radioactivity, SBP- 2.3, 2.4, 2.6 ,2.7, 2.8, 2.9 3. Determination of the age of the Earth, Carbon dating, SBP - 2.12, 2.13 4. Radioisotopes and its Applications. (DCT:2.13 Page No.86 and 87) Additional : https://dae.gov.in/node/191 Radiation hazards (AB:12.1 Page No. 422,423) 5. Nuclear Reactions: Introduction, Types of nuclear reactions, Q equation, SBP :3.1,3.2,3.3,3.4	15 Lectures
2	Binary number system , Arithmetic building blocks , Types of registers and counters. Binary to Decimal ,Decimal to binary , Hexadecimal number, Hexadecimal to decimal Conversion, Decimal to hexadecimal conversion, Hexadecimal to binary conversion, Binary to hexadecimal conversion, Binary addition, Unsigned binary numbers, Sign magnitude numbers , 1's complement , 2's complement , Converting to and from 2's complement representation , 2's complement arithmetic, The adder-subtractor. RS Flip-Flops (only NOR gate latch) , Edge-Triggered RS Flip-Flop, Edge- Triggered D Flip-Flop, Edge-Triggered J-K Flip-Flop, Bounce elimination switch.	15 Lectures

	Types of registers : SISO , SIPO, PISO , PIPO [SISO and PIPO in detail, in this chapter the teacher should make all IC-specific diagrams into general diagrams ie. Ignore pin numbers and IC numbers] Asynchronous counter -3 bit (ignore IC specific diagrams), Synchronous counter only mod 8, Decade Counters Mod5 and Mod10	

References:

1. AB: Concepts of modern physics by Arthur Beiser, McGraw Hill
2. SBP :Nuclear Physics An Introduction by S. B. Patel (New Age International Publication second edition)
3. DCT : Nuclear Physics - DC Tayal (Himalaya Publishing House) (5th edition)
4. LMS – Digital Principles and Aplications By Leach, Malvino, Saha 6th edn.
5. TF – Digital Fundamentals by Thomas L Floyd 10th edn. (Additional Reading)
6. RPJ – Modern Digital Electronics by R P Jain 4th edn. (Additional Reading)

Additional Reference:

1. Nuclear Physics by S. N. Ghoshal
2. Nuclear Physics by Irwing Kaplan, Oxford Publishing

Course Title: Minor SEM 5 Practical

Course code:

Objective: To get familiar with use of basic instruments in Physics and develop deep understanding of concepts in areas studied in theory. To understand correlation between theory and practicals.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Plan experiments and record precise observations, plotting appropriate graphs to draw results.
LO2	Understand the use of different apparatus without fear and hesitation.
LO3	Use CRO and DSO confidently for different analysis
LO4	Make appropriate adjustments of the equipments.
LO5	Calculate results and estimate possible errors in the results.

LO6	Convert numbers from one system to other numbering system.
LO7	Do binary and hexadecimal addition, subtraction.
LO8	Trace different wave forms from DSO
LO9	Add subtract binary number using 8-bit adder/ subtractor

PRACTICAL Minor Sem 5 COURSE:

Name of the Experiment

1. Conversion between different numbering systems
2. Arithmetic of Binary Number
3. Arithmetic of Hexadecimal Number
4. RS Flip-flop
5. JK Flip-flop
6. SISO PIPO
7. 3-bit counter
8. MOD-5 Counter
9. MOD-10/Decade counter
10. half adder
11. full adder
12. 8-bit adder/ subtractor
13. G.M. counter characteristics
14. Decoder/ Encoder
15. Multiplexer/De-Multiplexer

References:

1. Digital Principles and Applications" by Malvino and Leach.

Modality of Assessment

The performance of the learners for those exams having Semester End Examinations and Internal Assessment shall be evaluated in two parts as per the following ratio:

Semester End Examination: Internal Assessment [60:40]

The learner's performance shall be assessed by conducting the **Semester-end Examination with 60% marks** and **Continuous Internal Assessment (CIA) with 40% mark**s. Practical Examination will consist of Semester-end examination.

Students will have to score 40% of marks INDIVIDUALLY in Internal assessment as well as Semester-end Examination to pass the course.

Internal Assessment: It is defined as the assessment of the learners on the basis of internal evaluation by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment: It is defined as the assessment of the learners on the basis of Performance in the Semester-end Theory/ Practical examination.

Theory Paper of Major and Minor Physics of 2 credits:

A. Theory - Internal assessment 40% 20 marks

Evaluation type	Marks
Assignments, Project based learning activities (Group Discussion Research/ Case studies/ Reports / Assignments / Presentations / Skit / Poster/etc.), Class Test (Objective - Multiple Choice Questions/ Subjective).	20

B. Theory - External examination - 60% 30 marks

Assessment of Lab courses of Major (4 Credits):

Evaluation of Practical papers will be based on performance of one experiment from each set (Set-1 and Set-2) from each group in major and based on one experiment.

Semester End Practical Assessment **50 marks**

A	One experiment /Lab activities	40 marks
B	Viva	5 marks
C	Journal	5 marks

Assessment of Elective Lab courses of Major (2 Credits):

Evaluation of Practical papers will be based on performance of one experiment from set -3 elective major and based on one experiment.

Semester End Practical Assessment **50 marks**

A	One experiment /Lab activities	40 marks
B	Viva	5 marks
C	Journal	5 marks

Assessment of lab-based VSC (2 Credits):

Evaluation of Practical papers will be based on performance of one experiment.

Semester End Practical Assessment **50 marks**

A	One experiment /Lab activities	40 marks
B	Viva	5 marks
C	Journal	5 marks

Assessment of lab-based Minor (2 Credits):

Evaluation of Practical papers will be based on performance of one experiment.

Semester End Practical Assessment **50 marks**

A	One experiment /Lab activities	40 marks
B	Viva	5 marks
C	Journal	5 marks

On Job training (OJT) 4 Credits

Students need to complete 120 hr on Job training. Students need to submit report.

Field project (FP) 2 Credits

Students need to complete Field project. Students need to submit report.