"Dissemination of Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(An Empowered Autonomous Institute).

DEPARTMENT OF PHYSICS

UG Programme

Syllabus as per NEP-2020 (Phase 1.0)

Curriculum, Teaching and Evaluation Structure

for

B.Sc.-III Physics

Semester – V & VI

(Implemented from academic year 2025-26 onwards)

VIVEKANAND COLLEGE, KOLHAPUR
(An Empowered Autonomous Institute)
Department of Physics
B.Sc.

Program Outcomes (POs):

PO1: **Disciplinary Knowledge:** Graduates will gain in-depth understanding in their specific major or discipline, mastering the foundational principles and theories, as well as advanced concepts. Execute strong theoretical and practical understanding developed from the specific programme in the area of work.

PO2: **Problem-Solving Skills:** Graduates will learn to use their knowledge to identify, analyze, and solve problems related to their field of study.

PO3: **Analytical Skills:** Graduates will gain the ability to collect, analyze, interpret, and apply data in a variety of contexts. They might also learn to use specialized software or equipment.

PO4: **Research Skills and Scientific temper:** Depending on the field, graduates might learn how to design and conduct experiments or studies, analyze results, and draw conclusions. They might also learn to review and understand academic literature.

PO5: **Communication Skills:** Many programs emphasize the ability to communicate effectively, both orally and in writing. Graduates may learn to present complex information clearly and succinctly, write detailed reports, and collaborate effectively with others.

PO6: **Ethics and Professionalism**: Graduates may learn about the ethical and professional standards in their field, and how to apply them in real-world situations.

Program Specific Outcomes (PSOs):

PSO1: Understand basic mechanics and properties of matter.

PSO2: Students should understand mathematical concepts needed for understanding Physics.

PSO3: Students should understand fundamental basic theories of General Physics, Classical Mechanics, Quantum mechanics, Electricity and magnetism, Modern Physics, Space Science, Semiconductor Physics and able to apply this knowledge to analyze the variety of physics phenomenon.

PSO4: Students should learn laboratory skills; students should take measurements in Physics laboratory and analyze the measurements to draw valid conclusions.

Vivekanand College, Kolhapur (An Empowered Autonomous Institute)
Department of Physics
Departmental Teaching and Evaluation scheme
UG Programme
Syllabus as per NEP-2020 (Phase 1.0) B.Sc. III, Semester-V&VI

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	ESE	CIE	PR	Marks	
Semester-V										
1	DSC-IX	DSC03PHY51	Mathematical Physics	2	-	40	10	-	50	2
2	DSC-X	DSC03PHY52	Quantum Mechanics	2	-	40	10	-	50	2
3	DSC-XI	DSC03PHY53	Classical Mechanics	2	-	40	10	-	50	2
4	DSE-I	DSE03PHY51	Atomic and Molecular Physics	2	-	40	10	-	50	2
		DSE03PHY52	Electrodynamics and Electromagnetic Waves	2	-	40	10	-	50	2
5	VSC-PR-III	VSC03PHY59	Lab activities in Energy and environmental studies	-	2	-	-	25	25	2
6	FP	FPR03PHY51	Field Project (FP)	-	2	-	-	25	25	2
7	DSC-PR-V	DSC03PHY59	Practical Lab-V	-	12	-	-	75	75	6
8	MIN-IX	MIN03PHY51	Introduction to nanoscience	2	-	40	10	-	50	2
9	MIN-PR-V	MIN03PHY59	MIN-Physics Lab-5		04	-	-	25	25	2
Semester –V Total				**10**	**20**	**160**	**40**	**150**	**400**	**22**
Semester-VI										
1	DSC-XII	DSC03PHY61	Nuclear and Particle Physics	2	-	40	10	-	50	2
2	DSC-XIII	DSC03PHY62	Semiconductor devices and Instrumentation	2	-	40	10	-	50	2
3	DSC-XIV	DSC03PHY63	Solid state physics-I	2	-	40	10	-	50	2
4	DSE-II	DSE03PHY61	Solid state physics-II	2	-	40	10	50	50	2
		DSE03PHY62	Energy Studies and Environmental Sciences	2	-	40	10	50	50	2
5	VSC-PR-IV	VSC03PHY69	Lab activities in numerical skills		2					2
6	OJT	OJT03PHY61	On Job Training (OJT)	-	2	-	-	25	25	2
7	DSC-PR-VI	DSC03PHY69	Practical Lab-VI (16)	-	12	-	-	75	75	6
8	MIN-X	MIN03PHY61	LASER and its applications	2	-	40	10	-	50	2
9	MIN-PR-VI	MIN03PHY69	MIN-Physics Lab-6	-	04	-	-	25	25	2
Semester –VI Total				**10**	**20**	**160**	**40**	**150**	**400**	**22**

SEM V

B.Sc. III, Semester-V (DSC-IX)
Mathematical Physics
(DSC03PHY51)

Theory: 30 Hours **Credits: 02**

CO's:

After completion, Students are able to

CO1	Understand Cartesian, spherical polar and cylindrical co-ordinate systems.
CO2	Understand Solve partial differential equations.
CO3	Understand applications of partial differential equations.
CO4	Solve problems based on mathematical Physics.

Unit	Syllabus	Lectures
Unit 1	**1. Orthogonal curvilinear co-ordinates** Introduction to Cartesian, spherical, polar and cylindrical co-ordinates system, concept of orthogonal curvilinear co-ordinates, unit tangent vectors, arc length, area and volume elements in orthogonal curvilinear co-ordinates system, Expression for gradient, divergence, Laplacian and curl in Cartesian, spherical, polar and cylindrical co-ordinate system. **2. Partial differential equation** Partial differential equation, degree, order, linearity and homogeneity of differential equations, methods of separation of variables, Frobenius method of power series, solution of Legendre, Hermite and Bessel differential equation.	15
Unit 2	**1. Complex analysis** Revision of complex numbers and their graphical representation, Euler's formula, De-Moiver's theorem, Roots of complex number, Functions of complex numbers, Analyticity and Cauchy- Reimann condition, examples of analytical function, Singular functions, Poles and branch points, order of singularity, Integration of function of complex variable, Cauchy's inequality, Cauchy's integral formula. **2. Fourier series and integrals** Fourier series and Fourier transform, Dirichlet condition, (Statement only) Properties of Fourier series: 1) convergence, 2) Integration 3) Differentiation. Physical applications of Fourier series 4) square wave (high frequencies) 5) full wave rectifier, Differentiation and integration of Fourier series, Fourier transform, Inverse functions.	15

Reference books:

1) Mathematical Physics; H. K. Das, Rama Varma, S. Chand Publishing; Eighth edition - 2019.
2) Partial Differential Equations; Gupta Malik & Mittal, Pragati Prakashan, 2010.
3) Differential Equations; Dr. N. Ch. S. N. Iyenger (1st edition 2000), Anmol Publications, 2000
4) Mathematical Physics; Dr. B. S. Rajput, Anu Books-2020
5) Mathematical Methods for Physicists (6th Edition); Arfken, Weber, Elsevier- 2005.
6) Essential Mathematical methods; K. F. Riley, M. P. Habson, Cambridge university press, 2011.

B.Sc. III Semester-V (DSC-X)
Quantum Mechanics
(DSC03PHY52)

Theory: 30 Hours **Credits: 02**

CO's:

After completion, Students are able to:

CO1	Define Concept of wave packet and Uncertainty principle.
CO2	Understand Schrödinger time dependent and time independent wave equations and their applications.
CO3	Understand applications of Operator in Quantum Mechanics
CO4	Understand the concept of Quantum Theory of hydrogen atom

Unit	Syllabus	Lectures
Unit 1	**1. Introduction to Quantum Mechanics** Origin of quantum mechanics, Review of black body radiation, Photoelectric effect, matter waves, De-Broglie hypothesis, experimental evidence of de Broglie theory (Davisson and Germer experiment), wave particle duality, Heisenberg's uncertainty principle and different forms uncertainty principle **2. The Schrodinger's Equation** Physical interpretation of wave function, Schrodinger's time dependent and independent equation (one and three dimensional) Requirements of wave function, Eigen value, Eigen function, Normalized orthogonal and orthonormal wave functions, Probability current density (Continuity equation). Examples on Normalization of wave function **3. Operator in Quantum Mechanics** Definition of an operator in quantum mechanics, commutation relation in quantum mechanics, position, momentum and angular momentum operator, Angular momentum operator in spherical polar coordinate system, Hamilton operator, Hamilton operator commutation relation between x' and p. Expectation value of an operator communication relation between L2 and components of L, Raising and lowering operator L+ and L-. Eigen values of L2 and L1. Concept of parity operator. Concept of Hermitian operator.	15
Unit 2	**1. Applications of Schrodinger's Steady State Equation** Quantum mechanics treatment of particle in rigid box (1D and 3D). Step potential relation and transmission coefficient. Barrier potential- Tunnelling effect, α-decay, simple harmonic oscillator. **2. Quantum Theory of Hydrogen Atom** Schrodinger's equation in spherical polar co-ordinates, Schrodinger's equation for hydrogen atom in spherical polar co-coordinators (r, θ, ϕ), separation of angular and radial part and their solution, quantum numbers. n, l, ml, m_s and their significances.	15

Reference Books:

1) Quantum Mechanics, Leonard I. Schiff, 3rd Ed. 2 Bow wow press 3rd emended ed. 2024
2) Quantum Mechanics Theory and Applications, Ajoy Ghatak and S. Lokanathan, 5th Ed., 2017, Trinity.
3) Quantum Mechanics, Gupta, Kumar, Sharma, Thirtieth Ed., Jai Prakash Nath Publications. Meerut - 2011.
4) Advanced Quantum Mechanics, Satya Prakash, Reprint KedarNath Ram Nath Meerut, 2011.
5) Perspectives of Modern Physics, Arthur Beiser, McGraw Hill International Editions – 1969.
6) Concepts of Modern Physics, Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Sixth Edition, Tata McGraw Hill Education Private Ltd. – 2009.

B.Sc. III Semester-V (DSC-XI)
Classical Mechanics
(DSC03PHY53)

Theory: 30 Hours **Credits: 02**

CO's :

After completion of the unit, Students are able to:

CO1	Define constraints, Degree of freedom and generalized coordinates etc., and understand principle of virtual work and D'Alembert's principle.
CO2	Derive Lagrange's equation from D'Alembert's principle and understand it's of Langrange's equation.
CO3	Derive Hamilton' equation from D'Alembert's principle.
CO4	Define Inertial and Non–Inertial reference frames, Understand Michelson Morley Experiment, define Relativistic addition of velocities, Length contraction, Time dilation. Describe mass energy relation.

Unit	Syllabus	Lectures
Unit 1	**1. Lagrangian Dynamics** Introduction Basic Concepts: (1) Co-ordinate system (2) Degrees of freedom; Constraints: Holonomic constraints, Nonholonomic constraints, Forces of constraints, Configuration space, Generalized Co-ordinates, Principle of virtual work, D'Alembert's principal. Lagrange's equation from D'Alembert's principle. Application of Lagrange's equation to a particle in a space, Atwood's machine and bead sliding on uniformly rotating wire under force free condition, simple pendulum **2. Variational principles** Hamilton's principle, Deduction of Hamilton's principle from D' Alembert's principle, Deduction of Lagrange's equation from Hamilton's principle. Application of Hamilton's principle: shortest distance between two points in plane, Brachistochrone problem.	15
Unit 2	**1. Non-inertial and Rotating co-ordinate system** Inertial and non-inertial framed of reference Fictitious or Pseudo force, centrifugal force, uniformly rotating frame, Motion relative to earth. Application of Coriolis force: 1) Formation of cyclone, 2) Particles in a horizontal plane, 3) Freely falling body at earth's surface **2. Special theory of Relativity** Introduction: Galilean transformation, the Michelson-Morley experiment, Ether hypothesis Postulates of special theory of relativity, Lorentz transformations, Relativistic addition of velocities, Length contraction, Time dilation, Variation of mass with velocity, Mass energy relation.	15

Reference Book:

1) Classical Mechanics, by H Goldstein, Addison Wesley, 1980.
2) Classical Mechanics, by J.C. Upadhyaya, Himalaya Publishing House, 2015.
3) Classical Mechanics, by N C Rana and P S Joag, Tata McGraw Hill, 1991.
4) Introduction to Classical Mechanics, by R G Takwale and P S Puranik, Tata McGraw Hill 1999.
5) Classical Mechanics, by Gupta, Kumar and Sharma, Pragati Prakashan, 2000.
6) Classical Mechanics, G. Aruldhas, Prentice Hall India Learning Private Limited, 2008.

B.Sc. III Semester-V (DSE-I)
Atomic and Molecular Physics
(DSE03PHY51)

Theory: 30 Hours **Credits: 02**

CO's :

After completion of the unit, Students are able to:

CO1	Describe the vector atom model.
CO2	Know and understand the normal and anomalous Zeeman effect, Paschen Back effect and Stark effect as well as Raman Effect.
CO3	Understand and explain Molecular Spectra.
CO4	Get knowledge about atomic spectroscopy.

Unit	Syllabus	Lectures
Unit 1	**1.Atomic Spectra:** Introduction of atomic structure and spectra, Spectral notations and optical spectral seriesfor doublet structure, Spectrum of sodium and its doublet fine structure, Selection and intensity rules for fine structure doublets, Observed hydrogen fine structure, Normal order of fine structure doublets, Electron spin-orbit interaction, Normal Zeeman effect (qualitative explanation) and anomalous Zeeman effect and their explanation from vector atom model, Lande's g factor. **2.Molecular Spectra:** Molecular bond, Electron sharing, H2+ molecular ion, the hydrogen molecule, Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational spectra, Vibration– rotation spectra, Electronic spectra of diatomic molecules.	20
Unit 2	**Raman Spectra:** Raman Effect, Experimental arrangement of Raman Effect, Characteristic properties of Raman lines, Classical and quantum theory of Raman Effect, Difference between Raman spectra and infrared spectra, Applications of Raman effect.	10

Reference Book:

1) Atomic and Nuclear Physics – H. Semat and T. E. Albright. 5th edition, Chapman and Hall - 1978.
2) Introduction to Atomic Spectra – H. E. White., MC Graw Hill Education – 2019.
3) Atomic Spectra - J B Rajam, S. Chand – 2008.
4) Concepts of Modern Physics – Arthur Beiser, MC Graw Hill International Edition - 1969.
5) Perspectives of Modern Physics – Arthur Beiser, MC Graw Hill Inc., US - 1969
6) Modern Physics- Agarwal, S. Chand – 2010.

OR

B.Sc. III Semester-V (DSE-I)

Electrodynamics and Electromagnetic Waves

(DSE03PHY52)

Theory: 30 Hours **Credits: 02**

CO's :

After completion of the unit, Students are able to:

CO1	Understand charge particle dynamics and solve problems on Laplace's equation.
CO2	Solve problems on Maxwell's Equations.
CO3	Understand and explain Electromagnetic Waves.
CO4	Get knowledge about reflection and refraction of Electromagnetic Waves.

Unit	Syllabus	Lectures
Unit 1	**1. Electrostatics and Charged Particle Dynamics**: Statement of Poisson's and Laplace's equations, motion of charged particles in (i) constant electric (E) and magnetic (B) fields (ii) crossed uniform electric (E) and magnetic (B) fields. **2. Maxwell's Equations** Bio-Savart's law, Ampere's law, derivative of $\nabla . B = 0$ and $\nabla \times B = J$, displacement current, Maxwell's correction to Ampere's law, Maxwell's equations for time dependents electric and magnetic fields in vacuum and material medium	15
Unit 2	**1. Electromagnetic Waves:** Wave equation for (E) and (B) fields in vacuum, plane wave solutions, orthogonality of E, B and propagation vector (k), plane e. m. waves in vacuum, dielectrics and conductors, attenuation of wave in metal (skin depth), Poynting's theorem, conservation of energy in e. m. fields. **2. Reflection and Refraction of E. M. waves:** Boundary conditions for e. m. field vectors, reflection and refraction of e. m. waves at a boundary of two dielectrics (normal incidence only), total internal reflection.	15

Reference Book:

1) Introduction to Electrodynamics 4th Edition by David J. Griffiths, Cambridge University Press, 2017.
2) Classical Electrodynamics by John David Jackson, Wiley, 2007.
3) Electrodynamics by Gupta, Kumar, and Singh, Pragati Prakashan, 2023.
4) Introduction to Quantum Electrodynamics and Particle Physics by Deep Chandra Joshi, TechSar Pvt. Ltd, 2013.
5) Principles of Electrodynamics, Melvin Schwartz, Dover Publications, 2012.
6) Classical Electrodynamics by P Sengupta, New Age International Private Limited, 2015.

B.Sc. III Semester-V (Minor)

Physics of Nanomaterials

(MIN03PHY51)

Theory: 30 Hours **Credits: 02**

CO's :

After completion of the unit, Students are able to:

CO1	Describe the requirements for a system to act as a laser.
CO2	Explain concept of Laser fundamentals, pumping mechanism pumping schemes.
CO3	Demonstrate potential applications of Lasers.
CO4	Design and development of different laser systems.

Unit	Syllabus	Lectures
Unit 1	**Introduction to nanomaterials:** Introduction to nano-sized materials and structures Brief history of nanomaterials and challenges in nanotechnology, Significance of nano-size and properties, classification of nanostructured materials **Methods of synthesis of nanomaterials:** Bottom-up and Top-down approaches Physical methods: High energy ball milling, Physical vapour deposition, Chemical methods: colloidal method, coprecipitation and sol-gel method. Hybrid method: Electrochemical and chemical vapour deposition	15
Unit 2	**Properties of nanomaterials:** Mechanical, Electrical, Thermal, Optical, solubility, melting point and Magnetic properties. **Characterization techniques:** UV- visible spectroscopy, X-ray diffraction, Scanning electron microscopy, Transmission electron microscopy. **Applications:** Medical, Biological, Automobiles, Space, Defense, Sports, Cosmetics, Cloth industry etc	15

References Book:

1. Nanotechnology: Principles and Practices by Sulabha Kulkarni, Capital Publishing Co. New Delhi., 2015.
2. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications., 2003.
3. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house, 2008.
4. Introduction to Nanoscience and Nanotechnology by Chattopadhyay K K, Prentice Hall India Learning Private Limited, 2009.
5. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Cao G, and Ying W, World Scientific Publishing Co Pte Ltd, 2011.
6. Nanophysics and Nanotechnology by Edward L Wolf, Wiley India Pvt Ltd, 2012.

B.Sc. III Physics Practical

Practical Lab-V

(DSC03PHY59)

Total marks: 75 **Credits: 06**

Laboratory Experiments

Group - I (General Physics)

1) Resonance pendulum.
2) Surface Tension of soap solution.
3) Surface Tension by Fergusson modified method.
4) Y & η using flat spiral spring.
5) 'Y' by Koenig's method.
6) 'Y' by cornu's method.
7) Measurement of heat capacity of solid.
8) Surface tension by drop weight method.
9) Young's modulus by vibration using AFG.
10) Expt. 1: Problems from Mathematical Physics Course
11) Expt. 2: Problems from Mathematical Physics Course
12) Expt. 3: Problems from Quantum Mechanics Course

Group - II (Electricity and Magnetism)

1) Self-inductance by Owen's bridge.
2) Self-inductance by Rayleigh's method.
3) Self-inductance by Maxwell bridge.
4) Measurement of B_V, B_H and θ using earth inductor.
5) Hysteresis by magnetometer.
6) e/m of electron by Thomson's method.
7) Measurement of dielectric constant.
8) Resistivity of semiconductor crystal with temperature by four probe method.
9) Calibration of wire using Carey-foster key.
10) Hall effect
11) Mutual Inductance
12) Absolute capacity of condenser

B.Sc. III Physics Practical

MIN Lab-V

(MIN03PHY59)

Total marks: 25 **Credits: 02**

1) Study of divergence of LASER beam.

2) Measurement of wavelength of LASER using grating.

3) Lattice constant using XRD powder.

4) To measure numerical aperture of optical fiber.

5) Obtain interference fringes using Biprism.

6) Thermal expansion of Quartz using LASER.

7) Measurement of refractive index of air.

8) Refractive index of glass by Brewster's law.

B.Sc. III, Semester-V
(Lab Activities on Energy and Environmental Studies)
VSC-PR-III
(VSC03PHY59)

Total marks: 25 **Credits: 02**

1. Measure solar panel efficiency using solar cell.
2. Calculate specific heat capacity of a metal.
3. Demonstrate and study wind energy (Measure power output of a small wind turbine).
4. Measure heat energy from biomass combustion.
5. Calculate simulation heat transfer from earth.
6. Analyze theoretically biomass energy content.
7. Study of hydroelectric power generation.
8. Calculate solar panel output.
9. Measure air quality index (AQI) and compare the results with standard AQI value.
10. Water quality analysis: measure pH, surface tension, dissolved oxygen and compare results with different water samples.
11. Measure noise level at different locations using decibel meter and compare results with standard noise pollution limit.

Evaluation Scheme

- The total marks for each paper will be 50.
- There will be semester end examination (SEE) of 40 marks for each paper.
- There will be continuous internal evaluation (CIE) of 10 marks for each paper.
- There will be separate passing for SEE, CIE, practical examination and vocational skill courses (VSC).

Paper No.	Semester End Examination (SEE)	Continuous Internal Evaluation (CIE)	Total
V	40	10	50
VI	40	10	50

- There will be practical examination of 50 marks at the end of semester V
- Distribution of marks of practical for major and minor course is as below

Major Course	
Group I	30
Group II	30
Journal	10
Seminar	05
Total	**75**

Minor Course	
Group I	22
Journal	03
Total	**25**

VSC Course	
Group I	22
Journal	03
Total	**25**

Nature of Question Paper (Semester End Examination)

Instructions:

1) All the questions are **compulsory**.
2). Figures to the right indicate **full** marks.
3) Draw neat labeled diagrams **wherever** necessary.

Time: 2 Hours **Total Marks:40**

Paper IX

Q:1] Chose correct alternative

Eight Multiple Choice Questions 8 Marks

1)
2)
3)
4)
5)
6)
7)
8)

Q:2] Long Answer questions (Attempt any **TWO** out of three) 16 Marks

1)
2)
3)

Q:3] Short Answer questions (Attempt any **FOUR** out of six) 16 Marks

1)
2)
3)
4)
5)
6)

B.Sc. III, Semester-V (FP)

Field project
(FPR03PHY51)

Field project (FP) evaluation marks scheme:

Sr. No.	Parameters	Marks distribution
		UG students (2 credit course) For 25 Marks
1	Problem finding	3
2	Data collection	3
3	Implementing solutions to actual problems	10
4	Quality and effectiveness of presentation	5
5	Field Project Report	4
Total marks		**25**

SEM VI

B.Sc. III Semester-VI (DSC-XII)
Nuclear and Particle Physics
(DSC03PHY61)

Theory : 30 Hours **Credits: 02**

CO's:

After completion, students are able to

CO1	Explain about the Nucleus and learn concept of General Properties of nuclei.
CO2	Know about the detectors and accelerators.
CO3	Understand the concept of Nuclear Radiation Detectors.
CO4	Explain significance of various decays in the nuclear process.

Unit	Syllabus	Lectures
Unit 1	**1. Nucleus (Nuclear Structure & General Properties of nuclei)** Introduction, Constituents of nuclei, Nuclear size, Nuclear magnetic moment, Electric quadrupole moment, Nuclear spin, Unit of atomic mass (amu), Mass defect, Packing fraction, Packing fraction curve, Binding energy, B.E. curve, Nuclear forces, Liquid drop model, Semiempirical B.E. formula, Magic numbers, Introduction of elementary particles. **2. Particle Accelerators** Need of accelerators, Types of accelerators (Qualitative) orbital accelerators, Cyclotron, (Principle, construction, working, theory, merits, demerits). Limitation of cyclotron, Synchrocyclotron, (construction, working, theory). Betatron, (principle, construction, working, mathematical theory, merits) Accelerators in India.	15
Unit 2	**1. Nuclear Radiation Detectors** Introduction: Ionization chamber, G. M. counter, (principle, construction, working mechanism, limitations, merits) Scintillation Counter (principle, construction, working, advantages) Introduction to cosmic radiations, Wilson cloud chamber, Bubble chamber. **2. Radioactive Decay** Natural radioactivity, Artificial radioactivity, Study of alpha decay by magnetic spectrograph, Velocity of alpha particles, Range of α- particles, α-disintegration energy, fine structure of α- rays. Beta decay, Study by β - ray spectrometer, continuous nature, neutrino hypothesis, Gamma Decay, origin & gamma rays, γ- ray spectrum, internal conversion, Isomerism.	15

Reference Books

1) Concepts of nuclear physics by Bernard L. Cohen., McGraw Hill, Higher Education - 1998.
2) Introduction to Elementary Particles, D. Griffith, John Wiley & Sons – 2008.
3) Theoretical Nuclear Physics, J.M. Blatt &V.F. Weisskopf, Dover Pub. Inc., 2003.
4) Modern Physics by R. Murugeshan, S. Chand & company Ltd, Ram Nagar New Delhi – 2010.
5) Nuclear Physics by D. C. Tayal, Himalaya Publishing house – 2008.
6) Concept of modern physics by Arthur Beiser, Tata McGraw- Hill publishing company ltd. New Delhi – 1969.

B.Sc. III Semester-VI (DSC-XIII)

Semiconductor Devices and Instrumentation

(DSC03PHY62)

Theory: 30 Hours **Credits: 02**

CO's :

After completion, students are able to

CO1	Learn about the CRO, IC's.
CO2	Understand the knowledge of digital electronics.
CO3	Know the devices made up of semiconductors.
CO4	Develop critical skill of electronic device fabrication.

Unit	Syllabus	Lectures
Unit 1	**1. Instrumentations: Introduction to CRO** Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **2. Special functions of ICs** IC 555, Block diagram and special functions if ICs, Astable Operation: Circuit diagram, frequency of oscillation and duty cycle, Applications as tone brust oscillator, voltage-controlled frequency shifters. Monostable operation: circuit diagram, Applications as touch switch and frequency divider. Bistable Operation: Circuit diagram and circuit action. **3. Semiconductor Devices** Introduction to semiconductor devices, p-n junction diode: current flow mechanics in forward and reversed biased diode, characteristics of p-n junction diode, static and dynamic resistance, Principle, construction and working of (1) LEDs (2) Photodiode (3) Solar Cell.	15
Unit 2	**1. 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. Active, Cut-off, and Saturation Regions. Voltage Divider Bias Circuit for CE Amplifier. h- parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance, Current, Voltage and Power Gains. 2. **Operational Amplifiers (Black Box approac**h): Introduction of differential amplifier and its types, symbol of Op-Amp, different parameters of Op-Amp, Characteristics of Op-Amp (IC 741), Open-loop & Closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and Non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator	15

Reference Books:

1) Integrated Electronics, J. Millman and C.C. Halkias, Tata Mc-Graw Hill, 1991.
2) Electronic devices and circuits, S. Salivahanan and N. Suresh Kumar, Tata Mc-Graw Hill, 2012.
3) Modern Electronic Instrumentation & Measurement Tech., Helfrick & Cooper, PHI Learning 1990.
4) Digital Principles & Applications, A.P. Malvino, D.P. Leach & Saha, 7th Ed., Tata McGraw Hill, 2011.
5) Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, PHI Learning Pvt. Ltd., 2009.
6) Electronics: Fundamentals and Applications, J.D. Ryder, Prentice Hall, 2004.

B.Sc. III Semester-VI (DSC-XIV)
Solid State Physics I
(DSC03PHY63)

Theory: 30 Hours **Credits: 02**

CO's :

After completion, students are able to

CO1	Define various types of solids depending on crystal structure.
CO2	Learn the concept of lattice vibration and thermal properties of solid.
CO3	Explain Magnetic Properties of Materials in solid.
CO4	Explain superconductivity phenomenon and its types.

Unit	Syllabus	Lectures
Unit 1	**1. Crystal Structure** Types of the solids, Amorphous, crystalline, lattice, lattice translation vectors, lattice with basis (Central, non central elements) Unit cell, Examples of crystal structure NaCl, KCl, ZnS, Diamond, Miller Indices, Calculations of coordination number, lattice constant, reciprocal lattices, types of lattices, Brillouin Zones, Diffraction of X-rays, Bragg's law, atomic, geometrical factor, Bragg's X-ray spectrometer, **2. Lattice Vibration and Thermal Properties of Solid** Lattice vibrations, Phonons, normal modes of one dimensional and diatomic chain, Acoustical and optical phonons, Phonons spectrum in solids, Dulong Petit's law (Classical Theory), Einstein and Debye theories of specific heat of solids.	15
Unit 2	**1. Magnetic Properties of Materials** Magnetic materials, permeability, susceptibility, magnetization, magnetic moment, electron spin, Diamagnetic materials, Paramagnetic materials, ferromagnetic, ferromagnetic, classical theory of diamagnetism and paramagnetism, Curie law, Curie constant, Weiss theory of ferromagnetism, and ferromagnetic domain, Hysteresis loop for ferromagnetic materials. **2. Superconductivity** Idea of superconductivity, Critical temperature, Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth, Isotope effect	15

Reference Books:

1) Introduction to Solid State Physics-Charles Kittle, 8th Ed., Wiley India Pvt. Ltd., 2004.
2) Elements of Solid State Physics - J.P. Srivastava, 2nd Ed., Prenice-Hall of India, 2006.
3) Introduction to Solid - Leonid V. Azaroff, Tata Mc-Graw Hill, 2004.
4) Solid State Physics - Neil W. Aschroft and N. David Mermin, Cengage Learning, 1976.
5) Solid State Physics, Rita John, Mc-Graw Hill, 2014.
6) Solid State Physics, Adrianus J. Dekker, Macmillan Publishers India Ltd., 2008.

B.Sc. III Semester-VI (DSE-II)
Solid State Physics II
(DSE03PHY61)

Theory : 30 Hours **Credits: 02**

CO's:

After completion, students are able to

CO1	Know about free electron theory, band gap energy, Hall effect.
CO2	Know about dielectric properties of material.
CO3	Explain concept of X-ray diffraction.
CO4	Analyze different materials with the help of x-ray diffraction pattern.

Unit	Syllabus	Lectures
Unit 1	**1. Elementary band theory** Introduction of free electron theory (Classical and Quantum mechanical), Kronig Penny model, Effective mass of an electron, Band Gaps. Conductors, Semiconductors, and insulators. P and N type semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall voltage and Hall coefficient. **2. Dielectric Properties of Materials** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius -Mosotti 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.	20
Unit 2	**1. X-Ray Diffraction** Reciprocal lattice and its properties, concept of Brillouin zone, diffraction of X-rays by crystals, Ewald construction, Bragg's law in reciprocal lattice, X-ray diffraction methods: 1) Laue method. 2) Rotating crystal 3) Powder method - Principle, Construction, Working, analysis of cubic crystal by powder crystal method	10

Reference Books:

1) Introduction to Solid State Physics-Charles Kittle, 8th Ed., Wiley India Pvt. Ltd., 2004.
2) Elements of Solid State Physics - J.P. Srivastava, 2nd Ed., Prenice-Hall of India, 2006.
3) Introduction to Solid - Leonid V. Azaroff, Tata Mc-Graw Hill, 2004.
4) Solid State Physics - Neil W. Aschroft and N. David Mermin, Cengage Learning, 1976.
5) Solid State Physics, Rita John, Mc-Graw Hill, 2014.
6) Solid State Physics, Adrianus J. Dekker, Macmillan Publishers India Ltd., 2008.

B.Sc. III Semester-VI (DSE-I)
Energy Studies Environmental Science
(DSE03PHY62)

Theory: 30 Hours **Credits: 02**

CO's:

After completion, students are able to

CO1	Demonstrate and understand the applied knowledge of energy.
CO2	Students will demonstrate a proficiency in solving problems in energy.
CO3	Understand the basic concepts of solar cell, solar PV panel, wind energy etc.
CO4	Demonstrate and understand the applied knowledge of Environment and demonstrate a proficiency in solving problems in Atmosphere and Energy.

Unit	Syllabus	Lectures
Unit 1	**Energy and Wind Energy** Energy, Forms of energy, Man and environment, Energy chains, Classification of energy resources, Energy demands, Age of renewable and alternatives, Wind energy, Wind energy chains, Wind energy quantum, Planning of wind farm, Wind power density, Efficiency factor of wind turbine (P-H graph), Power of wind turbine for a given incoming wind velocity, Types of a wind turbine generator unit, Horizontal axis propeller type wind turbine generator unit. **Solar Energy** Solar energy, Solar energy spectrum (UV, Visible and IR), Utilization of solar energy-thermal route, photovoltaic route, Essential subsystems in solar energy plant, Solar constant, Clarity index, Solar insolation, Solar energy from satellite station through microwave to earth station, Solar photovoltaic systems, Merits and limitations of solar PV systems, Prospects of solar PV systems, Power of a solar cell and solar PV panel.	20
Unit 2.	**Environmental Pollution** Environmental Problems, Standards for Environmental Quality, Sun Light and the Solar Spectrum, Photosynthesis, Greenhouse Effect, Human Induced Changes, Natural Changes, Ozone and Life, Solar UV and Biological Molecules, The Ozone Filter, Ozone in the Troposphere.	10

Reference Books:

1) Non-conventional Energy sources – G. D. Rai, Khanna Publisher, 1988.

2) Solar energy and non-conventional energy sources – V. M. Dhomkundwar, Dhanpat Rai & Co., 2022.

3) Renewable energy sources and emerging technologies – D.P. Kothari, R. Ranjan, 3rd edition, PHI Learning, 2021.

4) Environmental Pollution - R. K. Khitoliya, S. Chand Publication, 2012.

5) Textbook of environmental chemistry & Pollution control - S.S. Dara, D.D. Mishra, S. Chand Publication, 2012.

6) Fundamentals of Environmental Studies, Mahua Basu and S. Xavier, Cambridge university press, 2018.

B.Sc. III Semester-VI (Minor Paper X)
LASER
(MIN03PHY61)

Theory: 30 Hours **Credits: 02**

CO's:

After completion, students are able to

CO1	Describe the requirements for a system to act as a laser.
CO2	Explain concept of Laser fundamentals, pumping mechanism pumping schemes.
CO3	Compare three level and four level Laser systems. Design and development of different laser systems.
CO4	Compare three level and four level Laser systems. Design and development of different laser systems.

Unit	Syllabus	Lectures
Unit 1	**Laser fundamentals :** Ordinary light and Lasers, Brief history of Lasers, Interaction of radiation with matter, Energy levels, Population density, Boltzmann distribution, Transition Lifetimes, Allowed and Forbidden Transitions, Metastable states Stimulated Absorption, Spontaneous Emission and Stimulated Emission, Einstein's Coefficients, Einstein's relations Condition for large stimulated emission, Population inversion	10
Unit 2.	**Types of Lasers:** Solid State Lasers – Ruby Laser, Diode Laser, Nd: YAG laser, Gas Lasers – He-Ne Laser, CO2 Laser Liquid Lasers: Tunable dye laser **Applications of Lasers:** Nuclear Science – laser isotope separation, laser fusion Defense Applications Medical – Introduction to nonthermal Lasers for medical applications, Eye surgery, Photodynamic therapy Optical - Holography, supermarket scanners, compact discs, Nonlinear Optics, SHG	20

Reference Books:

1. Lasers, Fundamentals and Applications, K. Thyagarajan, Ajoy Ghatak, Springer, 2011.
2. Laser Fundamentals, William T. Silfvast, Cambridge university press, 2008.
3. An introduction to Lasers – Theory and applications, M. N. Avadhanulu, S. Chand Ltd., 2001.
4. Introduction to Laser Technology, C. Breck Hitz, J. Ewing, Jeff Hecht, Wiley, 2012.
5. Principles of Lasers by O Svelto, Springer, 2010.
6. Lasers: Theory, Principles and Applications, Singh, Vei, 2012.

B.Sc. III Physics Practical Semester VI
Practical Lab-VI
(DSC03PHY69)

Total marks: 75 **Credits: 06**

Laboratory Experiments

Group - III (Optics)

1) Cardinal points by turn table method.
2) Cardinal points by Newton's method.
3) Diffraction at single slit.
4) Diffraction at cylindrical obstacle.
5) Diffraction at straight edge
6) Lloyd's single mirror.
7) Double refracting prism
8) Diameter of lycopodium powder.
9) Spherical aberration.
10) Absorption of spectrum of $KMnO_4$ solution.
11) Refractive index of Glass by Brewster's Law
12) Double refracting Prism

Group - IV (Electronics)

1) UJT as voltage sweep generator.
2) Astable multivibrator by using IC 555 timer.
3) Monostable multivibrator by using IC 555 timer.
4) IV characteristics of P-N diode and LED.
5) Inverting amplifier using op - Amp 741.
6) I - V characteristics of solar cell.
7) Band gap energy of semiconductor using P-N junction.
8) Determination of plank's constant.
9) FET characteristics.
10) FET as VVR.
11) Stair case ramp generator
12) Non-inverting amplifier using op - Amp 741.

B.Sc. III Physics Practical
MIN Lab-VI
(MIN03PHY69)

Total marks: 25 **Credits: 02**

1) To measure current, voltage, power in D.C, AC, circuits.

2) Assemble of given electronic circuit.

3) Testing of electronic electric component.

4) Resistance of galvanometer by Kelvin method.

5) To verify superposition theorem. 6) To verify millman's theorem.

7) Study of hysteresis using anchor ring and C. R. O.

8) Measurement of active and reactive power in A.C circuit.

B.Sc. III, Semester-VI
(Lab activities on Numerical Skills)
VSC-PR-IV
(VSC03PHY69)

Total marks: 25 **Credits: 02**

1. Write an algorithm to find whether a number is even or odd.
2. Draw a flowchart to calculate the sum of the first 10 natural numbers.
3. Write a Python program to Print “Hello” on the screen.
4. Write a Python program to display the current date and time. Sample Output : Current date and time.
5. Write a program to convert the given temperature from Fahrenheit to Celsius and vice versa depending upon user’s choice.
6. Write a Python program to find those numbers which are divisible by 7 and multiple of 5, between 1500 and 2700 (both included).
7. Write a Python program to find the median of three values. Go to the editor Expected Output: Input first number: 15, Input second number: 26, Input third number: 29, The median is 26.0.
8. Draw flowchart to verify the Ohm’s law.
9. Draw a flowchart to find Maximum Height & Range of Projectile Motion.
10. Write and run a C/C^{++}programme on Newton’s second law: calculate force.
11. Write and run a C/C^{++}programme to calculate time period of simple pendulum.

Evaluation Scheme

- The total marks for each paper will be 50.
- There will be semester end examination (SEE) of 40 marks for each paper.
- There will be continuous internal evaluation (CIE) of 10 marks for each paper.
- There will be separate passing for SEE, CIE, practical examination and vocational skill courses (VSC).

Paper No.	Semester End Examination (SEE)	Continuous Internal Evaluation (CIE)	Total
V	40	10	50
VI	40	10	50

- There will be practical examination of 50 marks at the end of semester VI
- Distribution of marks of practical for major, VSC and minor course is as below

Major Course	
Group I	30
Group II	30
Journal	10
Seminar	05
Total	**75**

Minor Course	
Group I	22
Journal	03
Total	**25**
VSC course	
Group I	22
Journal	03
Total	**25**

Nature of Question Paper (Semester End Examination)

Instructions:

1) All the questions are **compulsory**.
2). Figures to the right indicate **full** marks.
3) Draw neat labeled diagrams **wherever** necessary.

Time: 2 Hours **Total Marks:40**

Paper XII

Q:1] Chose correct alternative

Eight Multiple Choice Questions 8 Marks

1)
2)
3)
4)
5)
6)
7)
8)

Q:2] Long Answer questions (Attempt any **TWO** out of three) 16 Marks

1)
2)
3)

Q:3] Short Answer questions (Attempt any **FOUR** out of six) 16 Marks

1)
2)
3)
4)
5)
6)

B.Sc. III Semester-VI (OJT)
On Job Training
(OJT03PHY61)
OJT evaluation marks scheme

Sr. No.	Parameters of Assessment	Marks Distribution
		UG students (2 credit course) for 25 Marks
1	Quality and effectiveness of presentation	5
2	Depth of knowledge and demonstrated skills	5
3	Variety and relevance of learning experience	5
4	Practical applications and relationships with concepts taught in the course	-
5	Internship Report	5
6	Attendance record, student log, supervisor evaluation	5
	Total Marks	**25**