Kashi Naresh University, Bhadohi

Syllabus

of

Physics

(National Education Policy-2020)

Effective from Academic Session: 2026-27

For

B.Sc.

Approved by

Board of Studies
Department of Physics
Faculty of Science
Kashi Naresh University
Bhadohi

Kalpana
Convenor/Head
Department of Physics
Kashi Naresh University, Bhadohi

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Member of Board of Studies

Kashi Naresh University, Bhadohi laid down the following guidelines for three Years B.Sc. Programme:

Types of Courses:

Student has to choose two Major disciplines (subjects) from their faculty and study them for three years (six semesters).

Additionally, they will choose a minor discipline (subject) either from their faculty or from other faculties and study it for the even semesters of first two years (credits: 6+6).

Additional Course Requirements:

Every student must opt for the following courses:

- One Skill Enhancement course per semester from a pool of courses offered by the university in the first three semesters (Semesters I, II, III) of credit 3 (3+3+3).
- One Co-curricular course per semester from a pool of courses offered by the university in the first four semesters (Semesters I, II, III, IV) of credit 2 (2+2+2).

Course Structure for Three Years B.Sc. Programme (Physics)

YEAR	SEMESTER	COURSE CODE	PAPER TITLE	T / P	CREDIT	EVALUATION	
		CERTIFICATE -IN BASIC PHYSICS & SEMICONDUCTOR DEVICES				CIE	EE
FIRST YEAR	I	B010101T	Mathematical Physics & Newtonian Mechanics	T	4	25	75
		B010102P	Mechanical Properties of Matter	P	2	25	75
	II	B010201T	Thermal Physics & Semiconductor Devices	T	4	25	75
		B010202P	Thermal Properties of Matter & Electronic Circuits	P	2	25	75
		B010203MT	Minor Elective Paper	T	6	25	75
		DIPLOMA - IN APPLIED PHYSICS WITH ELECTRONICS					
SECOND YEAR	III	B010301T	Electromagnetic Theory & Modern Optics	T	4	25	75
		B010302P	Demonstrative Aspects of Electricity & Magnetism	P	2	25	75
	IV	B010401T	Perspectives of Modern Physics & Basic Electronics	T	4	25	75
		B010402P	Basic Electronics Instrumentation	P	2	25	75
		B010403MT	Minor Elective Paper	T	6	25	75
		B010404RP	Research Project	-----	3	100	
		DEGREE -IN BACHELOR OF SCIENCE					
THIRD YEAR	V	B010501T	Classical & Statistical Mechanics	T	4	25	75
		B010502T	Quantum Mechanics & Spectroscopy	T	4	25	75
		B010503P	Demonstrative Aspects of Optics & Lasers	P	2	25	75
	VI	B010601T	Solid State & Nuclear Physics	T	4	25	75
		B010602T	Analog & Digital Principles & Applications	T	4	25	75
		B010603P	Analog & Digital Circuits	P	2	25	75

Note:
T/P: Theory / Practical
EE: External evaluation and respective examination will be conducted by the university
CIE: Continuous internal evaluation

Internal evaluation for theory paper		Practical Evaluation & Assessment (25+75)			
Assessment	Marks (25)	Internal Assessment	Marks (25)	External Assessment *Student has to perform one experiment in examination*	Marks (75)
Test/Quiz	10	Record file (*No. of experiments performed from the total assigned experiments)*	15	Experiment	40
Assignment/Presentation/Project /seminar	10	Viva voce	05	Viva voce	20
Class performance	05	Class performance	05	Record file	15

SUBJECT PREREQUISITES

To study this subject, a student must have had the subjects **Physics & Mathematics** in class 12^{th}.

PROGRAMME OUTCOMES (POs)

Physics is a basic science; it attempts to explain the natural phenomenon in as simple a manner as possible. The starting point of all physics lies in experience. Experiment, whether done outside or in the laboratory, is an important ingredient of learning physics and hence the present programme integrates six experimental physics papers focusing on various aspects of modern technology based equipments. Following are the POs for Students having degree in B.Sc. (with Physics)

- The main aim of this programme is to help cultivate the love for nature and its manifestations, to transmit the methods of science to observe things around, to do intelligent guessing, to formulate a theory & model, and at the same time, to hold an element of doubt and thereby to hope to modify it in terms of future experience and thus to practice a pragmatic outlook.
- The programme intends to nurture the proficiency in functional areas of Physics, which is in line with the international standards, aimed at realizing the goals towards skilled India.
- Keeping the application-oriented training in mind; this programme aims to give students the competence in the methods and techniques of theoretical, experimental and computational aspects of Physics so as to achieve an overall understanding of the subject for holistic development. This will cultivate in specific application-oriented training leading to their goals of employment.
- The Bachelor's Project (Industrial Training / Survey / Research Project) is intended to give an essence of research work for excellence in explicit areas.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

CERTIFICATE
IN BASIC PHYSICS & SEMICONDUCTOR DEVICES

FIRST YEAR

- This programme aims to give students the competence in the methods and techniques of calculations using Newtonian Mechanics and Thermodynamics. At the end of the course the students are expected to have hands on experience in modeling, implementation and calculation of physical quantities of relevance.
- An introduction to the field of Circuit Fundamentals and Basic Electronics which deals with the physics and technology of semiconductor devices is practically useful and gives the students an insight in handling electrical and electronic instruments.
- Experimental physics has the most striking impact on the industry wherever the instruments are used. The industries of electronics, telecommunication and instrumentation will specially recognize this course.

DIPLOMA
IN APPLIED PHYSICS WITH ELECTRONICS

SECOND YEAR

- This programme aims to introduce the students with Electromagnetic Theory, Modern Optics and Relativistic Mechanics. Electromagnetic Wave Propagation serves as a basis for all communication systems and deals with the physics and technology of semiconductor optoelectronic devices. A deeper insight in Electronics is provided to address the important components in consumer Optoelectronics, IT and Communication devices, and in industrial instrumentation.
- The need of Optical instruments and Lasers is surely highlighted everywhere and at the end of the course the students are expected to get acquaint with applications of Lasers in technology.
- Companies and R&D Laboratories working on Electromagnetic properties, Laser Applications, Optoelectronics and Communication Systems are expected to value this course.

DEGREE
IN BACHELOR OF SCIENCE

THIRD YEAR

- This programme contains very important aspects of modern-day course curriculum, namely, Classical, Quantum and Statistical computational tools required in the calculation of physical quantities of relevance in interacting many body problems in physics. It introduces the branches of Solid State Physics and Nuclear Physics that are going to be of utmost importance at both undergraduate and graduate level. Proficiency in this area will attract demand in research and industrial establishments engaged in activities involving applications of these fields.
- This course amalgamates the comprehensive knowledge of Analog & Digital Principles and Applications. It presents an integrated approach to analog electronic circuitry and digital electronics.
- Present course will attract immense recognition in R&D sectors and in the entire cutting edge technology based industry.

First Year

Detailed Syllabus for

Certificate

in

Basic Physics and Semiconductor Devices

Programme/ Class: Certificate	Year: **First**	Semester: **First**
Course Code: **B010101T**	Course Title: **Mathematical Physics & Newtonian Mechanics**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: 25+75

Course Outcomes (COs)

- Recognize the difference between scalars, vectors, pseudo-scalars and pseudo-vectors.
- Understand the physical interpretation of gradient, divergence and curl.
- Comprehend the difference and connection between Cartesian, spherical and cylindrical coordinate systems.
- Know the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors.
- Study the origin of pseudo forces in rotating frame.
- Study the response of the classical systems to external forces and their elastic deformation.
- Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).
- Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

PART A: Basic Mathematical Physics

Unit- I: Vector Algebra

Coordinate rotation, reflection and inversion as the basis for defining scalars, vectors, pseudo-scalars and pseudo-vectors (include physical examples). Component form in 2D and 3D. Geometrical and physical interpretation of addition, subtraction, dot product, wedge product, cross product and triple product of vectors. Position, separation and displacement vectors.

Unit- II: Vector Calculus

Geometrical and physical interpretation of vector differentiation, Gradient, Divergence, and Curl, and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gradient theorem, Gauss-divergence theorem, Stoke-curl theorem, Greens theorem and Helmholtz theorem (statement only). Introduction to Dirac delta function.

Unit- III: Coordinate Systems

2D & 3D Cartesian, Spherical and Cylindrical coordinate systems, basis vectors, transformation equations. Expressions for displacement vector, arc length, area element, volume element, gradient, divergence and curl in different coordinate systems. Components of velocity and acceleration in different coordinate systems. Examples of non-inertial coordinate system and pseudo-acceleration.

Unit- IV: Introduction to Tensors

Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. Coordinate transformations for general spaces of nD, contravariant, covariant & mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew-symmetric tensors. Invariant tensors, Kronecker delta and Epsilon (Levi Civita) tensors. Examples of tensors in physics.

PART B: Newtonian Mechanics & Wave 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 problem, 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.

Suggested Readings

- J.C. Upadhyaya, "Mathematical Physics & Newtonian Mechanics", Ram Prasad Publication, 1905
- A.W. Joshi, "Matrices and Tensors in Physics", New Age International Private Limited, 1995, 3e
- Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017, 2e
- Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017, 14e
- D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e
- S. Hemne, C.L. Arora, "Mathematical Physics and Newtonian Mechanics" S. Chand, 2022

Suggestive Digital Platforms / Web Links

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Course Code: **B010102P**	Course Title: **Mechanical Properties of Matter**	Credits: **2**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**		Max. Marks: 25+75

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Lab Experiment List

1. Acceleration due to gravity by bar pendulum
2. Moment of inertia of a flywheel
3. Moment of inertia of an irregular body by inertia table
4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle)
5. Young's modulus by bending of beam
6. Elastic constants by Searle's apparatus.
7. Surface tension of water by Jaeger's method
8. Surface tension of water by capillary rise method
9. Coefficient of viscosity of water by Poiseuille's method
10. Frequency of AC mains by Sonometer
11. Height of a building by Sextant
12. Frequency of an electrically maintained tuning fork by Melde's Experiments

Online Virtual Lab Experiment List / Link:

Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/?sub=1&brch=74

Virtual Labs an initiative of MHRD Govt. of India
http://www.vlab.co.in

Web Links of other virtual labs may be suggested by individual intuitions.

1. Torque and angular acceleration of a fly wheel
2. Torsional oscillations in different liquids
3. Moment of inertia of flywheel
4. Newton's second law of motion
5. Ballistic pendulum
6. Collision balls
7. Projectile motion
8. Elastic and inelastic collision

Suggested Readings:

- B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
- 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

Further Suggestions:

- The institution may add / modify / change the experiments of the same standard in the subject.
- The institution may suggest a minimum number of experiments (05) to be performed by each student per semester from the Lab Experiment List.
- The institution may suggest a minimum number of experiments (02) to be performed by each student per semester from the Online Virtual Lab Experiment List.

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**
Course Code: **B010201T**	Course Title: **Thermal Physics & Semiconductor Devices**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: **25+75**

Course Outcomes (COs)

- Recognize the difference between reversible and irreversible processes.
- Understand the physical significance of thermodynamical potentials.
- Comprehend the kinetic model of gases with respect to various gas laws.
- Study the implementations and limitations of fundamental radiation laws.
- Utility of AC bridges.
- Recognize the basic components of electronic devices.
- Design simple electronic circuits.
- Understand the applications of various electronic instruments.

PART A
Thermodynamics & Kinetic Theory of Gases

Unit-I: 0^{th} & 1^{st} Law of Thermodynamics

State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between C_P and C_V. Carnot's engine, efficiency and Carnot's theorem. Efficiency of internal combustion engines (Otto and diesel).

Unit-II:2^{nd} & 3^{rd} Law of Thermodynamics

Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermodynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermodynamical potentials, Maxwell's relations, conditions for feasibility of a process and equilibrium of a system. Clausius- Clapeyron equation, Joule-Thompson effect.

Unit-III: Kinetic Theory of Gases

Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).

Unit-IV: Theory of Radiation

Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan-Boltzman law and Wien's displacement law from Planck's law.

PART B
Circuit Fundamentals & Semiconductor Devices

Unit-I: DC & AC Circuits

Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. Network Analysis - Superposition, Reciprocity, Thevenin's and Norton's theorems. AC Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges).

Unit II: Semiconductors & Diodes

P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.

Unit III: Transistors

Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff & saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time. DC Load Line analysis and Q-point stabilisation. Voltage Divider Bias circuit for CE amplifier. Qualitative discussion of RC coupled amplifier (frequency response not included).

Unit IV: Electronic Instrumentation

Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (no mathematical treatment). Front panel controls, special features of dual trace CRO, specifications of a CRO and their significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.

Suggested Readings

- M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
- F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
- Enrico Fermi, "Thermodynamics", Dover Publications, 1956
- S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
- Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e
- J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
- B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
- Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e
- S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
- S. Hemne, C.L. Arora, "Thermal Physics and Semiconductor Devices" S. Chand, 2022

Suggestive Digital Platforms / Web Links

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**
Course Code: **B010202P**	Course Title: **Thermal Properties of Matter & Electronic Circuits**	Credits: **2**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**		Max. Marks: **25+75**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the thermal and electronic properties. Measurement precision and perfection is achieved through lab experiments. Online virtual lab experiments give an insight in simulation techniques and provide a basis for modeling.

Lab Experiment List

1. Coefficient of thermal conductivity of copper by Searle's apparatus
2. Coefficient of thermal conductivity of rubber
3. Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method
4. Value of Stefan's constant
5. Verification of Stefan's law
6. A.C. Bridges: Various experiments based on measurement of L and C
7. Study the behavior of LCR circuit
8. Characteristics of PN Junction, Zener, Tunnel, Light Emitting and Photo diode
9. Characteristics of a transistor (PNP and NPN) in CE, and CB configurations
10. Half wave & full wave rectifiers and Filter circuits
11. Resonance in series and parallel RCL circuit
12. Unregulated and Regulated power supply
13. Various measurements with Cathode Ray Oscilloscope (CRO)
14. Thevenin's and Norton's, Maximum Power Transfer theorems

Online Virtual Lab Experiment List / Link:

Virtual Labs at Amrita Vishwa Vidyapeetham

https://vlab.amrita.edu/?sub=1&brch=194

Virtual Labs an initiative of MHRD Govt. of India

http://www.vlab.co.in

Web Links of other virtual labs may be suggested by individual intuitions.

Thermal Properties of Matter:

1. Heat transfer by radiation
2. Heat transfer by conduction
3. Heat transfer by natural convection
4. The study of phase change
5. Black body radiation: Determination of Stefan's constant
6. Newton's law of cooling
7. Lee's disc apparatus
8. Thermo-couple: Seebeck effects

Semiconductor Devices:

9. Ohm's Law
10. RC Differentiator and integrator
11. VI characteristics of a diode

12. Half & Full wave rectification
13. Capacitative rectification
14. Zener Diode voltage regulator
15. BJT common emitter characteristics
16. BJT common base characteristics
17. Studies on BJT CE amplifier

Suggested Readings

- 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

Further Suggestions:

- The institution may add / modify / change the experiments of the same standard in the subject.
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- The institution may suggest a minimum number of experiments (02) to be performed by each student per semester from the Online Virtual Lab Experiment List.

Second Year
Detailed Syllabus for

Diploma
in
Applied Physics with Electronics

Programme/ Class: **Diploma**	Year: **Second**	Semester: **Third**
Course Code: **B010301T**	Course Title: **Electromagnetic Theory & Modern Optics**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: **25+75**

Course Outcomes (COs)

- Better understanding of electrical and magnetic phenomenon in daily life.
- To troubleshoot simple problems related to electrical devices.
- Comprehend the powerful applications of ballistic galvanometer.
- Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).
- Study the working and applications of Michelson and Fabry-Perot interferometers.
- Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.
- Comprehend the use of polarimeters.
- Study the characteristics and uses of lasers.

PART A
Electromagnetic Theory

Unit- I: Electrostatics

Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field **D** (Electric displacement), electric susceptibility and permittivity.

Unit-II: Magnetostatics

Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetisation, auxiliary field **H**, magnetic susceptibility and permeability.

Unit-III: Time Varying Electromagnetic Fields

Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included).

Unit-IV: Electromagnetic Waves

Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law.

PART B
Physical Optics & Lasers

Unit-I: Interference

Conditions for interference and spatial & temporal coherence. Division of Wave front - 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

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

Polarisation by dichronic crystals, birefringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartz polarimeters.

Unit-IV: Lasers

Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems (qualitative discussion).

Suggested Readings

- D.J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
- D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e
- Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e
- A. Ghatak, "Optics", McGraw Hill, 2017, 6e
- J.P. Agarwal, A. Agarwal, "Electromagnetic Theory and Modern Optics", Pragati Prakashan, 2017
- P.S. Hemne, C.L. Arora, "Electromagnetic Theory and Modern Optics" S. Chand, 2022
- K. Thyagarajan and A. K. Ghatak, "Lasers: Fundamentals and Applications", Springer

Suggestive Digital Platforms / Web Links

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Programme/Class: **Diploma**	Year: **Second**	Semester: **Third**
Course Code: **B010302P**	Course Title: **Demonstrative Aspects of Electricity & Magnetism**	Credits: **2**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**		Max. Marks: **25+75**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the electric and magnetic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Lab Experiment List

1. Variation of magnetic field along the axis of single coil
2. Variation of magnetic field along the axis of Helmholtz coil
3. Ballistic Galvanometer: High resistance by Leakage method
4. Ballistic Galvanometer: Capacity of Condenser
5. Ballistic Galvanometer: Mutual Inductance
6. Carey Foster Bridge: Resistance per unit length and low resistance
7. Low resistance with the help of Students Potentiometer
8. Specific resistance (resistivity) of a given wire using P.O.Box .
9. Specific charge (e/m) of an electron using magnetron tube

Online Virtual Lab Experiment List/ Link:

Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/?sub=1&brch=194
Virtual Labs an initiative of MHRD Govt. of India
http://www.vlab.co.in
Web Links of other virtual labs may be suggested by individual intuitions.

1. Tangent galvanometer
2. Magnetic field along the axis of a circular coil carrying current
3. Deflection magnetometer
4. Van de Graaff generator
5. Barkhausen effect
6. Temperature coefficient of resistance
7. Anderson's bridge
8. Quincke's method

Suggested Readings

- B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
- 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

Further Suggestions:

- The institution may add / modify / change the experiments of the same standard in the subject.
- The institution may suggest a minimum number of experiments (05) to be performed by each student per semester from the Lab Experiment List.
- The institution may suggest a minimum number of experiments (02) to be performed by each student per semester from the Online Virtual Lab Experiment List.

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Course Code: **B010401T**	Course Title: **Perspectives of Modern Physics & Basic Electronics**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: **25+75**

Course Outcomes (COs)

- Recognize the difference between the structure of space & time in Newtonian & Relativistic mechanics.
- Understand the physical significance of consequences of Lorentz transformation equations.
- Comprehend the wave-particle duality.
- Develop an understanding of the foundational aspects of Quantum Mechanics.
- Study the comparison between various biasing techniques.
- Study the classification of amplifiers.
- Comprehend the use of feedback and oscillators.
- Comprehend the theory and working of optical fibers along with its applications.

PART A
Perspectives of Modern Physics

Unit-I: Relativity-Experimental Background

Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Newtonian relativity. Galilean transformation and Electromagnetism. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity.

Unit-II: Relativity-Relativistic Kinematics

Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations (4-vector formulation included). Consequences of Lorentz Transformation Equations (derivations & examples included): Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass (Variation of mass with velocity). Relation between Energy & Mass (Einstein's mass & energy relation) and Energy & Momentum.

Unit -III: Inadequacies of Classical Mechanics

Particle Properties of Waves: Spectrum of Black Body radiation, Photoelectric effect, Compton effect and their explanations based on Max Planck's Quantum hypothesis.

Wave Properties of Particles: Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment and Thomson's experiment.

Unit IV: Introduction to Quantum Mechanics

Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function: Functional form, Normalisation of wave function, Orthogonal & Orthonormal wave functions and Probabilistic interpretation of wave function based on Born Rule.

PART B
Basic Electronics & Introduction to Fiber Optics

Unit-I: Transistor Biasing

Faithful amplification & need for biasing. Stability Factors and its calculation for transistor biasing circuits for CE configuration: Fixed Bias (Base Resistor Method), Emitter Bias (Fixed Bias with Emitter Resistor), Collector to Base Bias (Base Bias with Collector Feedback) &, Voltage Divider Bias. Discussion of Emitter-Follower configuration.

Unit-II: Amplifiers

Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade & cascode connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification) and Frequency capabilities (AF, IF, RF & VF).

Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, and Frequency response) and Transformer coupled power amplifier (calculation of Power, Effect of temperature, Use of heat sink & Power dissipation).

Calculation of Amplifier Efficiency (power efficiency) for Class A Series-Fed, Class A Transformer Coupled, Class B Series-Fed and Class B Transformer Coupled amplifiers.

Unit-III: Feedback & Oscillator Circuits

Feedback Circuits: Effects of positive and negative feedback. Voltage Series, Voltage Shunt, Current Series and Current Shunt feedback connection types and their uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and Band Width for Voltage Series negative feedback and their comparison between different negative feedback connection types.

Oscillator Circuits: Use of positive feedback for oscillator operation. Barkhausen criterion for self-sustained oscillations. Feedback factor and frequency of oscillation for RC Phase Shift oscillator and Wein Bridge oscillator. Qualitative discussion of Reactive Network feedback oscillators (Tuned oscillator circuits): Hartley & Colpitt oscillators.

Unit IV: Introduction to Fiber Optics

Basics of Fiber Optics, step index fiber, graded index fiber, light propagation through an optical fiber, acceptance angle & numerical aperture, qualitative discussion of fiber losses and applications of optical fibers.

Suggested Readings

- A. Beiser, Shobhit Mahajan, "Concepts of Modern Physics: Special Indian Edition", McGraw Hill, 2009, 6e
- R.A. Serway, C.J. Moses, and C.A. Moyer, "Modern Physics", Cengage Learning India Pvt. Ltd, 2004, 3e
- R. Resnick, "Introduction to Special Relativity", Wiley India Private Limited, 2007
- R. Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
- J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
- S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
- P.S. Hemne, C.L. Arora, "Perspectives of Modern Physics and Basic Electronics" S. Chand, 2023

Suggestive Digital Platforms / Web Links

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Course Code: **B010402P**	Course Title: **Basic Electronics Instrumentation**	Credits: **2**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**		Max. Marks: **25+75**

Course Outcomes (COs)

Basic Electronics instrumentation has the most striking impact on the industry wherever the components / instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Lab Experiment List

1. Transistor Bias Stability
2. Comparative Study of CE, CB and CC amplifier
3. Frequency response of single stage RC coupled amplifier
4. Frequency response of single stage Transformer coupled amplifier
5. Clippers and Clampers
6. Study of Emitter Follower
7. Characteristics of semiconductor Photo Diode in presence of light and in absence of light
8. Study of Hartley oscillator
9. Study of Wein Bridge oscillator

Online Virtual Lab Experiment List / Link:

Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/psac/#

1. Diode as Clippers
2. Diode as Clampers
3. BJT as switch and Load Lines

Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/be/#

4. RC frequency response

Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/index.php?sub=1&brch=201

5. Hartley oscillator
6. Colpitt oscillator

Virtual Labs at Amrita Vishwa Vidyapeetham
http://vlab.amrita.edu/index.php?sub=59&brch=269

7. Fiber Optic Analog and Digital Link
8. Fiber Optic Bi-directional Communication
9. Wavelength Division Multiplexing

10. Measurement of Bending Losses in Optical Fiber
11. Measurement of Numerical Aperture
12. Study of LED and Detector Characteristics

Web Links of other virtual labs may be suggested by individual intuitions.

Suggested Readings
• R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e • J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e • S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
Further Suggestions: • The institution may add / modify / change the experiments of the same standard in the subject. • The institution may suggest a minimum number of experiments (05) to be performed by each student per semester from the Lab Experiment List. • The institution may suggest a minimum number of experiments (02) to be performed by each student per semester from the Online Virtual Lab Experiment List.

Year: **Second**		Semester: **Fourth**
Course Code: **B010404RP**	Course Title: **Research Project Work**	Max. Marks: **100**

Course Objective:

- Develop the ability to conduct independent research in a specific area of physics.
- Enhance critical thinking skills by analyzing and evaluating existing literature and experimental data.
- Demonstrate the capacity to solve complex physics problems related to the chosen topic.
- Improve scientific writing skills, including the ability to clearly and concisely communicate research findings through oral presentations and written reports
- Gain proficiency in data analysis techniques and the use of relevant software and tools.

Note:

- This research project may be interdisciplinary.
- The research project will be done under the supervision of a teacher. Another co-supervisor may be taken from any industry/ university/ technical institute/research institute etc.
- Evaluated by internal faculty.

Third Year

Detailed Syllabus for

Degree

in

Bachelor of Science

Programme/Class: **Degree**	Year: **Third**	Semester: **Fifth**
Course Code: **B010501T**	Course Title: **Classical & Statistical Mechanics**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: **25+75**

Course Outcomes (COs)

- Understand the concepts of generalized coordinates and D'Alembert's principle.
- Understand the Lagrangian dynamics and the importance of cyclic coordinates.
- Comprehend the difference between Lagrangian and Hamiltonian dynamics.
- Study the important features of central force and its application in Kepler's problem.
- Recognize the difference between macrostate and microstate.
- Comprehend the concept of ensembles.
- Understand the classical and quantum statistical distribution laws.
- Study the applications of statistical distribution laws.

PART A
Introduction to Classical Mechanics

Unit -I: Constrained Motion

Constraints - Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalised notations & relations. Principle of Virtual work and D'Alembert's principle.

Unit -II: Lagrangian Formalism

Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.

Unit -III: Hamiltonian Formalism

Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian & Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.

Unit -IV: Central Force

Definition and properties (with prove) of central force. Equation of motion and differential equation of orbit. Bound & unbound orbits, stable & non-stable orbits, closed & open orbits and Bertrand's theorem. Motion under inverse square law of force and derivation of Kepler's laws. Laplace-Runge-Lenz vector (Runge-Lenz vector) and its applications.

PART B

Introduction to Statistical Mechanics

Unit- I: Macrostate & Microstate

Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D.

Unit -II: Concept of Ensemble

Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.

Unit-III: Distribution Laws

Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in i^{th} state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac statistics. Comparison of statistical distribution laws and their physical significance.

Canonical Distribution Law: Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.

Unit- IV: Applications of Statistical Distribution Laws

Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law.

Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and concept of Density of States (Density of Orbitals).

Suggested Readings

- Herbert Goldstein, Charles P. Poole, John L. Safko, "Classical Mechanics", Pearson Education, India, 2011, 3e
- N.C. Rana, P.S. Joag, "Classical Mechanics", McGraw Hill, 2017
- R.G. Takwale, P.S. Puranik, "Introduction to Classical Mechanics", McGraw Hill, 2017
- B.B. Laud, "Fundamentals of Statistical Mechanics", New Age International Private Limited, 2020, 2e
- B.K. Agarwal, M. Eisner, "Statistical Mechanics", New Age International Private Limited, 2007, 2e
- P.S. Hemne, C.L. Arora, "Quantum Mechanics and Spectroscopy" S. Chand, 2023

Suggestive Digital Platforms / Web Links

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Programme/Class: **Degree**	Year: **Third**	Semester: **Fifth**
Course Code: **B010502T**	Course Title: **Quantum Mechanics & Spectroscopy**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: **25+75**

Course Outcomes (COs)

- Understand the significance of operator formalism in Quantum mechanics.
- Study the eigen and expectation value methods.
- Understand the basis and interpretation of Uncertainty principle.
- Develop the technique of solving Schrodinger equation for 1D and 3D problems.
- Comprehend the success of vector atomic model in the theory of atomic spectra.
- Study the different aspects of spectra of Group I & II elements.
- Study the production and applications of X-rays.
- Develop an understanding of the fundamental aspects of Molecular spectra.

PART A

Introduction to Quantum Mechanics

Unit -I: Operator Formalism

Operators: Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables.

Commutators: Definition, commutator algebra and commutation relations among position, linear momentum & angular momentum and energy & time. Simple problems based on commutation relations.

Unit-II: Eigen & Expectation Values

Eigen & Expectation Values: Eigen equation for an operator, Eigen state (value) and Eigen functions. Linear superposition of Eigen functions and Non-degenerate & Degenerate Eigen states. Expectation value pertaining to an operator and its physical interpretation.

Hermitian Operators: Definition, properties and applications. Prove of the Hermitian nature of various physical-dynamical operators.

Unit-III: Uncertainty Principle & Schrodinger Equation

Uncertainty Principle: Commutativity & simultaneity (theorems with proofs). Non-commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical-dynamical parameters and its applications.

Schrodinger Equation: Derivation of time independent & time dependent forms, Schrodinger equation as an Eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation.

Unit- IV: Applications of Schrodinger Equation

Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator.

Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included). (Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted) .

PART B

Introduction to Spectroscopy

Unit-I: Vector Atomic Model

Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & jj couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.

Unit-II: Spectra of Alkali & Alkaline Elements

Spectra of alkali elements: Screening constants for s, p, d & f orbitals; sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line.

Spectra of alkaline elements: Singlet and triplet structure of spectra.

Unit-III:X-Rays & X-Ray Spectra

Nature & production, Continuous X-ray spectrum & Duane-Hunt's law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.

Unit-IV: Molecular Spectra

Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Rotational-Vibrational spectra; transition rules; fundamental band & hot band; O, P, Q, R, S branches.

Suggested Readings

- D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
- R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
- H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
- C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw Hill, 2017, 4e
- S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e

Programme/Class: **Degree**	Year: **Third**	Semester: **Fifth**
Course Code: **B010503P**	Course Title: **Demonstrative Aspects of Optics & Lasers**	Credits: **2**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**		Max. Marks: **25+75**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the optical properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Lab Experiment List:

1. Focal length of thin lenses and their combination by Nodal slide.
2. Fresnel Biprism: Wavelength of sodium light
3. Newton's Rings: Wavelength of sodium light
4. Newton's Rings: Refractive index of liquid
5. Plane Diffraction Grating: Resolving power
6. Plane Diffraction Grating: Spectrum of mercury light
7. Spectrometer: Refractive index of the material of a prism using sodium light
8. Spectrometer: Dispersive power of the material of a prism using mercury light
9. Polarimeter: Specific rotation of sugar solution
10. Wavelength of Laser light using diffraction by single slit

Online Virtual Lab Experiment List/ Link:

Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=189

1. Michelson's Interferometer
2. Michelson's Interferometer: Wavelength of laser beam
3. Newton's Rings: Wavelength of light
4. Newton's Rings: Refractive index of liquid
5. Brewster's angle determination
6. Laser beam divergence and spot size

Virtual Labs at Amrita Vishwa Vidyapeetham

https://vlab.amrita.edu/index.php?sub=1&brch=281

7. Spectrometer: Refractive index of the material of a prism
8. Spectrometer: Dispersive power of a prism
9. Spectrometer: Determination of Cauchy's constants
10. Diffraction Grating

Web Links of other virtual labs may be suggested by individual intuitions.

Suggested Readings

- 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

Further Suggestions:

- The institution may add / modify / change the experiments of the same standard in the subject.
- The institution may suggest a minimum number of experiments (05) to be performed by each student per semester from the Lab Experiment List.
- The institution may suggest a minimum number of experiments (02) to be performed by each student per semester from the Online Virtual Lab Experiment List.

Programme/Class: **Degree**	Year: **Third**	Semester: **Sixth**
Course Code: **B010601T**	Course Title: **Solid State & Nuclear Physics**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: **25+75**

Course Outcomes (COs)

- Understand the crystal geometry w.r.t. symmetry operations.
- Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
- Study various properties based on crystal bindings.
- Recognize the importance of Free Electron & Band theories in understanding the crystal properties.
- Understand the importance of nuclear models, nuclear reactions and the working and applications of nuclear accelerators and detectors.
- Understand the classification and properties of basic building blocks of nature.

PART A
Introduction to Solid State Physics

Unit-I: Crystal Structure

Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations, Point group & Space group. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP & FCC, Diamond, Cubic Zinc Sulphide, Sodium Chloride, Cesium Chloride and Glasses.

Unit-II: Crystal Diffraction

X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Diffraction conditions, Ewald's method and Brillouin zones. Reciprocal lattice to SC, BCC & FCC lattices. Atomic Form factor and Crystal Structure factor.

Unit-III: Crystal Bindings

Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals-London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant.

Unit-IV: Lattice Vibrations

Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains, Dispersion relations and Acoustical & Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Dulong-Petit's law and Einstein's theory of lattice heat capacity.

Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals.

Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effectice mass of an electron & Concept of Holes & Classification of solids on the basis of band theory.

PART B

Introduction to Nuclear Physics

Unit-I: Nuclear Forces & Radioactive Decays

General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor.

Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties.

Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay & electron capture, fundamental laws of radioactive disintegration and radioactive series.

Unit-II: Nuclear Models & Nuclear Reactions

Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model (the level scheme in the context of reproduction of magic numbers included).

Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion.

Unit-III: Accelerators & Detectors

Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.

Unit-IV: Elementary Particles

Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model.

Suggested Readings

- Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2012, 8e
- R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015
- Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
- Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
- S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019
- R.K. Verma, S. Tomar, A.K. Srivastava, "Solid State and Nuclear Physics", Ram Prasad Publication,1905

Suggestive Digital Platforms / Web Links

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Programme/Class: **Degree**	Year: **Third**	Semester: **Sixth**
Course Code: B010602T	Course Title: **Analog & Digital - Principles & Applications**	Credits: **4**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**		Max. Marks: **25+75**

Course Outcomes (COs)

- Study the drift and diffusion of charge carriers in a semiconductor.
- Understand the Two-Port model of a transistor.
- Study the working, properties and uses of FETs.
- Comprehend the design and operations of SCRs and UJTs.
- Understand various number systems and binary codes.
- Familiarize with binary arithmetic.
- Study the working and properties of various logic gates.
- Comprehend the design of combinational and sequential circuits

PART A
Analog Electronic Circuits

Unit-I: Semiconductor Junction

Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors.

Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.

Unit-II: Transistor Modeling

Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).

Unit -III: Field Effect Transistors

JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs).

MOSFET: Construction and Working of DE-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of DE-MOSFET and E-MOSFET; Comparison of JFFET and MOSFET.

Unit -IV: Other Devices

SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger).
UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators).

PART B
Digital Electronics

Unit-I: Number System

Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion.

Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.

Unit-II: Binary Arithmetic

Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.

Unit-III: Logic Gates

Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as pairty checker. Boolean Algebra. Karnaugh Map.

Unit-IV: Combinational & Sequential Circuits

Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders.

Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.

Suggested Readings

- J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
- B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
- J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
- S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
- D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
- R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

Suggestive Digital Platforms / Web Links

- MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
- National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
- Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Programme/Class: **Degree**	Year: **Third**	Semester: **Sixth**
Course Code: **B010603P**	Course Title: **Analog & Digital Circuits**	Credits: **2**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**		Max. Marks: **25+75**

Course Outcomes (COs)

Analog & digital circuits have the most striking impact on the industry wherever the electronics instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Lab Experiment List

1. Verification of Richardson-Dushman equation and evaluation of work function of cathode material.
2. Characteristics of FET, MOSFET, SCR, UJT
3. Energy Band Gap of a P-N junction Diode
4. Hybrid parameters of transistor
5. Verification of truth table of OR, AND and NOT gates.
6. Study and Verification of AND gate using TTL IC 7408
7. Study and Verification of OR gate using TTL IC 7432
8. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400
9. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402
10. Study and Verification of NOT gate using TTL IC 7404

Online Virtual Lab Experiment List/Link:

Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/ssd/#

1. ID-VD characteristics of Junction Field Effect Transistor (JFET)
2. Silicon Controlled Rectifier (SCR) characteristics
3. Unijunction Transistor (UJT) and relaxation oscillator

Virtual Labs an initiative of MHRD Govt. of India
https://de-iitr.vlabs.ac.in/List%20of%20experiments.html

4. Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates
5. Construction of half and full adder using XOR and NAND gates and verification of its operation
6. To study and verify half and full subtractor
7. Realization of logic functions with the help of Universal Gates (NAND, NOR)
8. Construction of a NOR gate latch and verification of its operation
9. Verify the truth table of RS, JK, T and D Flip Flops using NAND and NOR gates
10. Design and verify the 4-Bit Synchronous or Asynchronous Counter using JK Flip Flop
11. Verify Binary to Gray and Gray to Binary conversion using NAND gates only
12. Verify the truth table of 1-Bit and 2-Bit comparator using logic gates

Web Links of other virtual labs may be suggested by individual intuitions.

Suggested Readings

- R.L. Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, Prentice-Hall of India Pvt. Ltd., 2015, 11e
- J.D. Ryder, “Electronic Fundamentals and Applications”, Prentice-Hall of India Private Limited, 1975, 5e
- S.L. Gupta, V. Kumar, “Hand Book of Electronics”, Pragati Prakashan, Meerut, 2016, 43e
- R.P. Jain, “Modern Digital Electronics”, McGraw Hill, 2009, 4e

Further Suggestions:

- The institution may add / modify / change the experiments of the same standard in the subject.
- The institution may suggest a minimum number of experiments (05) to be performed by each student per semester from the Lab Experiment List.
- The institution may suggest a minimum number of experiments (02) to be performed by each student per semester from the Online Virtual Lab Experiment List.