# Dr. Bhimrao Ambedkar University, Agra

**A State University of Uttar Pradesh (Paliwal Park, Agra -282004)**

**www.dbrau.ac.in**

A Documentary Support

*for*

*Matric No. – 1.1.1*

# Programme Outcomes & Course Outcomes

*under the*

***Criteria – I***

## (Curriculum Design and Development)

*Key Indicator - 1.1*

*in*

*Matric No. – 1.1.1*

# B. Sc. (PHYSICS)

**2022**

Registrar
Dr. B.R.A. University, Agra

*Mapping:*

Signature Not Verified
RAJEEV KUMAR
Digitally Signed By: Registrar

*Local Need* *Regional* *National* *Global Need*

## SUBJECT PREREQUISITES

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

## PROGRAMME OUTCOMES (POs)

*The practical value of science for productivity, for raising the standard of living of the people is surely recognized. Science as a power, which provides tools for effective action for the benefit of mankind or for conquering the forces of Nature or for developing resources, is surely highlighted everywhere. Besides the utilitarian aspect, the value of Science, lies in the fun called intellectual enjoyment. Science teaches the value of rational thought as well as importance of freedom of thought.*

*Our teaching so far has been aimed more at formal knowledge and understanding instead of training and application oriented. Presently, the emphasis is more on training, application and to some extent on appreciation, the fostering in the pupils of independent thinking and creativity. Surely, teaching has to be more objective based. The process of application based training, whether we call it a thrill or ability, is to be emphasized as much as the content.*

*Physics is a basic science; it attempts to explain the natural phenomenon in as simple a manner as possible. It is an intellectual activity aimed at interpreting the Multiverse. 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. With all the limitations imposed (even the list of experiments as given in the syllabus) if the spirit of discovery by investigation is kept in mind, much of the thrill can be experienced.*

1. The main aim of this programme is to help cultivate the love for Nature and its manifestations, to transmit the methods of science (the contents are only the means) to observe things around, to generalize, 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.
2. 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.
3. 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.
4. The Bachelor's Project (Industrial Training / Survey / Dissertation) is intended to give an essence of research work for excellence in explicit areas. It integrates with specific job requirements / opportunities and provides a foundation for Bachelor (Research) Programmes.

<table>
<tr><th colspan="2">PROGRAMME SPECIFIC OUTCOMES (PSOs)</th></tr>
<tr><td colspan="2">CERTIFICATE<br>IN BASIC PHYSICS & SEMICONDUCTOR DEVICES</td></tr>
<tr><td>FIRST YEAR</td><td>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.<br><br>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.<br><br>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.</td></tr>
<tr><td colspan="2">DIPLOMA<br>IN APPLIED PHYSICS WITH ELECTRONICS</td></tr>
<tr><td>SECOND YEAR</td><td>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.<br><br>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.<br><br>Companies and R&D Laboratories working on Electromagnetic properties, Laser Applications, Optoelectronics and Communication Systems are expected to value this course.</td></tr>
<tr><td colspan="2">DEGREE<br>IN BACHELOR OF SCIENCE</td></tr>
<tr><td>THIRD YEAR</td><td>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.<br><br>This course amalgamates the comprehensive knowledge of Analog & Digital Principles and Applications. It presents an integrated approach to analog electronic circuitry and digital electronics.<br><br>Present course will attract immense recognition in R&D sectors and in the entire cutting edge technology based industry.</td></tr>
</table>

| SEMESTER-WISE PAPER TITLES WITH DETAILS | | | | | |
|---|---|---|---|---|---|
| **YEAR** | **SEME-STER** | **PAPER** | **PAPER TITLE** | **PREREQUISITE For Paper** | **ELECTIVE For Major Subjects** |
| **CERTIFICATE IN BASIC PHYSICS & SEMICONDUCTOR DEVICES** | | | | | |
| **FIRST YEAR** | **SEMESTER I** | Theory Paper-1 | Mathematical Physics & Newtonian Mechanics | Physics in 12$^{th}$ / Mathematics in 12$^{th}$ | YES Open to all |
| | | Practical Paper | Mechanical Properties of Matter | Opted / Passed Sem I, Th Paper-1 | YES Bota./Chem./Comp. Sc./ Math./Stat./Zool. |
| | **SEMESTER II** | Theory Paper-1 | Thermal Physics & Semiconductor Devices | Physics in 12$^{th}$ / Chemistry in 12$^{th}$ | YES Open to all |
| | | Practical Paper | Thermal Properties of Matter & Electronic Circuits | Opted / Passed Sem II, Th Paper-1 | YES Bota./Chem./Comp. Sc./ Math./Stat./Zool. |
| **DIPLOMA IN APPLIED PHYSICS WITH ELECTRONICS** | | | | | |
| **SECOND YEAR** | **SEMESTER III** | Theory Paper-1 | Electromagnetic Theory & Modern Optics | Passed Sem I, Th Paper-1 | YES Open to all |
| | | Practical Paper | Demonstrative Aspects of Electricity & Magnetism | Opted / Passed Sem III, Th Paper-1 | YES Bota./Chem./Comp. Sc./ Math./Stat./Zool. |
| | **SEMESTER IV** | Theory Paper-1 | Perspectives of Modern Physics & Basic Electronics | Passed Sem I, Th Paper-1 | YES Open to all |
| | | Practical Paper | Basic Electronics Instrumentation | Opted / Passed Sem IV, Th Paper-1 | YES Bota./Chem./Comp. Sc./ Math./Stat./Zool. |
| **DEGREE IN BACHELOR OF SCIENCE** | | | | | |
| **THIRD YEAR** | **SEMESTER V** | Theory Paper-1 | Classical & Statistical Mechanics | Passed Sem I, Th Paper-1 | YES Chem./Comp. Sc./Math./Stat. |
| | | Theory Paper-2 | Quantum Mechanics & Spectroscopy | Passed Sem IV, Th Paper-1 | YES Chem./Comp. Sc./Math./Stat. |
| | | Practical Paper | Demonstrative Aspects of Optics & Lasers | Passed Sem III, Th Paper-1 | YES Chem./Comp. Sc./Math./Stat. |
| | **SEMESTER VI** | Theory Paper-1 | Solid State & Nuclear Physics | Passed Sem V, Th Paper-2 | YES Chem./Comp. Sc./Math./Stat. |
| | | Theory Paper-2 | Analog & Digital Principles & Applications | Passed Sem IV, Th Paper-1 | YES Open to all |
| | | Practical Paper | Analog & Digital Circuits | Opted / Passed Sem VI, Th Paper-2 | YES Chem./Comp. Sc./Math./Stat. |

| YEAR | SEME-STER | PAPER | PAPER TITLE | UNIT TITLE<br>(Periods Per Semester) |
|---|---|---|---|---|
| **CERTIFICATE IN BASIC PHYSICS & SEMICONDUCTOR DEVICES** | | | | |
| **FIRST YEAR** | **SEMESTER I** | Theory Paper-1 | **Mathematical Physics & Newtonian Mechanics**<br><br>Part A: Basic Mathematical Physics<br>Part B: Newtonian Mechanics & Wave Motion | **Part A**<br>I: Vector Algebra (7)<br>II: Vector Calculus (8)<br>III: Coordinate Systems (8)<br>IV: Introduction to Tensors (7)<br>**Part B**<br>V: Dynamics of a System of Particles (8)<br>VI: Dynamics of a Rigid Body (8)<br>VII: Motion of Planets & Satellites (7)<br>VIII: Wave Motion (7) |
| | | Practical Paper | **Mechanical Properties of Matter** | Lab Experiment List<br>Online Virtual Lab Experiment List/Link |
| | **SEMESTER II** | Theory Paper-1 | **Thermal Physics & Semiconductor Devices**<br><br>Part A: Thermodynamics & Kinetic Theory of Gases<br>Part B: Circuit Fundamentals & Semiconductor Devices | **Part A**<br>I: $0^{th}$ & $1^{st}$ Law of Thermodynamics (8)<br>II: $2^{nd}$ & $3^{rd}$ Law of Thermodynamics (8)<br>III: Kinetic Theory of Gases (7)<br>IV: Theory of Radiation (7)<br>**Part B**<br>V: DC & AC Circuits (7)<br>VI: Semiconductors & Diodes (8)<br>VII: Transistors (8)<br>VIII: Electronic Instrumentation (7) |
| | | Practical Paper | **Thermal Properties of Matter & Electronic Circuits** | Lab Experiment List<br>Online Virtual Lab Experiment List/Link |

| Programme/Class: **Certificate** | Year: **First** | | Semester: **First** |
|---|---|---|---|
| Subject: **Physics** | | | |
| Course Code: **B010101T** | Course Title: **Mathematical Physics & Newtonian Mechanics** | | |
| **Course Outcomes (COs)** | | | |
| 1. Recognize the difference between scalars, vectors, pseudo-scalars and pseudo-vectors.<br>2. Understand the physical interpretation of gradient, divergence and curl.<br>3. Comprehend the difference and connection between Cartesian, spherical and cylindrical coordinate systems.<br>4. Know the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors.<br>5. Study the origin of pseudo forces in rotating frame.<br>6. Study the response of the classical systems to external forces and their elastic deformation.<br>7. Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).<br>8. Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation. | | | |
| Credits: **4** | | Core Compulsory / Elective | |
| Max. Marks: **25+75** | | Min. Passing Marks: | |
| Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0** | | | |

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **PART A**<br>**Basic Mathematical Physics** | |
| **I** | ***Introduction to Indian ancient Physics and contribution of Indian Physicists, in context with the holistic development of modern science and technology, should be included under Continuous Internal Evaluation (CIE).***<br><br>**Vector Algebra**<br>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. | 7 |
| **II** | **Vector Calculus**<br>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. | 8 |
| **III** | **Coordinate Systems**<br>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. | 8 |

| | | |
|---|---|---|
| **IV** | **Introduction to Tensors**<br>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. | 7 |
| | **<u>PART B</u>**<br>**Newtonian Mechanics & Wave Motion** | |
| **V** | **Dynamics of a System of Particles**<br>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. | 8 |
| **VI** | **Dynamics of a Rigid Body**<br>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. | 8 |
| **VII** | **Motion of Planets & Satellites**<br>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). | 7 |
| **VIII** | **Wave Motion**<br>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. | 7 |

**Suggested Readings**

**<u>PART A</u>**

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017, 2e
2. A.W. Joshi, "Matrices and Tensors in Physics", New Age International Private Limited, 1995, 3e

**<u>PART B</u>**

1. 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
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
3. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017, 14e
4. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e

***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.***

| Suggestive Digital Platforms / Web Links |
|---|
| 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/<br>2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd<br>3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx<br>4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8 |
| **Course Prerequisites** |
| Physics in 12$^{th}$ / Mathematics in 12$^{th}$ |
| **This course can be opted as an Elective by the students of following subjects** |
| Open to all |
| **Suggested Continuous Internal Evaluation (CIE) Methods** |
| 20 marks for Test / Quiz / Assignment / Seminar<br>05 marks for Class Interaction |
| **Suggested Equivalent Online Courses** |
| 1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics<br>2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html<br>3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy<br>4. edX, https://www.edx.org/course/subject/physics<br>5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/ |
| **Further Suggestions** |
| • Other Digital Platforms / Web Links and Equivalent Online Courses may be suggested / added to the respective lists by individual Universities.<br>• **In End-Semester University Examinations, equal weightage should be given to Part A (units I to IV) and Part B (units V to VIII) while framing the questions.** |

| | | |
|---|---|---|
| Programme/Class: **Certificate** | Year: **First** | Semester: **First** |
| Subject: **Physics** | | |
| Course Code: **B010102P** | Course Title: **Mechanical Properties of Matter** | |

**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.

| | |
|---|---|
| Credits: **2** | Core Compulsory / Elective |
| Max. Marks: **25+75** | Min. Passing Marks: |

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**

| **Unit** | **Topics** | **No. of Lectures** |
|---|---|---|
| | **Lab Experiment List**<br>1. Moment of inertia of a flywheel<br>2. Moment of inertia of an irregular body by inertia table<br>3. Modulus of rigidity by statistical method (Barton’s apparatus)<br>4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell’s needle)<br>5. Young’s modulus by bending of beam<br>6. Young’s modulus and Poisson’s ratio by Searle’s method<br>7. Poisson’s ratio of rubber by rubber tubing<br>8. Surface tension of water by capillary rise method<br>9. Surface tension of water by Jaeger’s method<br>10. Coefficient of viscosity of water by Poiseuille’s method<br>11. Acceleration due to gravity by bar pendulum<br>12. Frequency of AC mains by Sonometer<br>13. Height of a building by Sextant<br>14. Study the wave form of an electrically maintained tuning fork / alternating current source with the help of cathode ray oscilloscope.<br>**Online Virtual Lab Experiment List / Link**<br>Virtual Labs at Amrita Vishwa Vidyapeetham<br>https://vlab.amrita.edu/?sub=1&brch=74<br>1. Torque and angular acceleration of a fly wheel<br>2. Torsional oscillations in different liquids<br>3. Moment of inertia of flywheel<br>4. Newton's second law of motion<br>5. Ballistic pendulum<br>6. Collision balls<br>7. Projectile motion<br>8. Elastic and inelastic collision | 60 |

| Suggested Readings |
| --- |
| 1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e<br>2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e<br>3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019<br>4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e<br><br>***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.*** |
| **Suggestive Digital Platforms / Web Links** |
| 1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74<br>2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities. |
| **Course Prerequisites** |
| Opted / Passed Semester I, Theory Paper-1 (B010101T) |
| **This course can be opted as an Elective by the students of following subjects** |
| Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology |
| **Suggested Continuous Internal Evaluation (CIE) Methods** |
| 15 marks for Record File (depending upon the no. of experiments performed out of the total assigned experiments)<br>05 marks for Viva Voce<br>05 marks for Class Interaction |
| **Suggested Equivalent Online Courses** |
| |
| **Further Suggestions** |
| • The institution may add / modify / change the experiments of the same standard in the subject.<br>• The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.<br>• The institution may suggest a minimum number of experiments (say 3) to be performed by each student per semester from the Online Virtual Lab Experiment List / Link. |

| Programme/Class: **Certificate** | Year: **First** | Semester: **Second** |
|---|---|---|

Subject: **Physics**

| Course Code: **B010201T** | Course Title: **Thermal Physics & Semiconductor Devices** |
|---|---|

**Course Outcomes (COs)**

1. Recognize the difference between reversible and irreversible processes.
2. Understand the physical significance of thermodynamical potentials.
3. Comprehend the kinetic model of gases w.r.t. various gas laws.
4. Study the implementations and limitations of fundamental radiation laws.
5. Utility of AC bridges.
6. Recognize the basic components of electronic devices.
7. Design simple electronic circuits.
8. Understand the applications of various electronic instruments.

| Credits: **4** | Core Compulsory / Elective |
|---|---|
| Max. Marks: **25+75** | Min. Passing Marks: |

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **PART A**<br>**Thermodynamics & Kinetic Theory of Gases** | |
| **I** | **$0^{th}$ & $1^{st}$ Law of Thermodynamics**<br>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). | 8 |
| **II** | **$2^{nd}$ & $3^{rd}$ Law of Thermodynamics**<br>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. | 8 |
| **III** | **Kinetic Theory of Gases**<br>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). | 7 |
| **IV** | **Theory of Radiation**<br>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-Boltzmann law and Wien's displacement law from Planck's law. | 7 |

| PART B<br>Circuit Fundamentals & Semiconductor Devices | | |
|---|---|---|
| V | **DC & AC Circuits**<br>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). | 7 |
| VI | **Semiconductors & Diodes**<br>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. | 8 |
| VII | **Transistors**<br>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). | 8 |
| VIII | **Electronic Instrumentation**<br>Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.<br>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. | 7 |

**Suggested Readings**

**PART A**

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
5. Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e

**PART B**

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e
6. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.***

| | | |
|---|---|---|
| Programme/Class: **Certificate** | Year: **First** | Semester: **Second** |
| Subject: **Physics** | | |
| Course Code: **B010202P** | Course Title: **Thermal Properties of Matter & Electronic Circuits** | |

**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.

| | |
|---|---|
| Credits: **2** | Core Compulsory / Elective |
| Max. Marks: **25+75** | Min. Passing Marks: |

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-4**

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **Lab Experiment List** | 60 |

1. Mechanical Equivalent of Heat by Callender and Barne's method
2. Coefficient of thermal conductivity of copper by Searle's apparatus
3. Coefficient of thermal conductivity of rubber
4. Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method
5. Value of Stefan's constant
6. Verification of Stefan's law
7. Variation of thermo-emf across two junctions of a thermocouple with temperature
8. Temperature coefficient of resistance by Platinum resistance thermometer
9. Charging and discharging in RC and RCL circuits
10. A.C. Bridges: Various experiments based on measurement of L and C
11. Resonance in series and parallel RCL circuit
12. Characteristics of PN Junction, Zener, Tunnel, Light Emitting and Photo diode
13. Characteristics of a transistor (PNP and NPN) in CE, CB and CC configurations
14. Half wave & full wave rectifiers and Filter circuits
15. Unregulated and Regulated power supply
16. Various measurements with Cathode Ray Oscilloscope (CRO)

**Online Virtual Lab Experiment List / Link**

**Thermal Properties of Matter:**
Virtual Labs at Amrita Vishwa Vidyapeetham
https://vlab.amrita.edu/?sub=1&brch=194

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

<table>
<tr><th>YEAR</th><th>SEME-<br>STER</th><th>PAPER</th><th>PAPER TITLE</th><th>UNIT TITLE<br>(Periods Per Semester)</th></tr>
<tr><td colspan="5">DIPLOMA<br>IN APPLIED PHYSICS WITH ELECTRONICS</td></tr>
<tr><td rowspan="4">SECOND YEAR</td><td rowspan="2">SEMESTER III</td><td>Theory Paper-1</td><td>Electromagnetic Theory & Modern Optics<br><br>Part A: Electromagnetic Theory<br>Part B: Physical Optics & Lasers</td><td><u>Part A</u><br>I: Electrostatics (8)<br>II: Magnetostatics (8)<br>III: Time Varying Electromagnetic Fields (7)<br>IV: Electromagnetic Waves (7)<br><u>Part B</u><br>V: Interference (8)<br>VI: Diffraction (8)<br>VII: Polarisation (7)<br>VII: Lasers (7)</td></tr>
<tr><td>Practical Paper</td><td>Demonstrative Aspects of Electricity & Magnetism</td><td>Lab Experiment List<br>Online Virtual Lab Experiment List/Link</td></tr>
<tr><td rowspan="2">SEMESTER IV</td><td>Theory Paper-1</td><td>Perspectives of Modern Physics & Basic Electronics<br><br>Part A: Perspectives of Modern Physics<br>Part B: Basic Electronics & Introduction to Fiber Optics</td><td><u>Part A</u><br>I: Relativity-Experimental Background (7)<br>II: Relativity-Relativistic Kinematics (8)<br>III: Inadequacies of Classical Mechanics (8)<br>IV: Introduction to Quantum Mechanics (7)<br><u>Part B</u><br>V: Transistor Biasing (7)<br>VI: Amplifiers (7)<br>VII: Feedback & Oscillator Circuits (8)<br>VIII: Introduction to Fiber Optics (8)</td></tr>
<tr><td>Practical Paper</td><td>Basic Electronics Instrumentation</td><td>Lab Experiment List<br>Online Virtual Lab Experiment List/Link</td></tr>
</table>

<table>
<tr><td colspan="2">Programme/Class: Diploma</td><td colspan="2">Year: Second</td><td>Semester: Third</td></tr>
<tr><td colspan="5">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code: B010301T</td><td colspan="3">Course Title: Electromagnetic Theory & Modern Optics</td></tr>
<tr><td colspan="5">Course Outcomes (COs)</td></tr>
<tr><td colspan="5">1. Better understanding of electrical and magnetic phenomenon in daily life.<br>2. To troubleshoot simple problems related to electrical devices.<br>3. Comprehend the powerful applications of ballistic galvanometer.<br>4. Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).<br>5. Study the working and applications of Michelson and Fabry-Perot interferometers.<br>6. Recognize the difference between Fresnel’s and Fraunhofer’s class of diffraction.<br>7. Comprehend the use of polarimeters.<br>8. Study the characteristics and uses of lasers.</td></tr>
<tr><td colspan="3">Credits: 4</td><td colspan="2">Core Compulsory / Elective</td></tr>
<tr><td colspan="3">Max. Marks: 25+75</td><td colspan="2">Min. Passing Marks:</td></tr>
<tr><td colspan="5">Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0</td></tr>
<tr><td>Unit</td><td colspan="3">Topics</td><td>No. of Lectures</td></tr>
<tr><td colspan="5"><u>PART A</u><br>Electromagnetic Theory</td></tr>
<tr><td>I</td><td colspan="3">Electrostatics<br>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.</td><td>8</td></tr>
<tr><td>II</td><td colspan="3">Magnetostatics<br>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.</td><td>8</td></tr>
<tr><td>III</td><td colspan="3">Time Varying Electromagnetic Fields<br>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).</td><td>7</td></tr>
<tr><td>IV</td><td colspan="3">Electromagnetic Waves<br>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.</td><td>7</td></tr>
</table>

| PART B<br>Physical Optics & Lasers | | |
|---|---|---|
| V | **Interference**<br>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. | 8 |
| VI | **Diffraction**<br>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. | 8 |
| VII | **Polarisation**<br>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. | 7 |
| VIII | **Lasers**<br>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). | 7 |

**Suggested Readings**

**PART A**

1. D.J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
2. E.M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017, 2e
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2", Pearson Education Limited, 2012
4. D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e

**PART B**

1. Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e
2. Samuel Tolansky, "An Introduction to Interferometry", John Wiley & Sons Inc., 1973, 2e
3. A. Ghatak, "Optics", McGraw Hill, 2017, 6e

***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.***

**Suggestive Digital Platforms / Web Links**

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

**Course Prerequisites**

Passed Semester I, Theory Paper-1 (B010101T)

**This course can be opted as an Elective by the students of following subjects**

Open to all

| Programme/Class: **Diploma** | Year: **Second** | Semester: **Fourth** |
|---|---|---|
| Subject: **Physics** | | |
| Course Code: **B010401T** | Course Title: **Perspectives of Modern Physics & Basic Electronics** | |

**Course Outcomes (COs)**

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

| Credits: **4** | Core Compulsory / Elective |
|---|---|
| Max. Marks: **25+75** | Min. Passing Marks: |

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0**

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **PART A**<br>**Perspectives of Modern Physics** | |
| **I** | **Relativity-Experimental Background**<br>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. | 7 |
| **II** | **Relativity-Relativistic Kinematics**<br>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. | 8 |
| **III** | **Inadequacies of Classical Mechanics**<br>Particle Properties of Waves: Spectrum of Black Body radiation, Photoelectric effect, Compton effect and their explanations based on Max Planck's Quantum hypothesis.<br>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. | 8 |
| **IV** | **Introduction to Quantum Mechanics**<br>Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities.<br>Wave Function: Functional form, Normalisation of wave function, Orthogonal & Orthonormal wave functions and Probabilistic interpretation of wave function based on Born Rule. | 7 |

| PART B<br>Basic Electronics & Introduction to Fiber Optics | | |
|---|---|---|
| **V** | **Transistor Biasing**<br>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. | 7 |
| **VI** | **Amplifiers**<br>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).<br>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).<br>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. | 7 |
| **VII** | **Feedback & Oscillator Circuits**<br>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.<br>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. | 8 |
| **VIII** | **Introduction to Fiber Optics**<br>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. | 8 |

**Suggested Readings**

**PART A**


1. A. Beiser, Shobhit Mahajan, "Concepts of Modern Physics: Special Indian Edition", McGraw Hill, 2009, 6e
2. John R. Taylor, Chris D. Zafiratos, Michael A.Dubson, "Modern Physics for Scientists and Engineers", Prentice-Hall of India Private Limited, 2003, 2e
3. R.A. Serway, C.J. Moses, and C.A. Moyer, "Modern Physics", Cengage Learning India Pvt. Ltd, 2004, 3e
4. R. Resnick, "Introduction to Special Relativity", Wiley India Private Limited, 2007
5. R. Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

| YEAR | SEME-STER | PAPER | PAPER TITLE | UNIT TITLE (Periods Per Semester) |
|---|---|---|---|---|
| **DEGREE IN BACHELOR OF SCIENCE** | | | | |
| THIRD YEAR | SEMESTER V | Theory Paper-1 | **Classical & Statistical Mechanics**<br><br>Part A: Introduction to Classical Mechanics<br>Part B: Introduction to Statistical Mechanics | **Part A**<br>I: Constrained Motion (6)<br>II: Lagrangian Formalism (9)<br>III: Hamiltonian Formalism (8)<br>IV: Central Force (7)<br>**Part B**<br>V: Macrostate & Microstate (6)<br>VI: Concept of Ensemble (6)<br>VII: Distribution Laws (10)<br>VIII: Applications of Statistical Distribution Laws (8) |
| | | Theory Paper-2 | **Quantum Mechanics & Spectroscopy**<br><br>Part A: Introduction to Quantum Mechanics<br>Part B: Introduction to Spectroscopy | **Part A**<br>I: Operator Formalism (5)<br>II: Eigen & Expectation Values (6)<br>III: Uncertainty Principle & Schrodinger Equation (7)<br>IV: Applications of Schrodinger Equation (12)<br>**Part B**<br>V: Vector Atomic Model (10)<br>VI: Spectra of Alkali & Alkaline Elements (6)<br>VII: X-Rays & X-Ray Spectra (7)<br>VIII: Molecular Spectra (7) |
| | | Practical Paper | **Demonstrative Aspects of Optics & Lasers** | Lab Experiment List<br>Online Virtual Lab Experiment List/Link |
| | SEMESTER VI | Theory Paper-1 | **Solid State & Nuclear Physics**<br><br>Part A: Introduction to Solid State Physics<br>Part B: Introduction to Nuclear Physics | **Part A**<br>I: Crystal Structure (7)<br>II: Crystal Diffraction (7)<br>III: Crystal Bindings (7)<br>IV: Lattice Vibrations (9)<br>**Part B**<br>V: Nuclear Forces & Radioactive Decays (9)<br>VI: Nuclear Models & Nuclear Reactions (9)<br>VII: Accelerators & Detectors (6)<br>VIII: Elementary Particles (6) |
| | | Theory Paper-2 | **Analog & Digital Principles & Applications**<br><br>Part A: Analog Electronic Circuits<br>Part B: Digital Electronics | **Part A**<br>I: Semiconductor Junction (9)<br>II: Transistor Modeling (8)<br>III: Field Effect Transistors (8)<br>IV: Other Devices (5)<br>**Part B**<br>V: Number System (6)<br>VI: Binary Arithmetic (5)<br>VII: Logic Gates (9)<br>VIII: Combinational & Sequential Circuits (10) |
| | | Practical Paper | **Analog & Digital Circuits** | Lab Experiment List<br>Online Virtual Lab Experiment List/Link |

| Programme/Class: **Degree** | Year: **Third** | Semester: **Fifth** |
|---|---|---|
| Subject: **Physics** | | |
| Course Code: **B010501T** | Course Title: **Classical & Statistical Mechanics** | |
| **Course Outcomes (COs)** | | |

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

| Credits: **4** | Core Compulsory / Elective |
|---|---|
| Max. Marks: **25+75** | Min. Passing Marks: |
| Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0** | |

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **PART A**<br>**Introduction to Classical Mechanics** | |
| **I** | **Constrained Motion**<br>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. | 6 |
| **II** | **Lagrangian Formalism**<br>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. | 9 |
| **III** | **Hamiltonian Formalism**<br>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. | 8 |
| **IV** | **Central Force**<br>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. | 7 |

| PART B<br>Introduction to Statistical Mechanics | | |
|---|---|---|
| V | **Macrostate & Microstate**<br>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. | 6 |
| VI | **Concept of Ensemble**<br>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. | 6 |
| VII | **Distribution Laws**<br>Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in ith state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac statistics. Comparison of statistical distribution laws and their physical significance.<br>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. | 10 |
| VIII | **Applications of Statistical Distribution Laws**<br>Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law.<br>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). | 8 |

## Suggested Readings


**PART A**

1. Herbert Goldstein, Charles P. Poole, John L. Safko, "Classical Mechanics", Pearson Education, India, 2011, 3e
2. N.C. Rana, P.S. Joag, "Classical Mechanics", McGraw Hill, 2017
3. R.G. Takwale, P.S. Puranik, "Introduction to Classical Mechanics", McGraw Hill, 2017

**PART B**

1. F. Reif, "Statistical Physics (In SI Units): Berkeley Physics Course Vol 5", McGraw Hill, 2017, 1e
2. B.B. Laud, "Fundamentals of Statistical Mechanics", New Age International Private Limited, 2020, 2e
3. B.K. Agarwal, M. Eisner, "Statistical Mechanics", New Age International Private Limited, 2007, 2e


***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.***

## Suggestive Digital Platforms / Web Links

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

## Course Prerequisites

Passed Semester I, Theory Paper-1 (B010101T)

| Programme/Class: **Degree** | Year: **Third** | Semester: **Fifth** |
|---|---|---|
| Subject: **Physics** | | |
| Course Code: **B010502T** | Course Title: **Quantum Mechanics & Spectroscopy** | |
| **Course Outcomes (COs)** | | |

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

| Credits: **4** | Core Compulsory / Elective |
|---|---|
| Max. Marks: **25+75** | Min. Passing Marks: |
| Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0** | |

| Unit | Topics | No. of Lectures |
|---|---|---|
| | **PART A**<br>**Introduction to Quantum Mechanics** | |
| **I** | **Operator Formalism**<br>Operators: Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables.<br>Commutators: Definition, commutator algebra and commutation relations among position, linear momentum & angular momentum and energy & time. Simple problems based on commutation relations. | 5 |
| **II** | **Eigen & Expectation Values**<br>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.<br>Hermitian Operators: Definition, properties and applications. Prove of the hermitian nature of various physical-dynamical operators. | 6 |
| **III** | **Uncertainty Principle & Schrodinger Equation**<br>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.<br>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. | 7 |

| | | |
|---|---|---|
| **IV** | **Applications of Schrodinger Equation**<br>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.<br>Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included).<br>(Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted). | 12 |
| | **<u>PART B</u>**<br>**Introduction to Spectroscopy** | |
| **V** | **Vector Atomic Model**<br>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. | 10 |
| **VI** | **Spectra of Alkali & Alkaline Elements**<br>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.<br>Spectra of alkaline elements: Singlet and triplet structure of spectra. | 6 |
| **VII** | **X-Rays & X-Ray Spectra**<br>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. | 7 |
| **VIII** | **Molecular Spectra**<br>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. | 7 |

**Suggested Readings**


**<u>PART A</u>**

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3", Pearson Education Limited, 2012
4. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

**<u>PART B</u>**

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


***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.***

| Programme/Class: **Degree** | Year: **Third** | Semester: **Sixth** |
|---|---|---|
| Subject: **Physics** | | |
| Course Code: **B010601T** | Course Title: **Solid State & Nuclear Physics** | |
| **Course Outcomes (COs)** | | |

1. Understand the crystal geometry w.r.t. symmetry operations.
2. Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
3. Study various properties based on crystal bindings.
4. Recognize the importance of Free Electron & Band theories in understanding the crystal properties.
5. Study the salient features of nuclear forces & radioactive decays.
6. Understand the importance of nuclear models & nuclear reactions.
7. Comprehend the working and applications of nuclear accelerators and detectors.
8. Understand the classification and properties of basic building blocks of nature.

| Credits: **4** | Core Compulsory / Elective |
|---|---|
| Max. Marks: **25+75** | Min. Passing Marks: |
| Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0** | |

| **Unit** | **Topics** | **No. of Lectures** |
|---|---|---|
| | **PART A**<br>**Introduction to Solid State Physics** | |
| **I** | **Crystal Structure**<br>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. | 7 |
| **II** | **Crystal Diffraction**<br>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. | 7 |
| **III** | **Crystal Bindings**<br>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. | 7 |

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| **IV** | **Lattice Vibrations**<br>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.<br>Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals.<br>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. | 9 |
| | **PART B**<br>**Introduction to Nuclear Physics** | |
| **V** | **Nuclear Forces & Radioactive Decays**<br>General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor.<br>Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties.<br>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. | 9 |
| **VI** | **Nuclear Models & Nuclear Reactions**<br>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).<br>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. | 9 |
| **VII** | **Accelerators & Detectors**<br>Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron.<br>Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber. | 6 |
| **VIII** | **Elementary Particles**<br>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. | 6 |

**Suggested Readings**

**PART A**


1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2012, 8e
2. A.J. Dekker, "Solid State Physics", Macmillan India Limited, 1993
3. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015


**PART B**


1. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
2. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
3. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019


***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.***

| Programme/Class: **Degree** | Year: **Third** | Semester: **Sixth** |
|---|---|---|
| Subject: **Physics** | | |
| Course Code: **B010602T** | Course Title: **Analog & Digital Principles & Applications** | |

**Course Outcomes (COs)**

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

| Credits: **4** | Core Compulsory / Elective |
|---|---|
| Max. Marks: **25+75** | Min. Passing Marks: |
| Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **4-0-0** | |

| **Unit** | **Topics** | **No. of Lectures** |
|---|---|---|
| | **PART A**<br>**Analog Electronic Circuits** | |
| **I** | **Semiconductor Junction**<br>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.<br>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. | 9 |
| **II** | **Transistor Modeling**<br>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). | 8 |
| **III** | **Field Effect Transistors**<br>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).<br>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. | 8 |

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|---|---|---|
| **IV** | **Other Devices**<br>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).<br>UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators). | 5 |
| | **PART B**<br>**Digital Electronics** | |
| **V** | **Number System**<br>Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion.<br>Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation. | 6 |
| **VI** | **Binary Arithmetic**<br>Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division. | 5 |
| **VII** | **Logic Gates**<br>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. | 9 |
| **VIII** | **Combinational & Sequential Circuits**<br>Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor.<br>Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders.<br>Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters. | 10 |

## Suggested Readings


**PART A**

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

**PART B**

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e


***Books published in Hindi & Other Reference / Text Books may be suggested / added to this list by individual Universities.***