Ordinance No. :- V-126-B-42

(Approved in Academic council meeting held on 11.03.2026
Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus

of

B.Sc. Physics

FOUR – YEAR UNDER GRADUATE
PROGRAM
(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand

SUBHARTI UNIVERSITY

Meerut

Effective from 2025-2026

K. V. Subharti College of Science
S. V. Subharti University
NH-58. Byepass Road, Meerut

Programme Objective

The four-year B.Sc. Physics programme under the NEP framework equips students with a strong foundation in classical and modern physics, mathematical reasoning, laboratory skills, and computational techniques. Graduates develop the ability to analyse physical phenomena, apply scientific methods, design experiments, interpret data, and use modern instruments responsibly. The programme fosters critical thinking, problem-solving, research aptitude, and ethical scientific behaviour while encouraging interdisciplinary learning and real-world applications. Students gain effective communication skills, teamwork capability, and digital proficiency, preparing them for higher studies, scientific research, industry roles, and innovation-driven careers.

Programme Outcomes (POs)

PO-1: Students will develop a strong foundation in fundamental principles of physics, including mechanics, electromagnetism, quantum physics, thermodynamics, and condensed matter physics.

PO-2: They will acquire the ability to think scientifically and use analytical and mathematical tools to model, analyse, and solve complex physical problems.

PO-3: Students will gain hands-on experimental skills, including the use of laboratory instruments, measurement techniques, data analysis, and interpretation using scientific methods.

PO-4: They will develop research aptitude through project-based learning, enabling them to frame hypotheses, conduct investigations, interpret results, and follow ethical research practices.

PO-5: Students will achieve computational proficiency by using programming languages, simulations, and numerical techniques to explore and solve physics-related problems.

PO-6: They will strengthen critical thinking and analytical reasoning skills, allowing them to evaluate scientific arguments and draw logical, evidence-based conclusions.

PO-7: Students will be able to communicate scientific concepts effectively through written reports, oral presentations, and graphical illustrations suitable for academic and general audiences.

PO-8: They will demonstrate professional ethics, scientific integrity, adherence to safety protocols, and responsibility in laboratory and research environments.

PO-9: Students will learn to work independently and collaboratively in multidisciplinary teams, integrating physics knowledge with related scientific and technological fields.

PO-10: They will understand the societal and environmental relevance of physics, contributing toward sustainable development, renewable energy solutions, and technological advancements that benefit society.

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Physics

B.Sc. Physics Program offered by Department of Physics (Session 2025-26 onwards)

		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
1	Major	6	6	9	15	10	14	16	4	80
2	Minor	3	3	3	3	6	6	4	4	32
3	Multi Disciplinary	3	3	3						9
4	Ability Enhancement Course	2	2	2	2					8
5	Skill Enhancement Course	3	3	3						9
6	Value Added Course	3	3							6
7	Internship					4				4
8	Research								12	12
	Total	20	20	20	20	20	20	20	20	160

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Physics												
Course Name - B.Sc. Physics												
Batch:2024 -25							SEM:I					
S.No.	Course Type	Course Code	Course Name	Teaching Load L	T	P	Credits		Internal Assessment		External Assessment	Total
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)	
1	Major 1	**BSPY-101**	**Mechanics And Wave Motion**	4	0	0	4	5	10	15	70	100
2	Practical Major 1	**BSPY-101P**	**Physics Practical Lab-I**	0	0	4	2	5	10	15	70	100
3	Minor 1	**BSPY-102**	**Newtonian Mechanics**	4	0	0	3	5	10	15	70	100
4	Multi Disciplinary	**M-DIS-FP**	**Fundamentals of Physics**	4	0	0	3	5	10	15	70	100
5	Ability Enhancement Course	**AEC-01**	**English Communication Skills**	2	0	0	2	5	10	15	70	100
6	Skill Enhancement Course	**SEC-BI**	**Basic Instrumentation Skills**	1	0	3	3	5	10	15	70	100
7	Value Added Course	**VAC-BR**	**Basic of Renewable energy Resources**	1	0	3	3	5	10	15	70	100
8	IKS / Rastra bodh	**VAC-RB**	**Rastra bodh** (Qualifying)	2	0	0	2	5	5	10	30	50
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	**700**

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Physics												
Batch:2024 -25							SEM:II					
S.No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total
				L	T	P						
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT /Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)	
1	Major 2	**BSPY-201**	**Electricity and Magnetism**	4	0	0	4	5	10	15	70	100
2	Practical Major 2	**BSPY-201P**	**Physics Practical Lab-II**	0	0	4	2	5	10	15	70	100
3	Minor 2	**BSPY-202**	**Wave and Optics**	4	0	0	3	5	10	15	70	100
4	Multi Disciplinary 2	**M-DIS-KT**	**Kinetic Theory**	4	0	0	3	5	10	15	70	100
5	Ability Enhancement Course 2	**AEC-02**	**Environment Science**	2	0	0	2	5	10	15	70	100
6	Skill Enhancement Course 2	**SEC-DS**	**Digital System**	1	0	3	3	5	10	15	70	100
7	Value Added Course 2	**VAC-LA**	**Laser and its Application**	1	0	3	3	5	10	15	70	100
8	IKS	**VAC-IKS**	**Indian Knowledge System-(Qualifying)**	2	0	0	2	5	5	10	30	50
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	700

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Semester I

Major Course 1

Course Name: Mechanics and Wave motion	**Course Code:BSPY-101**

Credits=L+T+P (4+0+0)=4	**Hours=60**

Objectives: To acquire basic knowledge about dynamics, work and energy, elasticity, gravitation and central force motion.

Unit-I

Angular momentum and Linear momentum, Equation of motion of rigid body Moment of inertia, Product of moment of inertia, Radius of gyration, Theorem of parallel and perpendicular axes, Moments of inertia of a ring and disc, Conservation law of energy, Conservative and non-conservative forces.

Unit-II

Central forces, Two body centre force Problem, Reduced mass, law of gravitation, Kepler 's law, Motion of Planets and satellites, geostationary satellites, Classification of Kepler's orbits.

Unit-III

Frame of references, Galilean transformation, Lorentz transformation, postulates of special theory of relativity, Relativistic mass, Relativistic energy, Relativistic momentum, Mass energy relation Transformation of momentum and Energy.

Unit-IV

Oscillation and their types, Simple harmonic motion, differential equation of S. H. M. and its solution, uses of complex notation, damped and forced vibrations, composition of simple harmonic motion. Differential equation of wave motion, plane progressive waves in fluid media, reflection of waves, phase change on reflection, superposition, stationary waves, pressure and energy distribution.

Course Outcome(s): After completion of this course the student will be able to:

1. Learners will understand basic theorems and concepts of basic physics.
2. To understand the dynamics of different types of pendulums and to determine 'g'.

3. To understand the elastic properties of matter and expression of bending beam with its application as a cantilever.
4. To understand concept of surface tension and its relationship with excess pressure and radius of curvature.
5. To determine the surface tension by Jaeger's method from experiments.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol.I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education Mechanics, D.S. Mathur, S.Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley Physics for scientists and Engineers with Modern Phys., J.W.Jewett, R.A.Serway,2010,Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Semester I **Major Course1: Physics Practical Lab-I**

Course Name: Physics Practical Lab-I	**Course Code: BSPY-101P**

Credits=L+T+P(0+0+4)=2	**Hours=30**

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine **g** and velocity for a freely falling body using Digital Timing Technique
6. To determine the Young's Modulus of a Wire by Optical Lever Method.
7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
8. To determine the elastic Constants of a wire by Searle's method.
9. To determine the value of g using Bar Pendulum.
10. To determine the value of g using Kater's Pendulum.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi&B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11thEdn, 2011,Kitab Mahal

Semester IMinor Course 1

Course Name: Newtonian Mechanics	Course Code:BSPY-102

Credits=L+T+P(4+0+0)=3	Hours=60

Objectives: To acquire basic knowledge about dynamics, work and energy, elasticity, gravitation and central force motion.

Unit-I: **Dynamics of a System of Particles**

Review of historical development of mechanics up to Newton. Background, statement and critical analysis of Newton's axioms of motion. Dynamics of a system of particles, centre of mass motion, and conservation laws & their deductions. Rotating frames of reference, general derivation of origin of pseudo forces (Euler, Coriolis & centrifugal) in rotating frame, and effects of Coriolis force.

Unit-II: **Dynamics of a Rigid Body**

Angular momentum, Torque, Rotational energy and the inertia tensor. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.

Unit-III: **Motion of Planets & Satellites**

Two particle central force problems, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion and their deductions. Motions of geo-synchronous & geo-stationary satellites and basic idea of Global Positioning System (GPS).

Unit-IV:Wave Motion

Differential equation of simple harmonic motion and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity.

Course outcomes (Cos):

1. Explain the historical evolution of classical mechanics and analyze Newton's laws of motion in the context of particle systems and conservation principles.

2. Apply the concepts of rotating frames and pseudo forces (Euler, Coriolis, centrifugal) to analyze motion in non-inertial reference frames.

3. Analyze the rotational dynamics of rigid bodies using angular momentum, torque, and the inertia tensor; evaluate elastic behavior through bending and torsion.

4. Solve problems involving the motion of planets and satellites using Newton's law of gravitation, Kepler's laws, and apply the concept of the Global Positioning System (GPS).

5. Derive and solve equations of harmonic and wave motion, including damped and forced oscillations, and apply the principles of wave superposition and velocity concepts to real-world systems.

Reference Books

- Physics –Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2 ndedn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

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Semester I

Multidisciplinary Course MDC-I

Course Name: Fundamentals of Physics	**Course Code:M-DIS-FP**

Credits=L+T+P(4+0+0)=3	**Hours=60**

Objectives: To acquire basic knowledge about dynamics, work and energy, elasticity, gravitation and central force motion.

Unit I: Vector Analysis Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss divergence theorem and Stoke's theorem of vectors (statement only).

Unit II: Laws of Motion Frames of reference. Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Momentum and Energy Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

Unit III: Rotational Motion Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Unit IV: Gravitation Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in aplane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications.

Course Outcomes:

1. Students will learn and develop the concepts of vector and basic knowledge of the vector differential operator Del and understand the operation on the scalar and vector field.

2. Students will Learn and realize about vector theorems like Divergence and Green theorem etc.

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3. Students will develop the concepts on classical mechanics and enhance the basic knowledge of the non-inertial and inertial frame of reference, variable mass, rocket motion, and special theory of relativity.

4. They will acquire knowledge about the elasticity of the material and the streamline and turbulent motion.

5. Enhance the capability to prepare and organize a presentation on the application of fundamental dynamics.

Reference Books

- UniversityPhysics. F.W. Sears, M.W. Zemansky and H.D. Young,13/e, 1986. AddisonWesley
- Mechanics Berkeley Physics, vol-1: Charles Kittel, et.al. 2007, Tata McGraw-Hill.
- Physics –Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2 ndedn., 2015, Oxford University Press

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Semester I

Skill Enhancement Course I

Course Name: BASIC INSTRUMENTATION SKILLS	**Course Code:SEC-BI**

Credits=L+T+P(1+0+3)=3	**Hours=45**

Objectives: To acquire basic knowledge about Basic of Measurement, Electronic Voltmeter, Oscilloscope and Signal and pulse Generators.

Unit I: Basic Measurement: Instruments accuracy, precision, sensitivity, resolution range. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Unit II: Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

AC mill voltmeter: Type of AC millivoltmeters. Block diagram ac millivoltmeter**,** specifications and their significance.

Unit III: Block diagram of basic CRO. Comparison of analog& digital instruments. Characteristics of digital meter. Working principles of digital voltmeter. Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time- base stability, accuracy and resolution.

Course Outcome(s): After completion of this course students would be able to

1. To understand standards of measurements and calibration.

1. To learn measurement of temperature using: Non - electrical, Electrical and Radiation Methods.

2. To learn measurement of pressure using McCluggage (b) Pirani Gauge.
3. To learn Measurement of flow using: Venturi tube, Pitot tube and Rotameter.
4. To understand characteristics of sound and to know typical sound measuring system.
5. To learn Measurement of magnetic field by using search coil method and Hall gauge meter.

Reference Books:

- A textbook in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.

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Semester I

VAC- I

Course Name: Basic of Renewable Energy Resources	**Course Code: VAC-BR**

Credits=L+T+P(1+0+3)=3	**Hours=45**

Objectives: To acquire basic knowledge about Fossil fuels and Alternate Sources of energy, Solar energy, Wind Energy harvesting, Ocean Energy and Geothermal Energy.

Unit I: Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Unit II: Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, Models and equivalent circuits, and sun tracking systems.

Unit III: Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Unit IV: Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impactof hydro power sources.

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Course Outcomes (COs):

1. Explain the limitations of fossil and nuclear energy and analyze the importance and potential of various renewable and non-conventional energy sources.

2. Describe the principles, storage methods, and applications of solar energy systems, including solar ponds, collectors, and photovoltaic technologies.

3. Understand the fundamentals of wind energy, the role of wind turbines, power electronics, and evaluate grid integration techniques.

4. Evaluate ocean energy systems such as wave, tidal, thermal, osmotic, and bio-mass energy based on their characteristics, potential, and technological applications.

5. Discuss geothermal and hydro energy resources, their technological developments, and assess their environmental impacts and sustainability.

Reference Books:

- Non-conventional energy sources, B.H. Khan, McGraw Hill
- Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd. Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn., 2012, Oxford University Press. Renewable Energy, 3rd Edition,
- Solar Energy: Resource Assesment Handbook, P Jayakumar, 2009, J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA). http://en.wikipedia.org/wiki/Renewable_energy

SEMESTER II

Major Course II

Course Name: Electricity And Magnetism	Course Code: BSPY-201

Credits=L+T+P(4+0+0)=4	Hours=60

Objectives: To acquire basic knowledge about Electric Field, Electrostatic energy, Dielectric Properties of Matter and Magnetic force.

Unit I: Electric Field and Electric Potential Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

Unit Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Unit III: Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between

E, **P** and **D**. Gauss' Law in dielectrics.

Unit IV:Magnetic Field: Magnetic force between current elements and definition of MagneticFieldB, Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole).Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on

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(1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop

in a uniform Magnetic Field.

Course Outcome(s): After completion of this course the student will be able to:

1. To understand basic concepts of current and current density vector.
2. To understand Kirchhoff's law by loop analysis.
3. To understand and illustrate Network theorem including Thevenin's theorem, Norton's theorem and Maximum power theorem.
4. To determine Time constant of L-R and C-R circuit and its physical significances.
5. To understand the concept of magnetism and magnetic properties of materials such as Ferromagnetic, Anti ferromagnetic and Ferrimagnetic.

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S.Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol.I, 1991, Oxford Univ. Press.

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Semester II

Major Course Physics Practical Lab-II

Course Name: Physics Practical Lab-II	**Course Code: BSPY-201P**

Credits=L+T+P(0+0+4)=2	**Hours=30**

1. To verify the Thevenin theorems.
2. To verify the Norton theorems
3. To verify the Superposition theorems.
4. To determine self-inductance of a coil by Anderson's bridge.
5. Determine high resistance by using Ballistic Galvanometer.
6. Variation of Magnetic field with respect to distance.
7. Sonometer

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Textbook of Practical Physics, I.Prakash&Ramakrishna, 11th Ed., 2011,Kitab Mahal Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.

SEMESTER II
MINOR COURSE II

Course Name: Waves And Optics	Course Code: BSPY-202

Credits=L+T+P(4+0+0)=3	Hours=60

Objectives: To acquire basic knowledge about Superposition of Collinear Harmonic oscillations, Plane and Spherical Waves, Wave Optics and Diffraction.

Unit I: Superposition of Collinear Harmonic oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. Superposition of two collinear oscillations having equal frequencies and different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with equal phase differences and equal frequency differences.Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies and their uses.

Unit II:Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Unit III: Wave Optics: Electromagnetic nature of light. Definition and properties of wave front.

Huygens Principle. Temporal and Spatial Coherence. Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

Unit IV:Diffraction:

Fraunhofer diffraction: Single slit. Rectangular and Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

Course Outcome(s): After completion of this course the student will be able to:

1. Analyze the principle of superposition in harmonic oscillations and construct Lissajous figures for collinear and perpendicular oscillations with various frequency and phase relationships.

2. Derive and interpret the wave equation for longitudinal and transverse waves; evaluate wave parameters such as particle velocity, intensity, energy transport, and normal modes in strings and pipes.

3. Explain the electromagnetic nature of light and apply Huygens' Principle to understand interference phenomena such as Young's double slit, Lloyd's mirror, Fresnel's biprism, and Newton's rings.

4. Examine the formation of interference patterns in thin films and use them to measure physical parameters like wavelength and refractive index.

5. Apply the theory of Fraunhofer diffraction to analyze diffraction through single slits, multiple slits, and gratings, and determine the resolving power of optical instruments.

Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7thEdn., 1999, Pergamon Press. Optics, AjoyGhatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications

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Semester II

Multidisciplinary Course- II

Course Name: Kinetic Theory	**Course Code: M-DIS-KT**

Credits=L+T+P(4+0+0)=3	**Hours=60**
Objectives: To grasp the concepts of Ideal Gas, Real Gas, and Liquefaction of gases and Transport phenomena in gases.	

UNIT - I

Ideal Gas: Kinetic model, Deduction of Boyle's law, interpretation of temperature, estimation of r.m.s. speeds of molecules. Brownian motion, estimate of the Avogadro number. Equipartition of energy, specific heat of monatomic gas, extension to di- and triatomic gases, Behavior at low temperatures. Adiabatic expansion of an ideal gas, applications to atmospheric physics.

UNIT - II

Real Gas: Vander Waals gas, equation of state, nature of Van der Waals forces, comparison with experimental P-V curves. The critical constants, gas and vapor. Joule expansion of ideal gas, and of a Vander Waals gas, Joule coefficient, estimates of J-T cooling.

UNIT -III

Liquefaction of gases: Boyle temperature and inversion temperature. Principle of regenerative cooling and of cascade cooling, liquefaction of hydrogen and helium gas. Refrigeration cycles, meaning efficiency.

UNIT - IV

Transport phenomena in gases: Molecular collisions mean free path and collision cross sections. Estimates of molecular diameter and mean free path. Transport of mass, momentum and energy and interrelationship, dependence on temperature and pressure.

Course Outcome(s): After completion of this course students would be able to

1. Apply the kinetic theory of gases to derive gas laws, interpret temperature microscopically, and estimate molecular speeds and Avogadro's number using Brownian motion.

2. Explain the equipartition of energy and analyze the specific heat capacities of monoatomic, diatomic, and triatomic gases, including their behavior at low temperatures and during adiabatic processes.

3. Evaluate the Van der Waals equation of state for real gases, understand intermolecular forces, and compare theoretical predictions with experimental P–V behavior.

4. Describe the principles and techniques of gas liquefaction, including regenerative and cascade cooling methods, and assess refrigeration cycles in terms of thermodynamic efficiency.

5. Analyze transport phenomena such as mass, momentum, and energy transfer in gases using concepts like molecular collisions, mean free path, and their dependence on temperature and pressure.

Text and Reference Books

- G.G. Agarwal and H.P. Sinha "Thermal Physics"
- S.K. Agarwal and B.K. Agarwal "Thermal Physics"

SEMESTER II

Skill Enhancement Course II   SEC-2

Course Name: Digital Systems	Course Code: SEC-DS

Credits=L+T+P(1+0+3)=3	Hours=45

Objectives: To acquire basic knowledge about CRO, Integrated Circuits, Digital Circuits and Boolean algebra.

Unit I: Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System andTime Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Unit II: Integrated Circuits (Qualitative treatment only): Active and Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of

ICs. Examples of Linear and Digital lCs.

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

Checkers.

Course Outcome(s): After completion of this course students would be able to

1. Understand the block diagram and working principles of a Cathode Ray Oscilloscope (CRO), including electron gun, deflection system, and time base.

2. Apply CRO for the analysis and measurement of electrical parameters such as waveform, voltage, current, frequency, and phase difference.

3. Identify and classify various electronic components and explain the basic concepts of integrated circuits, their advantages, limitations, and levels of integration (SSI to VLSI).

4. Distinguish between analog and digital circuits, and convert numbers between decimal, binary, octal, hexadecimal, and BCD formats.

5. Construct and analyze basic logic gates (AND, OR, NOT) using discrete components and use universal gates (NAND, NOR) and XOR/XNOR for applications like parity checking.

Reference Books:

- Digital Principles and Applications, A.P.Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2ndEdn, 2009, PHI Learning Pvt. Ltd. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, SubrataGhoshal, 2012, Cengage Learning. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

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Semester II

Value Added Course-2

Course Name: LASER & ITS APPLICATIONS	**Course Code: VAC-LA**

Credits=L+T+P(1+0+3)=3	**Hours=45**

Objectives: The outcome of this Course will prepare the students/trainees to use this knowledge for applications of lasers in specific fields of their interest

Unit I: INTERACTION OF LIGHT WITH MATTER Einstein coefficients, Relation between these coefficients, Lifetime of excited state, Line Broadening mechanisms, Population inversion, Threshold condition for Laser, Laser-Rate equations for three-level and four-level systems, Conditions for CW and pulsed laser action.

Unit II:DIFFERENT POPULATION INVERSION TECHNIQUES WITH EXAMPLES Optically pumped lasers, solid state lasers, dye lasers, electrical-discharge pumped lasers, gas lasers, chemical lasers, gas dynamic lasers, semiconductor lasers, free-electron lasers, gamma ray lasers, fiber lasers (only introductory description of these lasers).

Unit III:CHARACTERISTICS OF LASER BEAM Monochromaticity, Spatial & temporal coherence, temporal coherence & monochromaticity relation, connection between spatial coherence and directionality, rightness, Focus ability, ultra-short pulse generation. Peak Power, Average Power, Duty Cycle in Pulsed Lasers.

Unit IV: **TYPES OF LASERS** Solid, Liquid and Gas Lasers. Brief description of Ruby, He-Ne, Nd laser, Carbon Dioxide Lasers, Semiconductor Lasers.

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Unit V: **APPLICATION OF LASERS** General Applications of Lasers including Industry, Defense, Medicine, Entertainment etc.

Course Outcomes (Cos):

1. Explain the interaction of light with matter using Einstein coefficients, and analyze concepts such as population inversion, line broadening, and laser threshold conditions.

2. Understand and compare various population inversion techniques and identify the working principles of different types of lasers including optically pumped, gas, chemical, and semiconductor lasers.

3. Analyzing key characteristics of laser beams such as monochromaticity, coherence, directionality, brightness, and pulse properties (peak power, duty cycle, etc.).

4. Classify and describe major types of lasers (solid, liquid, gas) including the construction and functioning of Ruby, He-Ne, CO_2, and semiconductor lasers.

5. Evaluate diverse applications of lasers in fields such as industry, defense, medicine, and entertainment, demonstrating the practical significance of laser technology.

Reference Books:

- Laser Principles, Types & Applications: K R Nambiar, New Age International, 2004.
- Lasers: Theory and Applications: A K Ghatak and K Thyagarajan, McMillan, 2003.

Lecture Notes on “Laser Technology & Applications” (LOE2451) by P

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Physics												
Batch:2024 -25							SEM:III					
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total
				L	T	P						
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)	
1	Major 3	**BSPY-301**	**Optics**	4	0	0	3	5	10	15	70	100
2	Major 4	**BSPY-302**	**Classical Mechanics**	4	0	0	3	5	10	15	70	100
3	Minor 3	**BSPY-303**	**Thermodynamics**	4	0	0	3	5	10	15	70	100
4	Multi Disciplinary 3	**M-DIS-IP**	**Introduction to Physics Devices**	4	0	0	3	5	10	15	70	100
5	Ability Enhancement Course 3 (Disaster Risk Management)	**AEC-03**	**Disaster Risk Management**	2	0	0	2	5	10	15	70	100
6	Skill Enhancement Course 3	**SEC-RE**	**Renewable Energy and Energy Harvesting**	1	0	3	3	5	10	15	70	100
7	Practical 3 (based on Major 3+4)	**BSPY-304P**	**Physics Practical Lab-III**	0	0	4	3	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	**700**

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Physics												
Batch:2024 -25								**SEM:IV**				
S. *N* o.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 5	**BSPY-401**	**Mathematical Physics-I**	4	0	0	4	5	10	15	70	100
2	Major 6	**BSPY-402**	**Elements of Modern Physics**	4	0	0	4	5	10	15	70	100
3	Major 7	**BSPY-403**	**Circuit Fundamental and Basic Electronics**	4	0	0	4	5	10	15	70	100
4	Minor 4	**BSPY-404**	**Energy Physics**	4	0	0	3	5	10	15	70	100
7	Practical 4 (based on Major (5+6+7)	**BSPY-405P**	**Physics Practical Lab-IV**	0	0	4	3	5	10	15	70	100
5	Ability Enhancement Course 3 (Course on NCC/NSS/NGO,s / Scout Guide / Sports)	**AEC-04A/AEC-04B/AEC-04C/AEC-04D/AEC-04E**	**NCC/NSS/NGO/Scout Guide/Sports**	2	0	0	2	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**

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Semester III Major Course –III

Course Name: Optics	Course Code: BSPY-301
Credits=L+T+P(4+0+0)=4	Hours=60
Objectives: To acquire basic knowledge about Light, and Different phenomena of light	

Unit -1 Interference

Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot.

Unit –II Diffraction I

Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate.

Unit –III Diffraction II

Fraunhofer diffraction at a single slit, n slits and

Diffracting Grating. Resolving Power of Optical Instruments - Rayleigh's criterion and resolving power of telescope, microscope & grating.

Unit –IV Polarization

Polarization by dichroic crystals, birefringence, Nicol prism, retardation plates and Babine's compensatory. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartz polarimeters.

Course Outcomes (COs)

1. Comprehend the powerful applications of ballistic galvanometers.
2. Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).

3. Study the working and applications of Michelson and Fabry-Perot interferometers.

4. Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.

5. Comprehend the use of polarimeters.

Reference Books:

- Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e
- Samuel Tolansky, "An Introduction to Interferometry", John Wiley & Sons Inc., 1973, 2e
- A. Ghatak, "Optics", McGraw Hill, 2017.

Semester III Major Course –III**

Course Name: Physics Practical LAB III	Course Code: BSPY-304P
Credits=L+T+P(0+0+4)	Hours=30

1. Study of interference of light (biprism or wedge film).
2. To determine the wavelength of sodium light by Newton's Rings.
3. To determine the wavelength of monochromatic light by plane diffraction grating.
4. Study of diffraction at a straight edge or a single slit.
5. Use of diffraction grating and its resolving limit.
6. Resolving the limit of a telescope system.
7. Polarization of light by reflection.
8. Study of optical rotation for any system.
9. Nodal Slide

Text and reference books

- D.P. Khandelwal, "A Laboratory Manual for Undergraduate Classes (Vani Publishing House, New Delhi).
- S.P. Singh, "Advanced Practical Physics" (Pragati Prakashan, Meerut).
- Worsnop and Flint- Advanced Practical physics for students.

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Semester III **Major Course –IV**

Course Name: Classical Mechanics	**Course Code: BSPY-302**
Credits=L+T+P (4+0+0)	**Hours =60**
Objectives: To acquire basic knowledge about Classical Mechanics, Small Amplitude Oscillations, Special Theory of Relativity and Fluid Dynamics	

Unit I: Classical Mechanics of Point Particles: Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field-gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional

Unit II: Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude, oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Unit III: Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four vectors: space-like, time-like and light-like. Four-velocity and acceleration. Concept of four-force. Conservation of four-momentum.

Unit IV: Fluid Dynamics: Density and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, qualitative description of turbulence, Reynolds number.

Course Outcomes (Cos):

1. Analyze the motion of charged particles in uniform and crossed electric and magnetic fields, and apply Hamilton's principle to derive Lagrange's and Euler-Lagrange equations for mechanical systems.

2. Understand and solve problems involving small amplitude oscillations around stable equilibrium and determine normal modes in systems of coupled oscillators.
3. Explain and apply the postulates of Special Theory of Relativity, Lorentz transformations, and phenomena like time dilation, length contraction, and relativistic kinematics using four-vector formalism.
4. Construct and interpret space-time diagrams, light cones, and apply conservation principles using relativistic momentum and energy relations.
5. Apply the principles of fluid dynamics to describe fluid motion, derive the continuity equation and Poiseuille's law, and explain concepts like laminar flow, turbulence, and Reynolds number.

Reference Books:

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rdEdn. 2002, Pearson Education. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rdEdn., 1998, Wiley.
- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4thEdn., 2003, Elsevier. Classical Mechanics, P.S. Joag, N.C. Rana, 1stEdn., McGraw Hall.
- Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

Semester III **Minor Course III**

Course Name: Thermodynamics	Course Code: BSPY-303
Credits=L+T+P (4+0+0)	Hours =60
Objectives: To learn the basic principles of thermodynamics, Thermodynamic relationships, and blackbody radiation.	

UNIT - I

Zeroth law, various indicator diagrams, work done by and on the system, first law of thermodynamics, internal energy as a state function and other applications. Reversible and irreversible changes, Carnot cycle and its efficiency, Carnot theorem.

UNIT - II

The second law of thermodynamics. Different versions of the second law, practical cycles used in internal combustion engines. Entropy, principle of increase of entropy. The thermodynamic scale of temperature; its identity with the perfect gas scale. Impossibility of attaining absolute zero; third law of thermodynamics.

UNIT - III

Thermodynamic relationships: Thermodynamic variables; extensive and intensive, Maxwell's general relationships, application to Joule-Thomson cooling and adiabatic cooling in a general system, Van der Waals gas, Clausius-Clapeyron heat equation. Thermodynamic potential and equilibrium of thermodynamic systems, relation with thermodynamic variables. Cooling due to adiabatic demagnetization, production and measurement of very low temperatures.

UNIT - IV

Pure temperature dependence, Stefan-Boltzmann law, pressure of radiation, spectral distribution of Black body radiation, Wien's displacement law, Rayleigh-Jean's law, Plank's Law the ultraviolet catastrophe.

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Course Outcome(s): After completion of this course students would be able to

1. Understand basic concept of thermodynamics and to distinguish between work done due to Adiabatic and isothermal changes.
2. To state laws of thermodynamics and concept of internal energy.
3. To understand Carnot's ideal heats engine, Carnot cycle and its efficiency, Carnot's theorem, Otto and Diesel engines with their efficiencies.
4. To state first and second latent heat equations.
5. To understand Concept of entropy, Change of entropy in Reversible process and Irreversible process, T-S diagram.

Text and Reference Books

- G.G. Agarwal and H.P. Sinha "Thermal Physics"
- S.K. Agarwal and B.K. Agarwal "Thermal Physics"

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Semester IIIMULTIDISCIPLINARY COURSE-3

Course Name: Introduction to Physics Devices	Course Code: M-DIS-IP

Credits=L+T+P(1+0+3)	Hours=45

Unit-I

Measurement of Voltage and current: Working of ideal and constant current source, Ideal and constant voltage source, Dependent and independent current and voltage source. Working of moving coil galvanometers, its use as Voltmeter and Ammeter, Use of digital multimeter for measurement of R, L, C, ac and de voltage and current, type of transistor etc.

Unit-II

Two layered devices: Working principle and I-V characteristics of p-n junction diode, Zener diode, LED, photodiode and solar cell. Centre- tapped and Bridge Full-wave Rectifiers, Calculation of ripple factors and rectification efficiency, basic idea about capacitor filter, Working of regulator IC 7805.

UNIT-III

Types of Transistors: Introduction to Bipolar Junction Transistor (BJT), BJT Structure and Operation: n-p-n and p-n-p types, working principle, Transistor Configurations: Common Emitter (CE), Common Base (CB), and Common Collector (CC) input/output characteristics (qualitative), current gain (β).

UNIT-IV

Basic concept and working of Optoelectronic devices: Photodiodes, Phototransistors, and LDRs,

Introduction to temperature sensors: Thermistor and Thermocouple, Applications of sensors in daily-life electronic systems (e.g., smoke detectors, automatic lights, IR thermometers).

Course Outcomes (Cos):

1. Understand and analyze the working principles of ideal and practical current/voltage sources and measure electrical quantities using devices such as galvanometers and digital multimeters.
2. Explain the I-V characteristics and applications of two-layer semiconductor devices like p-n junction diodes, Zener diodes, LEDs, photodiodes, and solar cells, and evaluate rectifier circuits and voltage regulators.
3. Demonstrate understanding of BJT structure, types, configurations (CE, CB, CC), and describe their application as amplifiers and switches with qualitative analysis of their characteristics.

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4. Describe the working principles of optoelectronic and sensing devices, including photodiodes, phototransistors, LDRs, thermistors, and thermocouples, and explore their use in common electronic systems.
5. Apply basic concepts of electronic components and devices to analyze and design simple measurement, regulation, and sensor-based circuits used in real-life applications.

References

- Physics of Semiconductor Devices, S. M. Sze and K. K. Ng, 3rd Edition 2008, John Wiley and Sons

- Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.

- H. S. Kalsi, Electronic Instrumentation, TMH (2006).

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Semester III **Skill enhancement Course-3**

Course Name: Renewable Energy and Energy Harvesting	**Course Code: SEC-RE**

Credits=L+T+P(1+0+3)	**Hours=45**

Course Objectives

- To develop skills and understanding of various renewable energy resources.
- To study energy conversion techniques and instrumentation.
- To understand the working principles of solar, wind, and other renewable technologies.
- To promote practical exposure to small-scale energy systems.

Unit I: Introduction to Renewable Energy Sources

Classification of energy sources: renewable and non-renewable, Global and Indian energy scenario, Environmental impact of conventional energy, Basics of energy conversion and storage, Energy efficiency and sustainability.

Unit II: Solar Energy

Solar radiation and its measurement, Photovoltaic (PV) effect: working principle of solar cells, Types of solar cells and their characteristics, Design and operation of solar PV systems, Applications: solar lighting, solar cookers, solar heaters, Hands-on: Measurement of solar irradiance using pyranometer.

Unit III: Wind and Other Renewable Energy Sources

Wind energy principles and power generation, Components of wind turbines, site selection, and performance, Bioenergy: biogas plants, biofuels, and biomass gasification, Geothermal, tidal, and hydrogen energy basics, Small-scale hybrid systems, Hands-on: Study of a miniature wind turbine model.

Unit IV: Energy Harvesting and Storage Technologies

Concept of energy harvesting and smart materials, Piezoelectric and thermoelectric energy harvesting, Energy storage devices: batteries and supercapacitors.Fuel cells: working principle and applications, Case studies: sustainable campus and smart grid initiatives, Hands-on: Demonstration of piezoelectric and thermoelectric modules.

Course Outcomes

After completing this course, students will be able to:

1. Identify different renewable energy sources and their applications.
2. Understand the physical principles behind energy conversion.
3. Analyze the performance of solar and wind energy devices.

Gain hands-on experience in energy measurement and small-scale system design

Suggested Readings

1. Sukhatme, S. P., & Nayak, J. K. (2017). *Solar Energy: Principles of Thermal Collection and Storage*. Tata McGraw Hill.
2. Boyle, G. (2012). *Renewable Energy: Power for a Sustainable Future*. Oxford University Press.
3. Duffie, J. A., & Beckman, W. A. (2013). *Solar Engineering of Thermal Processes*. Wiley.
4. Kothari, D. P., Singal, K. C., & Ranjan, R. (2011). *Renewable Energy Sources and Emerging Technologies*. PHI Learning.
5. Twidell, J., & Weir, T. (2015). *Renewable Energy Resources*. Routledge.

__Semester IV__ **Major Course-5**

Course Name: Mathematical Physics-I	Course Code: BSPY-401
Credits=L+T+P(4+0+0)	Hours=60
Objectives: The emphasis of course is on applications in solving problems of interest to physicists.The students are to be examined entirely on the basis of problems, seen and unseen.	

Unit I: Plotting of functions. Approximation: Taylor and binomial series (statements only). First Order Differential. Equations exact and inexact differential equations and Integrating Factor. Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Particular Integral with operator method, method of undetermined coefficients and variation method of parameters.

Unit II: Vector Algebra: Properties of vectors. Scalar product and vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivatives. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

Unit III: Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their verification (no rigorous proof).

Unit IV: Orthogonal Curvilinear Coordinates, Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Dirac Delta function: Definition of Dirac delta function and simple examples.

Course outcomes: After completion of this course the student will be able to:

1. Have knowledge about, and being able to use, advanced mathematical methods and theories on various mathematical and physical problems.
2. Use mathematical formulations, analyses and models to obtain insight in specialized areas of Physics.
3. Be able to apply skills of mathematical, statistical and physical modeling in applied fields and on technological problems.
4. Be able to carry out, present and document comprehensive independent work, demonstrating command of the terminology of the subject area.

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5. Identify different special mathematical functions.

Reference Books:

- Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris,2013, 7thEdn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Advanced Engineering Mathematics, D.G. Zill and W.S.Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

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<u>Semester IV</u> Major Course-V

Course Name: Physics Practical Lab-IV	Course Code: BSPY-405P
Credits=L+T+P(0+0+4)	Hours=30

1. Moment of inertia of a flywheel
2. Moment of inertia of an irregular body by inertia table
3. Modulus of rigidity by statistical method (Barton's apparatus)
4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle)
5. Young's modulus by bending of beam
6. Young's modulus and Poisson's ratio by Searle's method
7. Poisson's ratio of rubber-by-rubber tubing
8. Surface tension of water by capillary rise method
9. Surface tension of water by Jaeger's method
10. Coefficient of viscosity of water by Poiseuille's method
11. Acceleration due to gravity by bar pendulum
12. Frequency of AC mains by Sonometer

<u>Reference Books</u>

- B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
- S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
- R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
- S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

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<u>Semester IV</u>Major Course VI

Course Name: Elements Of Modern Physics	**Course Code:BSPY-402**
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: To acquire basic knowledge about Planck's quantum, Wave-particle duality, slit interference experiment and one dimensional infinitely rigid box.	

Unit I: Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

Unit II: Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle

Unit III: Two slit interference experiments with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Unit IV: One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.

Course Outcomes: This course will enable the students to:

1. To solve problems associated with energy crisis by means of photo thermal conversion and photovoltaic conversion.
2. To demonstrate construction and working of flat-plate collector, liquid flat plate collector, Basic photovoltaic system and solar modules for power generation.

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3. To understand Laser, its types, applications - Ruby LASER, He-Ne LASER.
4. To verify experimentally of discrete atomic energy levels and correspondence principle
5. To understand atomic spectrum and distinguish classical planetary model and Bohr's theory of hydrogen atom and quantum mechanical Bohr's Somerfield model.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co. Six Ideas that Shaped Physics:Particle Behave like Waves, T.A.Moore,2003, McGraw Hill.

Semester IV Major Course VII

Course Name: Circuit Fundamentals and Basic Electronics	**Course Code: BSPY-403**
Credits=L+T+P(4+0+0)	**Hours= 60**
Objectives: To acquire the knowledge of Growth and decay of currents through inductive resistances, Semiconductors, Transistor biasing circuits and oscillator.	

UNIT – I Growth and decay of currents through inductive resistances, charging and discharging in R.C. and R.L.C. circuits, Time constant, Measurement of high resistance. A.C. Bridges, Maxwell's and Schering Bridges, Wien Bridge. THEVENIN, NORTON and Superposition theorems and their applications.

UNIT – II Semiconductors, intrinsic and extrinsic semiconductors, n-type and p-type semiconductors, unbiased diode forward bias and reverse bias diodes, diode as a rectifier, diode characteristics, Zener diode, avalanche and Zener breakdown, power supplies, rectifier, bridge rectifier, capacitor input filter, voltage regulation, Zener regulator.Bipolar transistors, three doped regions, forward and reverse bias, DC alpha, DC beta transistor curves.

UNIT – IIITransistor biasing circuits: base bias, emitter bias and voltage divider bias, DC load line.

Basic AC equivalent circuits, low frequency model, small signal amplifiers, common emitter amplifier, common collector amplifiers, and common base amplifiers, current and voltage gain, R.C. coupled amplifier, gain, frequency response, equivalent circuit at low, medium and high frequencies, feedback principles.

UNIT – IV Input and output impedance, transistor as an oscillator, general discussion and theory of Hartley oscillator only. Elements of transmission and reception, basic principles of amplitude modulation and demodulation. Principle and design of linear multimeters and their application, cathode ray oscillograph and its simple applications.

Course Outcome(s): After completion of this course students would be able to

1. To understand and learn the Mechanical Properties, Thermal Properties, Electrical Properties, and

Magnetic Properties of materials.

2. To understand the basic concept of Dislocations and Plastic Deformation.
3. To understand Atomic Diffusions and its Mechanism.
4. To state Fick's Law (Ist and IInd Law).
5. To understand the basics of phase diagram, its classifications, and its interpretation.

Text and Reference Books

- B.G. Streetman; "Solid State Electronic Devices", IInTdi Edition (Prentice Hall of India, New Delhi, 1986).
- W.D. Stanley: "Electronic Devices, Circuits and Applications" (Prentice-Hall, New TTC'A 1flOO\ JL4y, JJI. 1OO).
- J.D. Ryder, "Electronics Fundamentals and Applications", lI'' Edition (Prentice-Hall of India, New Delhi, 1986).
- J Millman and A Grabel, "Microelectronics", International Edition (McGraw Hill Book Company, New York, 1988).

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Semester IV **Minor Course IV**

Course Name: Energy Physics	Course Code: BSPY-404
Credits=L+T+P(4+0+0)	Hours=60
Objectives: To acquire the knowledge of Growth and decay of currents through inductive resistances, Semiconductors, Transistor biasing circuits and oscillator.	

UNIT I - INTRODUCTION

Units and scales of energy - various forms of energy – renewable and conventional energy systems – comparison – coal, oil and natural gas – availability– applications – merits and demerits. Impact due to non-conventional energy sources – global warming, Approaches to Energy conservation - energy conservation policies of different Governmental bodies.

UNIT II - SOLAR ENERGY

Solar radiation measurements (qualitative only), solar energy collectors, principle of the conversion of solar radiation into heat, classification of different types of solar energy collectors (qualitative ideas only)- merits and demerits, Solar energy storage, solar heaters, solar cookers, solar green houses, merits and demerits of solar energy, Solar cell technology (basic principle only)

UNIT III - WIND ENERGY

Basic principle of wind energy conversion, basic components of wind energy conversion system (WECS), wind energy collectors. Applications of wind energy.

UNIT IV - ALTERNATIVE ENERGY SOURCES

Geothermal energy sources, Applications of Geothermal energy, Energy from Oceans and Chemical energy resources: Ocean thermal energy Conversion, energy from waves and tides – basic ideas, nature, applications, merits and demerits.

Course Outcomes (Cos):

1. Understand and differentiate between conventional and renewable energy sources, assess their availability, applications, and environmental impacts including global warming and conservation policies.

2. Explain the basic principles of solar radiation conversion, types of solar energy collectors, and evaluate various solar energy applications such as solar heaters, cookers, greenhouses, and solar cells.
3. Describe the working principle of wind energy systems, identify components of Wind Energy Conversion Systems (WECS), and examine their practical applications.
4. Understand the basic concepts and applications of geothermal energy and analyze ocean energy sources such as tidal, wave, and ocean thermal energy conversion systems.
5. Evaluate the merits and limitations of various renewable energy technologies and explore their role in sustainable development and environmental protection.

Reference Books:

- Non – Conventional Energy Resources: G. D. Rai, Khanna Publishers, 2008.
- Solar energy: G. D. Rai, 5th edition, 1995.
- Solar Energy Fundamentals and application: H.P. Garg and J. Prakash,
- Tata McGraw - Hill Publishing company Ltd., 1997.

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Physics													
Batch:2024 -25							SEM:V						
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total	
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 8	**BSPY-501**	**Quantum Mechanics and Application**	4	0	0	4	5	10	15	70	100	
2	Major 9	**BSPY-502**	**Solid State Physics**	4	0	0	4	5	10	15	70	100	
3	Minor 5	**BSPY-503**	**Nuclear and Particle Physics**	4	0	0	3	5	10	15	70	100	
4	Minor 6	**BSPY-504**	**Physics of Devices and Communication**	4	0	0	3	5	10	15	70	100	
5	Internship	**BSPY-505I**	**Internship**	4	0	0	4	5	10	15	70	100	
6	Practical 5 (based on Major (8+9)	**BSPY-506P**	**Physics Practical Lab-V**	0	0	4	2	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**	

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT												
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE												
Department of Physics												
Batch:2024 -25							SEM:VI					
S.No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total
				L	T	P						
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)	
1	Major 10	BSPY-601	Nanoscience and Nanotechnology	4	0	0	4	5	10	15	70	100
2	Major 11	BSPY-602	Electromagnetic Theory	4	0	0	4	5	10	15	70	100
3	Major 12	BSPY-603	Statistical Mechanics	4	0	0	4	5	10	15	70	100
4	Minor 7	BSPY-604	Classical Dynamics	4	0	0	3	5	10	15	70	100
5	Minor 8	BSPY-605	Medical Physics	3	0	0	3	5	10	15	70	100
6	Practical 6 (based on Major (10+11+12)	BSPY-606P	Physics Practical Lab-VI	0	0	4	2	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							20	30	60	90	420	600

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SEMESTER VMajor Course -8

Course Name: Quantum Mechanics And Applications	**Course Code: BSPY-501**
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: To acquire basic knowledge about Schrodinger equation, bound states in an arbitrary potential and Quantum theory of hydrogen-like atoms.	

Unit I: Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions;Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions.

Unit II: Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states

Unit III: General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero-point energy & uncertainty principle.

Unit IV: Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground and first excited states.

Course Outcome(s): After completion of this course students would be able to

1. To develop a knowledge and understanding of the concept that quantum states live in a vector space.
2. To solve quantum mechanics problems.
3. Formulation of Schrödinger equation-time dependent and time independent forms.
4. To derive energy Eigen value and eigen functions particle in a box and 1-D harmonic oscillator.
5. To formulate the Schrödinger wave equation in terms of spherical polar co-ordinates for its application to solve Hydrogen atom problem.

Reference Books:

- A Textbook of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley. Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

SEMESTER VMajor Course Lab -8

Course Name: Physics Practical Lab-V	Course Code: BSPY-506P
Credits=L+T+P(0+0+4)	Hours=30

1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
2. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
3. To study the various biasing configurations of BJT for normal class A operation.
4. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
5. B-H curve and hysteresis loss.
6. Experiment on fiber optics
7. To plot the forward and reverse characteristics of SCR.
8. To study the RC coupled amplifier.
9. To determine the energy band gap in a semiconductor by four probe method.
10. To study the Ballistic galvanometer

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SEMESTER VMajor Course -9

Course Name: Solid State Physics	Course Code: BSPY-502
Credits=L+T+P(4+0+0)	Hours=60
Objectives: To acquire basic knowledge about Crystal Structure, Elementary Lattice Dynamics, Magnetic Properties of Matter and Dielectric.	

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

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

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

Unit IV: Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. ClausiusMosotti Equation. Classical Theory of Electric Polarizability. Langevin-Debye equation. Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration, Depth. Isotope effect. Idea of BCS theory (No derivation)

Course Outcome(s): After completion of this course students would be able to

1. Be able to account for interatomic forces and bonds
2. Have a basic knowledge of crystal systems and spatial symmetries
3. Be able to account for how crystalline materials are studied using diffraction, including concepts like the Ewald sphere, form factor, structure factor, and scattering amplitude.
4. Be able to perform structure determination of simple structures
5. Understand the concept of reciprocal space and be able to use it as a tool know the significance of Brillouin zones

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8thEdn. 2004, Wiley India Pvt. Ltd. Elements of Solid State Physics, J.P. Srivastava, 2ndEdn., 2006, Prentice-Hall of India. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.
- Solid State Physics, Rita John, 2014, McGraw Hill
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

SEMESTER VMinor Course -5

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Course Name: Nuclear and Particle Physics	Course Code:BSPY-503
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: To acquire basic knowledge about Properties of Nuclei, Nuclear Models, Radioactivity decay and Particle physics**.**	

Unit I: General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties,quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic-moment, electric moments, nuclear excites states.

Unit II: Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Unit III: Radioactivity decay :(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) -decay: energy kinematics for -decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays' emission & kinematics, internal conversion, Nuclear Reactions.

Unit IV: Particle physics: Particle interactions; basic features, types of particles and its families. symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quarkmodel, colour quantum number and gluons.

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

1. To understand nuclear compositions and Elementary particles, charge symmetry and independence, spin dependence of nuclear force.
2. To state Law of radioactive decay and its application.
3. To distinguish between Types of nuclear models: Single particle shell model and Liquid drop model.
4. To understand nuclear reactions and conservation laws.
5. To understand nuclear fission on the basis of liquid drop model and nuclear fusion.

Reference Books:

- Introductory nuclear Physics, Kenneth S. Krane (Wiley India Pvt. Ltd., 2008). Concepts of nuclear physics, Bernard L.Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei &particles, R.A. Dunlap. (Thomson Asia, 2004). Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

SEMESTER VMinor Course -6

Course Name: Physics Of Devices and Communication	Course Code: BSPY-504
Credits=L+T+P(4+0+0)	Hours=60
Objectives: To acquire basic knowledge about electronic Devices, Processing of Devices, Power supply & Filters and Digital Data Communication Standards.	

Unit I: Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO_2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices.

Unit II: Processing of Devices: Basic process flow for IC fabrication. Crystal plane and orientation. Diffusion and implantation of dopants. Passivation. Oxidation Technique for Si. Contacts and metallization technique. Wet etching. Dry etching (RIE). Positive and Negative Masks. Photolithography. Electron-lithography.

Unit III: Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, short circuit protection. RC Filters: Passive-Low pass and High pass filters, Active (1^{st} order Butterworth) –LowPass, High Pass, Band Pass and band Reject Filters.

Unit IV: Digital Data Communication Standards: Serial Communications: RS232, Handshaking, Implementation of RS232 on PC, Universal Serial Bus (USB), USB standards, Types and elements of USB transfers. Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.

Course Outcomes (Cos):

1. Analyse the characteristics and small-signal models of semiconductor devices including UJT, JFET, MOSFET (enhancement and depletion modes), and CMOS, and evaluate their performance limits.
2. Understand and explain the complete process flow for IC fabrication, including doping, oxidation, lithography, etching, and metallization techniques used in modern semiconductor industries.
3. Design and analyse regulated power supply systems using filters, IC regulators, and protective circuits; construct and evaluate passive and active filters including 1st order Butterworth configurations.
4. Describe various digital data communication standards such as RS232, USB, and GPIB, and understand their signalling, handshaking, and implementation in PC-based systems.
5. Demonstrate the ability to integrate theoretical knowledge of semiconductor devices, fabrication processes, and communication protocols in practical electronics and embedded systems applications.

Reference Books:

- Physics of Semiconductor Devices, S.M.Sze and K.K.Ng, 3rd Edition 2008, John Wiley & SonsOp-Amps & Linear Integrated Circuits, R.A.Gayakwad, 4 Ed. 2000, PHI Learning Pvt. Ltd
- Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Introduction to Measurements & Instrumentation, A.K.Ghosh, 3rd Edition, 2009, PHI Learning Semiconductor Physics and Devices, D.A.Neamen, 2011, 4th Edition, McGraw Hill PC based

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- instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India

SEMESTER VInternship

Course Name: Internship	**Course Code: BSPY-505I**
Credits=L+T+P(2+0+0)	

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SEMESTER VIMajor Course -10

Course Name: Nanoscience and Nanotechnology	**Course Code: BSPY-601**
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: To acquire basic knowledge about nano-scale systems, synthesis of nanostructure materials, optical properties and applications of nanoparticles	

Unit I: NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its Consequences.

Unit II: SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots

Unit III: OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Opticalproperties of heterostructures and nanostructures.

Unit IV: APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots hetero structure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nanoelectromechanical Systems (NEMS).

COURSE OUTCOMES (COs)

1. Understand the classification of nanostructures (1D, 2D, 3D) and analyze quantum confinement effects using Schrödinger equation models in nanoscale systems.
2. Compare and evaluate various nanomaterial synthesis techniques such as top-down and bottom-up approaches, including PVD, CVD, sol-gel, and MBE.
3. Analyze the optical properties of nanomaterials including excitons, Coulomb interactions, quasi-particles, and charging effects, and explain radiative processes in nanostructures.
4. Explore and interpret the optical characteristics and behaviour of heterostructures and nanostructures with respect to absorption, emission, and luminescence.
5. Identify and explain the application of nanomaterials in modern technologies such as photonic devices, CNT transistors, quantum dot lasers, optical storage, MEMS, and NEMS.

Reference books:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.). S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company) K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

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SEMESTER VIMajor Course -11

Course Name: Electromagnetic Theory	**Course Code: BSPY-602**
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: To acquire basic knowledge about Maxwell Equations, EM Wave Propagation in Unbounded & bound Media and Polarization of Electromagnetic Waves.	

Unit I: Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.

Unit II :EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases,

Unit III: EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection,)

Unit IV: Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates.

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

1. To understand basic concept of current and current density vector.
2. To understand Kirchhoff's law by loop analysis.
3. To understand and illustrate Network theorem including Thevenin's theorem, Norton's theorem and Maximum power theorem.
4. To determine Time constant of L-R and C-R circuit and its physical significances.
5. To understand the concept of magnetism and and magnetic properties of materials such as Ferromagnetic, Anti ferromagnetic and Ferrimagnetic.

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning

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- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2015, Cambridge University Press

SEMESTER VIMajor CourseLAb -11

Course Name: Physics Practical Lab- VI	**Course Code: BSPY-606P**
Credits=L+T+P(0+0+4)	**Hours=30**

1. Problems on assembly language programming using 8085 microprocessors.
2. Experiments on Microprocessor interfacing.
3. Studies on timer circuits (using 555 timer).
4. Design and study of multivibrators.
5. To study voice communication using PAM.
6. To study voice communication using PWM
7. To study the PPM using dc input.
8. Study of logic circuits TTL, NAND and NOR gates.
9. Study of flip-flops.
10. Study of characteristics of LED and PIN Photo Detector

SEMESTER VIMajor Course -12

Course Name: Statistical Mechanics	**Course Code: BSPY-603**
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: To acquire basic knowledge about Classical Statistics, Radiation, Bose-Einstein Statistics and Fermi-Dirac Statistics.	

Unit I: Classical Statistics: Macrostate and Microstate, Phase Space, Elementary Concept of Ensemble, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof)– Applications to Specific Heat and its Limitations, Thermodynamic

Unit II: Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Radiation Pressure. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

Unit III: Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

Unit IV: Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals Limit.

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

1. To understand basic concepts of probability and probability distribution.
2. To solve Random Walk problem in one dimension and Gaussian probability distribution.
3. To understand specification of the state of the system (Classical & Quantum).
4. To state Basic postulate of equal a priori probability,
5. To understand Statistical Ensembles and Calculation of microstates of an ideal monatomic gas

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Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2^{nd} Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill Thermodynamics.
- Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

SEMESTER VIMinor Course -7

Course Name: Classical Dynamics	**Course Code: BSPY-604**
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: To acquire basic knowledge about Classical Mechanics, Small Amplitude Oscillations, Special Theory of Relativity and Fluid Dynamics	

Unit I: Classical Mechanics of Point Particles: Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyro radius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations Hamilton's equations of motion.

Unit II: Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude, oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Unit III: Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Concept of four-force. Conservation of four-momentum. Relativistic kinematics.

Unit IV: Fluid Dynamics: Density and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

COURSE OUTCOMES (Cos)

1. Apply Newtonian mechanics to analyze the motion of charged particles in electric and magnetic fields, and formulate equations of motion using Lagrangian and Hamiltonian formalisms.
2. Understand the concept of small amplitude oscillations around stable equilibrium points and determine normal modes in coupled oscillating systems.
3. Explain the postulates of special relativity and apply Lorentz transformations to study time dilation, length contraction, and relativistic kinematics using four-vector formalism.
4. Construct and interpret space-time diagrams, analyze light cones and worldlines, and apply conservation of four-momentum in relativistic dynamics.
5. Derive and apply fluid dynamics equations including the continuity equation, Poiseuille's law, and Navier-Stokes equation, and describe laminar flow and turbulence using Reynolds number.

Reference Books:

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rdEdn. 2002, Pearson Education. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rdEdn., 1998, Wiley.
- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4thEdn., 2003, Elsevier. Classical Mechanics, P.S. Joag, N.C. Rana, 1stEdn., McGraw Hall.
- Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

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SEMESTER VIMinor Course -8

Course Name: Medical Physics	**Course Code: BSPY-605**
Credits=L+T+P(3+0+0)	**Hours=30**
Objectives: To acquire basic knowledge about Basic Anatomical Terminology, Acoustics of the body, X-Rays and Radiation Physics.	

Unit I: PHYSICS OF THE BODY-I

Basic Anatomical Terminology: Standard Anatomical Position, Planes. Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal. **Mechanics of the body:** Skeleton, forces, and body stability. Muscles and dynamics of body movement. Physics of Locomotors Systems: joints and movements, Stability and Equilibrium. **Energy household of the body:** Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation. **Pressure system of body:** Physics of breathing, Physics of cardiovascular system.

Unit II: PHYSICS OF THE BODY-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound.**Optical system of the body:**Physics of the eye. **Electrical system of the body:** Physics of the nervous system,Electrical signals and information transfer.

Unit III: PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS X-RAYS: Electromagnetic spectrum, production of x-rays, x-ray spectra, Bremsstrahlung, Characteristic x-ray. **X-ray tubes & types**: Coolidge tube, x-ray tube design, tube cooling stationary mode, Rotating anode x-ray tube, Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit. Single and three phase electric supply. Power ratings. Types of X-Ray Generator, high frequency generator.

Unit IV: RADIATION PHYSICS: Radiation units exposure, absorbed dose, units: rad, gray,relative biological effectiveness, effective dose- Rem & Sievert, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, linear attenuation coefficient. **Radiation Detectors**: ionization (Thimble chamber, condenser chamber), chamber. Geiger Muller counter, Scintillation counters and Solid-State detectors, TFT.

Course outcomes (Cos)

1. Understand and apply anatomical terminology and basic mechanical principles to analyze body stability, joint movement, muscle function, and the body's energy balance and thermal regulation.
2. Explain the physics underlying the acoustic, optical, and electrical systems of the human body including sound production, hearing, vision, and nerve signal transmission.
3. Describe the principles, generation, and applications of X-rays in medical diagnostics, including tube design, generator circuits, and characteristics of X-ray radiation.
4. Understand the fundamental concepts of radiation physics, including radiation units, biological effects, and the interaction of radiation with matter through mechanisms like the Compton and photoelectric effects.
5. Identify and explain the working principles of various radiation detectors such as ionization chambers, GM counters, scintillation detectors, and solid-state devices used in diagnostic imaging and radiation safety.

Reference Books:

- Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978) Basic Radiological Physics Dr. K.Thayalan- Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)

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- Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
- Physics of the human body, Irving P. Herman, Springer (2007)Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rd edition (2003)
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
- Handbook of Physics in Diagnostic Imaging: R.S.Livingstone: B.I. Publication Pvt Ltd. The Physics of Radiology-H E Johns and Cunningham.

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Physics													
Course B.Sc. Physics													
Batch:2024 -25								SEM:VII					
S.No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total	
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT /Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 13	**BSPY -701**	**Mathematical Physics-II**	4	0	0	4	5	10	15	70	100	
2	Major 14	**BSPY -702**	**Quantum Mechanics -I**	4	0	0	4	5	10	15	70	100	
3	Major 15	**BSPY -703**	**Photonic Devices**	4	0	0	4	5	10	15	70	100	
4	Minor 9	**BSPY -704**	**Electronic Devices**	4	0	0	4	5	10	15	70	100	
5	Practical 7 (based on Major (13+14))	**BSPY -705P**	**Physics Practical Lab-VII**	0	0	4	2	5	10	15	70	100	
6	Practical 8 (based on Major 15)	**BSPY -706P**	**Physics Practical Lab-VIII**	0	0	4	2	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**	

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Physics

Course B.Sc. Physics

Batch:2025-26							**SEM:VIII**					
S.No.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**CREDITS**	**Internal Assessment**			**External Assessment**	**Total**
	THEORY and PRACTICAL SUBJECTS			**L**	**T**	**P**		**Attendance (5)**	**Quiz/PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 16	**BSPY-801**	**Atomic and Molecular Physics**	4	0	0	4	5	10	15	70	100
2	Minor 10	**BSPY-802**	**Quantum Mechanics -II**	4	0	0	4	5	10	15	70	100
4	Research Project / Dissertation	**BSPY-803R**	**Dissertation**	2	0	0	12	5	10	15	70	100
TOTAL CREDITS / ASSESSMENT							**20**	**15**	**30**	**45**	**210**	**300**

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SEMESTER VII **Major Course -13**

Course Name: Mathematical Physics-II	**Course Code: BSPY-701**
Credits=L+T+P(4+0+0)	**Hours: 60**
Objectives: The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.	

Unit I: Fourier series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series.

Unit II: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials Zeros of Bessel Functions ($J_o(x)$ and $J_1(x)$) and Orthogonality.

Unit III: Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Unit IV: Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry. Solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes.

Course outcomes:

1. Understand and apply the concept of Fourier series to represent periodic functions and evaluate Fourier coefficients for both even and odd functions.
2. Solve second-order linear differential equations near singular points using the Frobenius method and analyze special functions like Legendre, Bessel, Hermite, and Laguerre functions.
3. Evaluate complex integrals using Beta and Gamma functions and understand their interrelation and applications in mathematical physics.
4. Solve partial differential equations using the method of separation of variables, with applications to Laplace's and wave equations in various geometries.
5. Apply mathematical methods involving special functions and PDEs to physical problems such as heat conduction, vibrations, and potential theory.

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Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole. Differential Equations, George F.
- Simmons, 2006, Tata McGraw-Hill.
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Mathematical methods for Scientists & Engineers, D.A.McQuarrie, 2003, Viva Books

SEMESTER VII **Major Course -13**

Course Name: Physics Practical Lab- VII	Course Code: BSPY-705P

Credit = L + T + P = (0 + 0 + 4)	Hours = 30

1. Design of a Regulated Power Supply.
2. To study the RC coupled amplifier.
3. Study of common Emitter Follower.
4. Study and Verification of Basic Logic gates.
5. To study the negative and positive clipping and clamping.

SEMESTER VII **Major Course -14**

Course Name: Quantum Mechanics I	Course Code: BSPY-702
Credits=L+T+P(4+0+0)	Hours=60
Objectives: To acquire basic knowledge about Schrodinger equation, bound states in an arbitrary potential and Quantum theory of hydrogen-like atoms.	

Unit I: Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions.Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions.

Unit II: Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states

Unit III: General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermitepolynomials; ground state, zero point energy & uncertainty principle.

Unit IV: Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground and first excited states;Orbital angular momentum quantum numbers l and m; s, p, d shells.

Course Outcome(s):

6. To develop knowledge and understanding of the concept that quantum states live in a vector space.
7. To solve quantum mechanics problems.
8. Formulation of Schrödinger equation-time dependent and time independent forms.
9. To derive energy Eigen value and eigen functions particle in a box and 1-D harmonic oscillator.
10. To formulate the Schrödinger wave equation in terms of spherical polar co-ordinates for its application to solve Hydrogen atom problem.

Reference Books:

- A Textbook of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley. Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

SEMESTER VII **Major Course Lab-14**

Course Name: Physics Practical Lab- VIII	**Course Code: BSPY-706P**

Credit = L + T + P = (0 + 0 + 4)	**Total Hours = 30**

1. To measure the value of energy band gap in Germanium material by four probe method.

2. To plot the V-I characteristics of a MOSFET.

3. To plot forward and reverse characteristics of SCR

4. To plot the V-I characteristics of FET

5. To study of the Hall coefficient and its applications

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SEMESTER VII **Major Course -15**

Course Name: PhotonicDevices	**Course Code: BSPY-703**
Credits=L+T+P(4+0+0)	**Hours=60**
Objectives: This paper aims to provide students with in-depth understanding of the principles, concepts,and applications of photonic devices and power electronics	

Unit– I

Classification of photonic devices: Radiative transition and optical absorption. Light Emitting Diodes(Construction, materials and operation) SemiconductorLASER:Conditionforamplification,lasercavity, LASER diode.

Unit– II

Photodetectors:Photoconductor,photodiodes(p-i-n,avalanche)andphototransistors,quantum efficiencyand responsivity, SolarCell:Construction,workingandcharacteristics.
LCDDisplays:Typesofliquidcrystals,PrincipleofLiquidCrystalDisplays,applications,advantagesoverLEDdispla ys.

Unit– III

Introduction to Fiber Optics: Element of an Optical Fiber Transmission link- Optical FiberModes and Configurations, Overview of Modes -Single Mode Fibers-Graded Index fiberstructure.

Unit– IV

PowerDevices:Needforsemiconductorpowerdevices,PowerMOSFET(qualitative);introductiontofamilyofthyristors;SiliconControlledRectifier(SCR)-structure,I-Vcharacteristics, Turn-On and Turn-Off characteristics, ratings, Gate-triggering circuits; DIACandTRIAC-Basicstructure, workingandV-Icharacteristics
Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switchingcharacteristics,devicelimitations and safeoperatingarea(SOA)

COURSEOUTCOMES (COs)

Upon completion of the course on Photonic Devices and Power Electronics, students areexpectedto achievethefollowinglearningoutcomes.

1. Understand the basic principles and concepts of photonic devices and power electronics,including semiconductor lasers, fiber optics, power diodes, power MOSFETs, and powerelectronicsapplications.
2. Develop the necessary knowledge and skills to design and analyse various photonic andpowerelectronicdevicesand systems.
3. Gainpracticalexperienceindevicedesign,fabrication,andcharacterization.
4. Applytheknowledgeandskillslearnedinthecoursetoreal-worldchallengesandopportunitiesin thefields ofphotonics and powerelectronics.
5. Develop problem-solving skills, critical thinking skills, and the ability to apply scientificandengineeringprinciples to practical problems.

References:

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- Optoelectronics,J.WilsonandJ.F.B.Hawkes,1996,PrenticeHall India
- Optoelectronics andPhotonics,S.O.Kasap,2009, PearsonEducation
- ElectronicDevicesandCircuits,D.A.Bell,2015,OxfordUniversityPress
- Introductiontofibreoptics,A.K.GhatakandK.Thyagarajan,1998,CambridgeUniversityPress
- PowerElectronics,M. D.SinghandK.B.Khanchandani,TataMcGrawHill.

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SEMESTER VII **Minor Course-9**

Course Name: ELECTRONIC DEVICES	**CourseCode:BSPY-704**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**
Course Objectives: Understanding functions of electronic devices and circuit logic.	

Unit I.Conduction Mechanism in Metals: Mobility and conductivity, Bound and free electrons, Energy distribution of electrons, Fermi level, the density of states, Thermionic emission.

Unit II.Conduction Mechanism in Semiconductors: Direct and indirect semiconductors, charge carriers concentrations, Drift of carriers in electric and magnetic fields, Diffusion of carriers, The contact potential.

Unit III.Semiconductor-diode characteristics: Qualitative theory of P-N junction, Space charge at a junction, Forward and reverse bias junctions, Reverse bias breakdown, Zener diode.

Unit IV.Bipolar Junction Transistors: Transistor current components, CB, CE, CC configurations, Input output characteristics, Early Effect, Graphical analysis of the CE configuration, Transistor hybrid model, h parameters, Analysis of a Transistor amplifier circuit using h parameters, Measurement and graphical determination of h parameters, Hybrid π model, The re transistor model, Ebers-Moll model, Transistor biasing and thermal stabilization, The operating point, Bias stability.

Course Outcomes:

1. Understand the conduction mechanism in metals and describe electron mobility, Fermi level, and thermionic emission based on the energy distribution of electrons.
2. Analyze the conduction processes in semiconductors including carrier drift and diffusion, and evaluate carrier concentration in direct and indirect semiconductors under applied electric and magnetic fields.
3. Explain the qualitative and quantitative behavior of p-n junction diodes under forward and reverse bias, including Zener breakdown and its applications in voltage regulation.
4. Evaluate the operation of Bipolar Junction Transistors (BJT) in CB, CE, and CC configurations using input-output characteristics, h-parameters, and models like hybrid-π and Ebers-Moll for amplifier analysis.
5. Understand the construction and operation of JFETs and MOSFETs, including various biasing techniques, small-signal models, and applications such as voltage-controlled resistors and amplifiers.

Text and Reference Books:

- Solid State Electronic Devices by B.G. Streetman
- Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
- Integrated Electronics by J. Millman and C.C. Halkias
- Introduction to Semiconductor Devices by M. S. Tyagi
- Electronic Devices and Circuits by Balbir Kumar and S.B. Jain

SEMESTER VIII **Major Course -16**

Course Name: Atomic And Molecular Physics	Course Code: BSPY=801

Credit = L + T + P = (4 + 0+ 0)	Total Hours = 60
Course Objectives: Objective of this course is to learn atomic, molecular and spin resonance spectroscopy, atomic theory and spectroscopic techniques that is required in physics, enhance problem solving skills, the ability to formulate different spectroscopy.	

Unit I.

Quantum Mechanical Treatment of one-electron Atom, Spin-Orbit interaction and fine structure of hydrogen atom, Spectra of alkali elements. Singlet and triplet States of Helium,

Unit II. Many electron atoms: Central field approximation, Thomas-Fermi field, atomic wave function, Hartree and Hartree –Fock approximations, Spectroscopic Terms: L S and J J coupling schemes for many electron atoms, wavefunctions and energies of multiples., Electric dipole and Electric Quadrupole.

Unit III. Born - Oppenheimer approximation, Heitler-London theory of H_2, Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Selection rules, nuclear spin and intensity alternation, Isotope effect, Classification of electronic states, Coupling of rotational and electronic motions, electronic spectra: Franck-Condon principle.

Unit IV. Infrared Spectroscopy, Raman spectroscopy, Photoelectron Spectroscopy, Nuclear Magnetic Resonance, Chemical Shift, and Electron Spin Resonance (Introduction and their principles only).

Course Outcomes:

1. Understand and apply quantum mechanical models to one-electron atoms, analyze fine structure due to spin-orbit coupling, and interpret spectra of hydrogen and alkali elements.
2. Analyze many-electron atoms using central field approximation, Hartree and Hartree-Fock methods, and distinguish between L-S and J-J coupling schemes and their spectroscopic implications.
3. Apply the Born-Oppenheimer approximation and Heitler-London theory to molecular systems, and explain the origin and characteristics of molecular spectra, including rotational and vibrational spectra.
4. Interpret Raman scattering, isotope effects, nuclear spin effects, and electronic transitions using the Franck-Condon principle and understand the coupling between rotational and electronic motions.
5. Describe the basic principles and applications of modern spectroscopic techniques such as Infrared (IR), Raman, Photoelectron Spectroscopy (PES), Nuclear Magnetic Resonance (NMR), and Electron Spin Resonance (ESR).

Text and Reference Books

- Introduction to atomic spectra by H.E. White

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- Spectra of diatomic molecules by Herzberg
- Atoms and molecules by M. Weissbluth
- Quantum theory of Atomic Structure Vol I by Slater
- Quantum theory of molecules and Solids by Slater
- Fundamentals of molecular spectroscopy by C.B.Banwell
- Introduction to molecular spectroscopy by G.M.Barrow
- Molecular spectroscopy by Jeanne L.McHale
- Molecular spectroscopy by J.M.Brown
- Spectra of atoms and molecules by P.F. Bemath

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SEMESTER VIII **Minor Course-10**

Course Name: QUANTUM MECHANICS- II	**Course Code: BSPY-802**

Credit = L + T + P = (4 + 1 + 0)	**Total Hours = 60**
Course Objectives: To impart knowledge of advanced quantum mechanics for solving relevant physical problems. To develop expertise in Quantum theory and techniques that are required in physics. enhance problem solving skills. the ability to formulate, interpret and draw inferences from Dirac solutions.	

Unit I. Time dependent Perturbation Theory: First order perturbation, Interation of an atom with electromagnetic field, Transition probabilities, Fermi Golden rule, Dipole approximation.

Unit II. Induced and Spontaneous radiation: Einstein A and B coefficients, Induced and spontaneous emissions of radiation, their applications in the construction of gas and solid lasers.

Unit III. Quantum Theory of Radiation: Classical radiation field, Fourier decomposition and radiation oscillators, Creation, annihilation and number operators, Photon states, Quantized radiation field, Basic matrix elements for emission and absorption, Spontaneous emission in the dipole approximation, Plank's radiation law.

Unit IV. Relativistic Equations: Klein-Gordon equation and its plane wave solution, Probability density in KG theory, Difficulties in KG equation, Dirac equation for a free electron, Dirac matrices and spinors, Plane wave solutions, Charge and current densities, Existence of spin and magnetic moment from Dirac equation of electron in an electromagnetic field.Dirac Equation: Dirac equation for central field with spin orbit interaction, Energy levels of Hydrogen atom from the solution of Dirac equation, covariant form of Dirac equation.

Course Outcomes:

1. Apply time-dependent perturbation theory to atomic systems and evaluate transition probabilities using Fermi's Golden Rule and the dipole approximation.
2. Understand the principles of induced and spontaneous radiation and apply Einstein's coefficients to explain the working principles of gas and solid-state lasers.
3. Analyze the quantization of the radiation field, construct photon states using creation and annihilation operators, and derive Planck's radiation law.
4. Derive and interpret the Klein-Gordon and Dirac equations, analyze their plane wave solutions, and understand the implications for spin, probability density, and current.
5. Solve the Dirac equation for a central field with spin-orbit interaction and derive relativistic corrections to hydrogen energy levels, including the covariant formulation.

Text and Reference Books

- Quantum Mechanics by L.I. Schiff
- Modern Quantum Mechanics by J.J. Sakurai
- A Text Book of Quantum Mechanics by P.M. Mathews and K.Venkatesan

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- Quantum Mechanics by A. P. Messiah

Research Project/ Dissertation	Code-BSPY-803R
Credit = L + T + P = (2 + 1 + 0)	

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