Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

BoS in Physics

SEMESTER PATTERN

(w.e.f. Academic Year 2015-16)

SYLLABUS FOR B.Sc.-III EXAMINATION

B.Sc.-III, PHYSICS

JUNE -2015

Rajarshi Shahu Mahavidyalaya Latur
(Autonomous)
Department of Physics (w.e.f. June 2015-16)
Structure of B. Sc. III Physics Syllabi

Sr No	Course Code	Title	Credits	Periods /Week	Marks		
					In Sem	End Sem	Total
		Sem V					
1	U-PHY-541	Quantum Mechanics-IX	2	3	20	30	50
2	U-PHY-542	Solid State and Nanophysics-X	2	3	20	30	50
3	U-PHY-543	Physics Laboratory Course VII	2	3		50	50
4	U-PHY-544	Physics Laboratory Course VIII	2	3		50	50
		Sem VI					
5	U-PHY-641	Atomic, Molecular and statistical Physics-XI	2	3	20	30	50
6	U-PHY-642	Fundamentals of Digital Electronics-XII	2	3	20	30	50
7	U-PHY-643	Physics Laboratory Course IX	2	3		50	50
8	U-PHY-644	Physics Laboratory Course X	2	3		50	50
9		Project	2	-		50	50
		Total	18				450

B.Sc.– III, Semester V

U-PHY-541 Quantum Mechanics-IX

Periods/Week: 3, Credits: 2, Total Periods: 45

Marks: 50, End Sem.: 30 & In Sem.:20 (UT: 15 &AT: 05)

Learning objectives:

(1) To know the background and the main features in the historical development of Quantum Mechanics,

(2) To understand the principles of quantum mechanics, wave function and its physical interpretation,

(3) To introduce both the time-independent and time-dependent Schrödinger equations and to develop an understanding of their meaning and how they are utilised.

(3) To solve simple potential problems exactly

(4) To identify the unique features of the hydrogen atom that makes it important for calculations in quantum mechanics

Course Outcomes:

Upon successful completion, students will have the knowledge and skills to:

(1) Show an understanding of wave mechanics;

(2) know the concept of operators in quantum mechanics;

(3) Perform calculations on wavefunctions, and solve the Schrödinger equation for simple potential problems;

(4) Apply Schrodinger's equation in Hydrogen atom;

(5) Describe the structure of the hydrogen atom and show an understanding of quantization of angular momentum.

Unit I: Origin of Quantum Mechanics: [12 periods]

Introduction, Photoelectric Effect, Quantum Theory of Light, Black Body Radiation, The Compton Effect, De Broglie Waves, De Broglie Wave Velocity, Wave and Group Velocities, G. P. Thomson's Experiment for Electron Diffraction, The Uncertainty Principle, Elementary Proof of Uncertainty Principle, Applications of Uncertainty Principle, The Wave Particle Duality. [Book 1 Chap. 3-4, Book 2 Chap. 1]

Unit II: Schrödinger's Wave Equation and Operators: [10 Periods]

Introduction, Wave Function and its Physical Interpretation, Wave Equation, Schrödinger's Wave Equation: Time Dependent Form (One Dimension and Three Dimension), Probability Current Density and its Physical Significance, Expectation Values, Schrödinger's Wave Equation: Time

Independent (Steady-State) Form, Operators, Eigen Values and Eigen Functions. [Book 1 Chap. 7, Book 2 Chap. 3]

Unit III: Applications of Schrödinger's Steady-State Equation: [11 Periods]

Introduction, the Particle in a Box: Energy Quantization, The Particle in a Box: Wave Functions, The Particle in a Box: Momentum Quantization, The Harmonic Oscillator, The Harmonic Oscillator-Energy Level, The Particle in a Three Dimensional Box: Energy Quantization. [Book 1 Chap. 8, Book 2 Chap. 4-6]

Unit IV: Quantum Theory of Hydrogen Atom: [12 Periods]

Schrödinger's Equation for the Hydrogen Atom in Spherical Polar Co-Ordinates, Separation of Variables, Quantum Numbers–Total Quantum Number, Orbital Quantum Number, Magnetic Quantum Number, Electron Probability Density. [Book 1 Chap. 9, Book 2 Chap. 7]

Recommended Books:

1. Arthur Beiser, Perspectives of Modern Physics- (McGraw-Hill International Editions)1969.

2. S. L. Kakani and H. M. Chandaliya, Quantum Mechanics ,Theory and Problems, (S. Chand & Sons) (2004).

Reference Books:

1. R. Murugeshan, Modern Physics (S. Chand and Co. XIth Revised Edition)

2. Ajoy Ghatak and S. Lokanathan, Quantum Mechanics Theory and Applications, Published By Mc. Millan (2012).

3. Leonard I. Schiff, Quantum Mechanics McGraw-Hill 1968 (International Series in Pure and Applied Physics)

4. J. M. Cassels, Basic Quantum Mechanics, McGraw –Hill Publishers (1970)

5. P.M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics Tata McGraw –Hill Publishers (2002).

6. G. R. Chatwal, S. K. Anand, Quantum Mechanics, Publisher, Himalaya Publishing House, (1988)

B.Sc. – III, Semester V
U-PHY-542 Solid State Physics and Nanotechnology-X
Periods/Week: 3, Credits: 2, Total Periods: 45
Marks: 50, End Sem.: 30 & In Sem.:20 (UT: 15 &AT: 05)

Learning Objectives:

(1) Review of the crystal representation in terms of space lattice, basis, unit cell and lattice parameters,
(2) Develop knowledge among the students about crystal systems and Bravais lattices,
(3) Develop understanding about symmetry elements and symmetry operations of simple cubic systems,
(4) To inculcate the idea of atomic arrangements in space lattice of few representative solids.
(5) To develop an understanding of relation between band structure and the electrical/optical properties of a material
(6) To develop an understanding of the potential of nanomaterials to develop future technology.
(7) To appreciate the foundations of nanotechnology in molecular machines and biology.
(8)To be capable of calculating changes in physical, chemical, electrical and optical properties as particle sizes scale (in nanoscale dimensions).

Course Outcomes:

After completion of the course student will:
(1) have a basic knowledge of crystal systems and spatial symmetries,
(2) be able to perform structure determination of simple structures,
(3) know the significance of Brillouin zones,
(4) know Bloch's theorem and what energy bands are,
(5) know the fundamental principles of semiconductors, including pn-junctions, and be able to estimate the charge carrier mobility and density,
(6) be able to account for what the Fermi surface is and how it can be measured.

Unit I: Crystal structure: [12 Periods]

Introduction, Crystal Lattices, bases and Translation vectors, Unit cell, Representation of Planes: Miller Indices, Spacing of Planes in Crystal lattice, Point group, space group, classification of crystals, Bravais lattice in two and three dimensions, Simple crystal structure: HCP, FCC, BCC, SC, Structure of Diamond, ZnS, NaCl. Numerical Problems.
[Book no.-1, Chapter-1]

Unit II: Free Electron Theory of Metals: [10 Periods]

Introduction, Outstanding properties of metals, Drude-Lorentz theory, Electrical conductivity, Thermal conductivity, Widemann-Franz relation, Somerfield model, Momentum space, Fermi Dirac distribution, Quantum theory of free electron in a box, Free electron concentration: non-degenerate and degenerate cases [Book no-1,Chapter-8].

Unit III: Band theory of Solids: [12 Periods]

Introduction, Splitting of atomic energy levels in to bands, Origin of band structure, Periodic potential in crystal, Bloch theorem, Origin of energy gap, Valence band, Conduction band

and forbidden band, Behavior of conductors, insulators and semiconductors on the basis of band theory, Effect of impurity on conductivity of semiconductors.
[Book-2, Ch-23]

Unit IV: Nanotechnology: [11 Periods]

Introduction, Definition of Nanoscience and nanotechnology (Book-3,Ch-1),Moore's law, Quantum structures: Quantum wires, Quantum dots, Nanoclusters, Carbon nanostructures, Carbon nanotubes, Applications of nanotechnology, Nanobiology, Nanocatyalysis, Nanoelectronics, Nanocomputers.
[Book-4, Ch-1, 4]

Recommended Books:

1. Solid State Physics – Saxena, Gupta, Saxena (Pragati Prakashan Meerut)
2. Physics for degree students-C.L.Arora and P.S. Hemesic (S.Chand 1st Edition2014)
3. Introduction to Nanotechnology-K.K. Chattopadhyay and A.N. Banergy.
4. Nanoscience and Technology-V.S.Murlidharan, A. Subramania.

Reference Book:

1. Solid State Physics and Electronics – R. K.Puri & V. K. Babar (S.chand & Co.)
2. Solid State Physics – Puri & Babar (S.chand & Co.)
3. Introduction to Solid State Physics -by Kittel, Wiley and Sons, 7th Edition.
4. Solid state Physics – R.L.Singhal (Kedar Nath Ram Nath Co., Meerut)
5. Modern physics – R. Murugeshan. (S.Chand & Co. XIth Revised edition)
6. Solid state physics- A.J.Dekkar(Macmillan India Ltd.2000)
7. Nanotechnology: Principles and Practices by Sulbha K Kulkarni, Capital Publishing Co. New Delhi.
8. Introduction to Nanotechnology, C.P. Poole Jr. and F.J. Ownes, Wiley Publication.
9. Origin and Development of Nanotechnology, P. K. Sharma, Vista International Publishing House
10. Developments in Nanotechnology-K. Krishna Reddn.

B.Sc. III Year, Semester-V

U-PHY-543 Physics Laboratory Course-VII

Credits: 2 No of periods / Wk: 3

Marks: 50, End Sem.: 30 & In Sem.:20 (RB-10&AT: 10)

Learning Objectives:

The objectives of present lab work are;

(1) To equip students with the optical measurement techniques using spectrometer,

(2) To inculcate the equipment handling skills related to optical instruments such as spectrometer, polariometer,

(3) To provide training to the students for using equipment's related to electricity and magnetism,

(4) To develop understanding of electronic oscillators.

Course Outcomes:

After successful completion of the course the students will be able to:

(1) Handle optical and magnetic equipment's with ease,

(2) Make use of CRO for measurement of Oscillator parameters,

(3) Determine specific rotation of sugar like solution,

(4) Understand the charge to mass ratio for electron.

List of Experiments

1. Dispersive Power of Prism.
2. Dispersive Power of grating.
3. Determination of dielectric constant.
4. Hall-probe method for measurement of magnetic field.
5. R. I. of liquid at various temperatures using Abbey Refractometer.
6. Temperature of flame.
7. Electrical conductivity of Graphite rod.
8. Study of RC Phase shift Oscillator.
9. Specific rotation by Laurent's half shade polarimeter.
10. e/m by Thomson's method.

* **Note:** Minimum six experiments should be performed, by each student.

B.Sc. III Year, Semester-V

U-PHY-544 Physics Laboratory Course-VIII

Credits: 2 No of periods / Wk: 3

Marks: 50, End Sem.: 30 & In Sem.:20 (RB-10&AT: 10)

Learning Objectives:

The objectives of present lab work are;

(1) To train the students to make use of spectrometer for determination of Refractive index,

(2) To imbibe the calibration skills of the measuring bridges/ equipment's,

(3) To develop understanding of band gap of semiconductor,

(4) To develop the measuring skill of frequency of an electronic oscillator,

Course Outcomes:

After successful completion of the course the students will be able to:

(1) Determine refractive indices of prism materials,

(2) make the calibration of given unknown bridge wire,

(3) find the bandgap of semiconductor diode,

(4) Trace out the sine waveforms of the oscillator and calculate its frequency.

List of Experiments

1. Cauchy's constant Using spectrometer.
2. Absorption spectra of iodine vapours.
3. Calibration of bridge wire using carry fosters bridge.
4. Temperature coefficient of thermistor.
5. Study of energy band gap of semiconductors.
6. Variation of thermo emf with temperature.
7. Study of Hartley oscillator.
8. Study of Colpits Oscillator.
9. Absolute capacity of condenser.

* **Note:** Minimum six experiments should be performed, by each student.

B.Sc. – III, Semester VI

U-PHY-641 Atomic, Molecular Physics and Statistical Physics-XI

Periods/Week: 3, Credits: 2, Total Periods: 45

Marks: 50, End Sem.: 30 & In Sem.:20 (UT: 15 &AT: 05)

Learning Objectives:

(1) To introduce students to the fundamentals of Atomic, Molecular and Statistical Physics,

(2) To study the structural, electronic and Vibrational properties of atoms and molecules,

(3) To study the spectral line when placed in magnetic and electric fields.

Course Outcomes:

Upon successful completion of this course student able to:

(1) Describe the latest vector atom model and drawbacks of previous models,

(2) Know and understand the normal and anomalous Zeeman effect, Paschen Back effect and Stark effect as well as Raman Effect basically,

(3) Define and discuss the concepts of microstate and macrostate of a model system,

(4) Define and discuss the Boltzmann distribution and the role of the partition function,

(5) Discuss the concept and role of indistinguishability in the theory of gases; know the results expected from classical considerations and when these should be recovered,

(6) Define the Fermi-Dirac and Bose-Einstein distributions; state where they are applicable.

Unit I Atomic Spectra: [12 periods]

Introduction, Drawbacks of Rutherford and Bhor's model, Somerfield relativistic atom model, Vector atom model, Quantum numbers associated with the vector atom model, Coupling schemes: L-S and j-j coupling. Pauli Exclusion Principle, Magnetic dipole moment due to orbital motion of the electron, Stern-Gerlach experiment, Spin-orbit coupling, Optical spectra:

Atoms in External Fields: Zeeman Effect (normal and anomalous), Paschen-Back Effect and Stark Effect, Problems. [Book-1, Chapter-6]

Unit II: Molecular Spectroscopy: [11 Periods]

Introduction, Diatomic molecule, molecular Spectra, Kinds of molecular spectra, Rotational spectra, Vibrational spectra, Vibrational rotational spectra, P.E curve, Luminescence, Raman effect: Experimental arrangement and explanation , Raman shift

[Book-2, Chapter- 11, 12]

Unit III: Maxwell-Boltzmann Statistics: [12 Periods]

Phase space, Macro state, microstate, Thermodynamic probability, Statistical ensembles, micro canonical, Canonical and grand canonical, Entropy and probability. Boltzmann Canonical distribution law, Maxwell-Boltzmann Entropy distribution law, Applications of Maxwell-Boltzmann distribution law to mono-atomic gases.

[Book-3, Chapter- 9, 10, 11]

Unit IV: Quantum statistics: [10 Periods]

Need and development of quantum statistics, Bose-Einstein distribution law, photon gas, Planck's radiation law, Fermi-Dirac distribution law, Free electrons in metal, Fermi energy and Fermi level, comparison of three distribution laws

[Book-3, Chapt.12]

Recommended Books:

1. Modern Physics by R. Murugeshan and KiruthigaSiva Prasanth. S.Chand & Co.

2. Physics for Degree students: C.L. Arora, Dr. P. S. Hemne., S. Chand &Co.

3. Heat, Thermodynamics and Statistical Physics by Brijlal, Dr. N. Subrahmanyam, P. S. Hemne

Reference books:

1. Introduction to Atomic spectra- White.

2. Fundamentals of Molecular spectroscopy - C. N. Banwell & Mc Cash

3. Molecular spectroscopy –G. M. Barrow

4. Spectroscopy- Atomic and Molecular by Gurudeep R. Chatwal and Shyam Anand- Himalaya Publishing House.

5. Atomic Physics by J.B. Rajam.

6. Atomic and molecular spectroscopy- Mool Chand Gupta.

7. Statistical Mechanics- B. B. Laud

8. Thermodynamics & Statistical physics – Sharma, Sarkar.

9. Thermodynamics and statistical physics- S.L Kakani.

B.Sc. – III, Semester-VI

U-PHY-642 Fundamentals of Digital Electronics-XII

Periods/Week: 3, Credits: 2, Total Periods: 45

Marks: 50, End Sem.: 30 & In Sem.: 20 (UT: 15 &AT: 05)

Learning Objectives:

(1) To develop understanding about number systems.

(2) to equip students with problem solving skill such as Binary arithmetic 1's and 2's complement and its application in arithmetic. Digital lodes such as BCD, Gray and Excess-3.

(3) To acquaint students with idea Logic gates: Basic, Universal and Derived gates (AND, OR, NOT, NAND, NOR, X-OR and X-NOR).

(4) to inculcate the idea of Boolean algebra, its laws and theorems, De-Morgan's theorem. Algebraic and K- map simplification of Boolean algebra expression and its implementation using logic gates.

(5) to develop knowledge of combinational and sequential logic circuits such as all types of flip-flop, SR, JK, T and D type, studied adder, Subtractor such as HA and FA and parallel binary adder.

(5) To develop skill to design counters of various mode, values of both Asynchronous and Synchronous are studied (mode-8).

Course Outcomes:

After successfully completion of above said course students will:

(1) get knowledge about various number system and codes (Decimal, binary, Oct, Hexa, BCD, GRAY and Ex-3). Inter conversion among number and codes etc.

(2) Able to draw symbol and truth table of logic gate circuits, basic, universal and derived gates (AND, OR, NOT, NAND, NOR, X-OR and X-NOR)

(3) Differentiate between ordinary algebra and Boolean algebra, laws and theorems of Boolean algebra. Some identities of Boolean algebra.

(4) Define and discuss Algebraic and K-map simplification methods. Implementation of Boolean equation.

(5) be able to explain Flip-Flop (RS, JK, T and D) i. e combinational logic circuits adder and subtractors. More about sequential logic circuits i.e. Asynchronous and Synchronous counters (mode- 8). About modulus of a counter. Race around condition etc.

Unit I: Number Systems and Codes: [12 Periods]

Introduction, Decimal numbers, Binary numbers, Octal Numbers, Hexadecimal numbers, Binary arithmetic, 1's and 2's complements, Inter-conversions of number systems.

Digital Codes: Binary coded decimals (BCD), Gray code, Excess-3 code

[Book-1, Chapter-2 and 3]

Unit II: Logic Gates: **[10 Periods]**

Introduction, AND Operation, OR operation, NOT operation.

Basic Gates: NOT gate, OR gate, AND gate (Symbol & truth tables), Universal Gates: NAND gate, NOR gate, Universal Property of NAND and NOR gates, EX-OR and EX-NOR gates (Symbols & truth tables). [Book-1, Chapter- 4, 5]

Unit III: Boolean algebra: **[12 Periods]**

Introduction, Boolean operations, logic expressions, Laws of Boolean algebra, DeMorgan's Theorems, Simplification of Boolean expressions using Boolean algebra Techniques, SOP and POS form of Boolean expressions for logic network, K-map, Simplification of Boolean expressions using Karnaugh map (2-variables, 3-variables and 4 variables).

[Book-1, Chapter-4, 6]

Unit IV: Combinational and Sequential Logic Circuits: **[11 Periods]**

Combinational Circuits:

Half adder, Full adder, Four-bit parallel binary adder, half Subtractor, Full Subtractor with suitable examples.

Sequential Logic Circuits:

Flip-flops: S-R- Latch using NAND and NOR Gate, Clocked S-R Flip flop, J-K-Flip Flop, D- Type Flip Flop, T- Type Flip Flop, Preset and Clear Operations, Race-around condition, Master Slave JK flip-flop.

Counters: Types of counters, Modulus of a counter, Mode-8, Mod-8 Asynchronous counter, Synchronous counter. [Book-1, Chapter-5, 7 and8]

Recommended Books:

1. Digital Principles and Applications- A. P. Malvino, McGraw Hill International Editions (Third Edition)

2. Modern Digital Electronics- R.P. Jain, Tata McGraw Hill Pub. Company (Fourth Edition)

3. Digital principles and Circuits- Dr. C.B. Agrawal, Himalaya Publications.

Reference books:

1. Digital Fundamentals-Thomas L. Floyd, Universal Book Stall

2. Digital Electronics with Practical Approach- G. N. Shinde, Shivani Pub., Nanded

3. Digital Electronics: An Introduction to Theory and Practice-William H.Gothmann, PHI

4. Digital principles and applications By Donald P. Leach & Albert Paul Malvino, (Glencoe, 1995).

B.Sc. III Year, Semester-VI

U-PHY-643 Physics Laboratory Course-IX

Credits: 2 No of periods / Wk: 3

Marks: 50, End Sem.: 30 & In Sem.:20 (RB-10 & AT: 10)

Learning Objectives:

The objectives of present lab work are;

(1) To develop understanding of the concepts of thermal conductivity, viscosity, Surface tension etc,

(2) To imbibe the phenomena of interference and diffraction,

(3) To develop understanding of acceleration due to gravity using Kater's pendulum,

Course Outcomes:

After successful completion of the course the students will be able to:

(1) Determine refractive index and viscosity of liquids and thermal conductivity of bad conductors,

(2) Measure thickness of thin slide/ blade/wire,

(3) find the wavelength of given unknown light source,

(4) Estimate the value of constants such as acceleration due to gravity and Plank's constant.

List of Experiments

1. Thermal conductivity of rubber tube.
2. Determination of thermal conductivity by Forbes Method.
3. Viscosity by oscillating disc method.
4. Hartman's dispersion relation.
5. Thickness of thin wire –Air wedge method.
6. R.I. of liquid using hollow prism.
7. Diffraction at straight edge: Determination of wavelength.
8. g –by Kater's pendulum.
9. Plank's constant h by LED.
10. Diffraction at cylindrical obstacle: Determination of wavelength.
11. Surface tension of a liquid by using laser.

* **Note:** Minimum six experiments should be performed, by each student.

B.Sc. III Year, Sem-VI

U-PHY-644 Physics Laboratory Course-X

Credits: 2 No of periods / Wk: 3

Marks: 50, End Sem.: 30 & In Sem.:20 (RB-10&AT: 10)

Learning Objectives:

(1) To acquire the basic knowledge of digital electronics circuits,

(2) To develop understanding of the basic, universal and derived logic gates,

(3) To inculcate the knowledge of the truth table verification using logic gates,

(4) To acquaint students about the construction of Half and Full adder,

Course Outcomes:

After successful completion of the course the students will be able to:

(1) Explain concepts and terminology of digital electronics,

(2) Application of logic gates to construct half and full adder,

(3) Use De Morgan's Theorem to simplify Boolean expression.

(4) Construct Basic logic gates using universal logic gates.

List of Experiments

1. Study of basic gates.
2. Study of basic gate using NAND gate.
3. Construction and study of Half and Full adder.
4. Verification of De Morgan's theorems.
5. Implementation of Boolean expression from the given truth table using K-Map.
6. Study of half and full Subtractor.
7. Study of S-R, J-K and D Flip-flops.
8. Study of NAND and NOR gates.
9. Construction of Ex-OR and Ex-NOR gates using basic gates.

* **Note:** Minimum six experiments should be performed, by each student.