REVISED SYLLABUS OF PHYSICS
BOS dated 17.06.2025

Curricular & Credit Framework
for
Four Year Undergraduate Programme
(FYUP)

NATIONAL EDUCATION POLICY-2020

C.S.J.M. University, Kanpur

As Proposed by
Board of Studies (Physics)
C.S.J.M. University, Kanpur

Chhatrapati Shahu Ji Maharaj University, Kanpur

Uttar Pradesh State University (Formerly Kanpur University, Kanpur)

Minutes of the Meeting of Board of Studies (held on 17 Jun 2025)

A Meeting of the Board of Studies (BOS) for the subject Physics was held on 17 June 2025 at 1:00 PM via online mode (Google-meet), with video conferencing at the CSJM University Campus Kanpur. The agenda was to discuss and approve the course structure and syllabus of the B.Sc., B.Sc. (Hons.) and M.Sc. Physics programs.

The detailed course structure and syllabus for both programs had already been shared with all BOS members. These programs have been designed in accordance with the Curricular & Credit Framework for the Four Year Undergraduate Programme (FYUP). During the meeting, a presentation on the course structure and syllabus was delivered. After thorough discussion on each aspect of the syllabus, the following suggestions and recommendations were made by the BOS members:

1. Corrections were suggested for the course B011006T - Laser Physics and Applications (X^{th} semester), and the syllabus has been revised accordingly.

2. Few corrections related to practicals were incorporated as per the members' suggestions.

3. All other minor recommendations were incorporated into the syllabus as advised by the Board members. The members unanimously approve the final syllabus.

The Meeting was attended by the Following BOS Members:

Convener

Prof. Rajesh Kumar Dwivedi, CSJM University, Kanpur

External Members

1. Prof. K.N. Uttam, Allahabad University, Allahabad
2. Prof. D.K. Dwivedi, MMMTU Gorakhpur
3. Prof. Manoj Kumar Sharma, Lucknow University, Lucknow

Internal Members

1. Prof. Preeti Dwivedi, VSSD College, Kanpur
2. Prof. Vivek Dwivedi, BND College, Kanpur
3. Prof.Anurag Saxena, DAV College,Kanpur
4. Dr Pradeep Gupta, DSN College, Unnao
5. Dr. Anju Dixit, CSJM University Campus, Kanpur — Anju Dixit

Invited Members

1. Prof. Rajiv Kumar, DAV College, Kanpur
2. Prof. P. S. Dobal, VSSD College Kanpur
3. Prof. S. P. Singh, Christ Church College, Kanpur
4. Dr. Prabal Pratap Singh, CSJM University Campus, Kanpur

Four Year Undergraduate Programme (FYUP)

SEMESTER-WISE TITLES OF THE PAPERS IN UG PHYSICS COURSE					
Year	**Semester**	**Course Code**	**Paper Title**	**Theory / Practical**	**Credit**
CERTIFICATE IN BASIC PHYSICS & SEMICONDUCTOR DEVICES					
First Year	I	B010101T	Mathematical Physics & Newtonian Mechanics	Theory	4
		B010102P	Mechanical Properties of Matter	Practical	2
	II	B010201T	Thermal Physics & Semiconductor Devices	Theory	4
		B010202P	Thermal Properties of Matter & Electronic Circuits	Practical	2
DIPLOMA IN APPLIED PHYSICS WITH ELECTRONICS					
Second Year	III	B010301T	Electromagnetic Theory & Modern Optics	Theory	4
		B010302P	Demonstrative Aspects of Electricity & Magnetism	Practical	2
	IV	B010401T	Perspectives of Modern Physics & Basic Electronics	Theory	4
		B010402P	Basic Electronics Instrumentation	Practical	2
		B010403R	Research Project	Project	3
DEGREE IN BACHELOR OF SCIENCE					
Third Year	**V**	B010501T	Classical & Statistical Mechanics	Theory	4
		B010502T	Quantum Mechanics & Spectroscopy	Theory	4
		B010503P	Demonstrative Aspects of Optics & Lasers	Practical	2
	VI	B010601T	Solid State & Nuclear Physics	Theory	4
		B010602T	Analog & Digital Principles & Applications	Theory	4
		B010603P	Analog & Digital Circuits	Practical	2
4 YEAR UG DEGREE (HONOURS)					
Fourth Year	VII	B010701T	Mathematical Physics-I	Theory	4
		B010702T	Classical Mechanics	Theory	4
		B010703T	Electromagnetic Theory	Theory	4
		B010704T	Quantum Mechanics-I	Theory	4

		B010705P	Practical Lab		Practical	4
	VIII	B010801T	Mathematical Physics-II		Theory	4
		B010802T	Solid State Physics		Theory	4
		B010803T	Statistical Mechanics		Theory	4
		B010804T	Electronics		Theory	4
		B010805P	Practical Lab		Practical	4
4- YEAR UG DEGREE (HONOURS WITH RESEARCH) Students who secure 75% marks in the first six semester						
Fourth Year	VII	B010701T	Mathematical Physics-I	***(Honours with research students Select any 3)** **All compulsory for Regular 2Yr MSc**	Theory	4
		B010702T	Classical Mechanics		Theory	4
		B010703T	Electromagnetic Theory		Theory	4
		B010704T	Quantum Mechanics-I		Theory	4
		B010705P	Practical		Practical	4
		B010706R	Research Project	To be evaluated in Sem 8	Project	4
	VIII	B010801T	Mathematical Physics-II	***(Honours with research students Select any 3)** **All compulsory for Regular 2Yr MSc**	Theory	4
		B010802T	Solid State Physics		Theory	4
		B010803T	Statistical Mechanics		Theory	4
		B010804T	Electronics		Theory	4
		B010805P	Practical		Practical	4
		B010806R	Research Project		Project	4
Beyond the Fourth year						
P.G (M.Sc. in Physics)						
Fifth Year	IX	B010901T	Classical Electrodynamics And Plasma Physics	***(Honours with research students Select any 2)** **All compulsory for Regular 2Yr MSc**	Theory	4
		B010902T	Quantum Mechanics-II		Theory	4
		B010903T	Nuclear		Theory	4

			Physics-I			
		B010904T	Electronics-I	***Specialization (Select any one)**	Theory	4
		B010905T	Condensed Matter Physics-I		Theory	4
		B010906P	Practical Lab		Practical	4
		B010907R	Research Project	To be evaluated in Sem 10	Project	4
	X	B011001T	Atomic And Molecular Physics	***(Honours with research students Select any 1) Both compulsory for Regular 2Yr MSc**	Theory	4
		B011002T	Nuclear Physics-II		Theory	4
		B011003T	Electronics-II	*** Specialization (Select the one chosen in Previous/ 9th Sem)**	Theory	4
		B011004T	Condensed Matter Physics-II		Theory	4
		B011005T	Physics of Liquid Crystals	***Elective (Select any one)**	Theory	4
		B011006T	Laser Physics and applications		Theory	4
		B011007T	Physics of Nano materials		Theory	4
		B011008T	Elements Of Atmospheric and Space Science		Theory	4
		B011009P	Practical Lab		Practical	4
		B011010R	Research Project		Project	4

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

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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)	
4-YEAR UG DEGREE (HONOURS)	
FOURTH YEAR	A 4-year undergraduate degree (Hons) in Physics offers several advantages, including more in-depth specialization, a stronger foundation for research and advanced studies, and a wider range of career options, particularly in fields like research, technology, and education. This Programme will Demonstrate comprehensive understanding of Mathematical Physics, classical mechanics, electromagnetism, quantum mechanics, statistical physics, and solid-state physics, including both theoretical foundations and practical applications. It will develop domain-specific expertise in advanced areas such as nuclear physics, astrophysics, condensed matter physics, material science, electronics, or nanotechnology, enabling pursuit of research, innovation, or higher studies.
OR **4-YEAR UG DEGREE WITH RESEARCH**	
FOURTH AND FIFTH YEAR	A 4-year undergraduate degree with a research component offers several advantages, including increased career opportunities, direct PhD admission eligibility, and enhanced employability. It also allows for a deeper understanding of the subject, prepares students for higher education, and can lead to more opportunities. Graduates from the 4-year program will find it easier to pursue advanced degrees abroad without having to complete additional bridge programs. The research components of the 4-year program also improve students' chances of securing scholarships and admissions to top international institutions.

FIRST YEAR

DETAILED SYLLABUS FOR

CERTIFICATE

IN

BASIC PHYSICS & SEMICONDUCTOR DEVICES

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.
2. Understand the physical interpretation of gradient, divergence and curl.
3. Comprehend the difference and connection between Cartesian, spherical and cylindrical coordinate systems.
4. Know the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors.
5. Study the origin of pseudo forces in rotating frame.
6. Study the response of the classical systems to external forces and their elastic deformation.
7. Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).
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 **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).*** **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.	7
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.	8
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.	8

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, Fourier Series.	7
PART B **Newtonian Mechanics & Wave Motion**		
V	**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 (Coriolis & centrifugal) in rotating frame, and effects of Coriolis force. Foucault Pendulum (Demonstration of Earth rotation).	8
VI	**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.	8
VII	**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).	7
VIII	**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.	7
Suggested Readings		

PART A

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

PART B

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/ 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
Physics in 12th / Mathematics in 12th
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 05 marks for Class Interaction
Suggested Equivalent Online Courses
1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 4. edX, https://www.edx.org/course/subject/physics 5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
• Other Digital Platforms / Web Links and Equivalent Online Courses may be suggested / added to the respective lists by individual Universities. • **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	60
	1. Moment of inertia of a flywheel 2. Moment of inertia of an irregular body by inertia table 3. Modulus of rigidity by statical method (Barton's apparatus) 4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle) 5. Young's modulus by bending of beam 6. Modulus of rigidity by torsional vibration 7. Young's modulus and Poisson's ratio by Searle's method 8. Poisson's ratio of rubber by rubber tubing 9. Surface tension of water by capillary rise method 10. Surface tension of water by Jaeger's method 11. Coefficient of viscosity of water by Poiseuille's method 12. Acceleration due to gravity by bar pendulum 13. Frequency of AC mains by Sonometer 14. Frequency of AC mains by Meldies Experiment 15. Acceleration due to gravity by Katers pendulum	
	Online Virtual Lab Experiment List / Link	
	Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=74 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
1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e 2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e 3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019 4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 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. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74 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) 05 marks for Viva Voce 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. • The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List. • 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 **Thermodynamics & Kinetic Theory of Gases**	
I	**0th & 1st 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. Heat Engines, efficiency, Carnot's engine.	8
II	**2nd & 3rd 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.	8
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).	7
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-Boltzmann law and Wien's displacement law from Planck's law.	7

PART B Circuit Fundamentals & Semiconductor Devices		
V	**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, Maximum Power Transfer 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** 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 reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Light Emitting diode, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.	8
VII	**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 stabilization.	8
VIII	**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.	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.

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
Physics in 12th / Chemistry in 12th
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 05 marks for Class Interaction
Suggested Equivalent Online Courses
1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 4. edX, https://www.edx.org/course/subject/physics 5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
• Other Digital Platforms / Web Links and Equivalent Online Courses may be suggested / added to the respective lists by individual Universities. • **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: **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 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. Variation of thermo-emf across two junctions of a thermocouple with temperature 7. Temperature coefficient of resistance by Platinum resistance thermometer 8. A.C. Bridges: Various experiments based on measurement of L and C 9. Thevenin's and Norton's, Maximum Power Transfer theorems 10. Characteristics of PN Junction diode 11. Characteristics of Zener diode 12. Characteristics of Light Emitting Diodes 13. Characteristics of Photo diode 14. Characteristics of a PNP/NPN transistor CB configuration 15. Characteristics of a PNP/NPN transistor CE configuration 16. Characteristics of a PNP/NPN transistor CC configuration 17. Study of Half wave & full wave rectifiers 18. Study full wave rectifiers with Filter circuits	60
	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	

	Semiconductor Devices: Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/be/# 9. Familiarisation with resistor 10. Familiarisation with capacitor 11. Familiarisation with inductor 12. Ohm's Law 13. RC Differentiator and integrator 14. VI characteristics of a diode 15. Half & Full wave rectification 16. Capacitative rectification 17. Zener Diode voltage regulator 18. BJT common emitter characteristics 19. BJT common base characteristics 20. Studies on BJT CE amplifier	

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
4. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e

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=194
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#
3. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

Course Prerequisites

Opted / Passed Semester II, Theory Paper-1 (B010201T)

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)
05 marks for Viva Voce
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.
- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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.

SECOND YEAR

DETAILED SYLLABUS FOR

DIPLOMA

IN

ADVANCED PHYSICS WITH ELECTRONICS

Programme/Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **Physics**		
Course Code: **B010301T**	Course Title: **Electromagnetic Theory & Modern Optics**	

Course Outcomes (COs)

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

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 **Electromagnetic Theory**	
I	**Electrostatics** Electric force between charges, General expression for Electric field in terms of linear, surface and volume charge densities, divergence & curl of Electric field, Gauss law and its applications to linear, surface and volume charge distributions, electric potential, General expression for electric potential in terms of volume charge density of an arbitrary charge distribution, electrostatic energy, Electric potential and field due an electric dipole and quadrupole. Electric fields in dielectrics, polarization, auxiliary field D (Electric displacement), electric susceptibility and permittivity.	8
II	**Magnetostatics** Lorentz force, Bio-Savart's law and its applications, divergence and curl of Magnetic field, Magnetic force between two current elements, Ampere's circuital law (applications included), General expression for Magnetic scalar and vector potential, Magnetic energy density, Magnetic fields in matter, magnetisation, auxiliary field H, magnetic susceptibility and permeability, introduction to diamagnetic, paramagnetic, and ferromagnetic materials.	8
III	**Time Varying Electromagnetic Fields** Faraday's laws of electromagnetic induction and Lenz's law. Self and mutual induction (applications included). Theory and working of moving coil ballistic galvanometer, Displacement current, equation of continuity and Maxwell's correction in Ampere's circuital law, Derivation and physical significance of Maxwell's equations.	7
IV	**Electromagnetic Waves** Electromagnetic energy density and Poynting vector, Plane electromagnetic waves in free space and isotropic dielectrics, Poynting's theorem, Boundary conditions, Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence).	7

PART B Physical Optics & Lasers		
V	**Interference** Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot.	8
VI	**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.	8
VII	**Polarisation** Polarisation by double-refraction, dichroic 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** Characteristics 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), Ruby laser and He-Ne gas laser. Holography	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

Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05 marks for Class Interaction
Suggested Equivalent Online Courses
1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 4. edX, https://www.edx.org/course/subject/physics 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. • **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: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **Physics**		
Course Code: **B010302P**	Course Title: **Demonstrative Aspects of Electricity & Magnetism**	

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.

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 1. Resonance in series and parallel RCL circuit 2. Charging and discharging in RC and RCL circuits 3. Variation of magnetic field along the axis of single coil 4. Variation of magnetic field along the axis of Helmholtz coil 5. Ballistic Galvanometer: Ballistic constant, current sensitivity and voltage sensitivity 6. High resistance by Leakage method 7. Ballistic Galvanometer: Low resistance by Kelvin's double bridge method 8. Ballistic Galvanometer: Self inductance of a coil by Rayleigh's method 9. Comparison of two resistances using a potentiometer. 10. Carey Foster Bridge: Resistance per unit length and low resistance 11. Deflection and Vibration Magnetometer: Magnetic moment of a magnet and horizontal component of earth's magnetic field 12. Earth Inductor: Horizontal component of earth's magnetic field	60
	Online Virtual Lab Experiment List / Link Virtual Labs at Amrita Vishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=192 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
1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e 2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e 3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019 4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 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. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=192 2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.
Course Prerequisites
Opted / Passed Semester III, Theory Paper-1 (B010301T)
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) 05 marks for Viva Voce 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. • The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List. • 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: **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 **Perspectives of Modern Physics**	
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.	7
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.	8
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.	8
IV	**Introduction to Quantum Mechanics** Matter Waves: Principal of linear superposition, Mathematical representation, Wavelength, Concept of Wave group, Group velocity, Phase 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.	7

PART B Basic Electronics & Introduction to Fiber Optics		
V	**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.	7
VI	**Amplifiers** Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade & cascade connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification). Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, and Frequency response) and Transformer coupled power amplifier. 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, Use of heat sink & Power dissipation.	7
VII	**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.	8
VIII	**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.	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

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. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
7. 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.

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

Suggested Continuous Internal Evaluation (CIE) Methods

20 marks for Test / Quiz / Assignment / Seminar
05 marks for Class Interaction

Suggested Equivalent Online Courses

1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
4. edX, https://www.edx.org/course/subject/physics
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.
- **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: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **Physics**		
Course Code: **B010402P**	Course Title: **Basic Electronics Instrumentation**	

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.

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 1. Transistor Biasing/bias Stability 2. Study of CB amplifier 3. Study of CE amplifier 4. Clippers and Clampers 5. Study of Emitter Follower 6. Frequency response of single stage RC coupled amplifier 7. Frequency response of single stage Transformer coupled amplifier 8. Effect of negative feedback on frequency response of RC coupled amplifier 9. Study of Schmitt Trigger 10. Study of Hartley oscillator 11. 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	60

	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	

Suggested Readings

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. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
7. 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.

Suggestive Digital Platforms / Web Links

1. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/psac/#
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#
3. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/index.php?sub=1&brch=201
4. Virtual Labs at Amrita Vishwa Vidyapeetham, http://vlab.amrita.edu/index.php?sub=59&brch=269
5. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

Course Prerequisites

Opted / Passed Semester IV, Theory Paper-1 (B010401T)

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)
05 marks for Viva Voce
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.
- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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.

THIRD YEAR

DETAILED SYLLABUS FOR

DEGREE

IN

BACHELOR OF SCIENCE

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 **Introduction to Classical Mechanics**	
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.	6
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.	9
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.	8
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.	7

PART B Introduction to Statistical Mechanics		
V	**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.	6
VI	**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.	6
VII	**Distribution Laws** 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. 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** 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.	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)

This course can be opted as an Elective by the students of following subjects
Chemistry / Computer Science / Mathematics / Statistics
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05 marks for Class Interaction
Suggested Equivalent Online Courses
1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 4. edX, https://www.edx.org/course/subject/physics 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. • **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: **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 **Introduction to Quantum Mechanics**	
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.	5
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. Proof of the hermitian nature of various physical-dynamical operators.	6
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, Derivation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation, Ehrenfest Theorem	7

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. 1D Harmonic oscillator. Quantum tunnelling. 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).	12
	PART B **Introduction to Spectroscopy**	
V	**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.	10
VI	**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.	6
VII	**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.	7
VIII	**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.	7

Suggested Readings

PART A

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

PART B

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.

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 IV, Theory Paper-1 (B010401T)
This course can be opted as an Elective by the students of following subjects
Chemistry / Computer Science / Mathematics / Statistics
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05 marks for Class Interaction
Suggested Equivalent Online Courses
1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 4. edX, https://www.edx.org/course/subject/physics 5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
• Other Digital Platforms / Web Links and Equivalent Online Courses may be suggested / added to the respective lists by individual Universities. • **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: **Degree**	Year: **Third**	Semester: **Fifth**
Subject: **Physics**		
Course Code: **B010503P**	Course Title: **Demonstrative Aspects of Optics & Lasers**	

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.

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. Fresnel Biprism: Wavelength of sodium light 2. Newton's Rings: Wavelength of sodium light 3. Plane Diffraction Grating: Resolving power 4. Resolving power of telescope 5. Plane Diffraction Grating: Spectrum of mercury light 6. Spectrometer: Refractive index of the material of a prism using sodium light 7. Spectrometer: Dispersive power of the material of a prism using mercury light 8. Polarimeter: Specific rotation of sugar solution 9. Photocell 10. Wavelength of Laser light using diffraction by single slit 11. Wavelength of Laser light using a plane diffraction grating 12. Wavelength of Laser light using Youngs double slit experiment 13. Measurement of wavelength of He-Ne laser using a steel scale 14. Measurement of intensity distribution in a single slit diffraction pattern produced by He- Ne laser.	
	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

Suggested Readings

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 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. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=189
2. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/index.php?sub=1&brch=281
3. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

Course Prerequisites

Passed Semester III, Theory Paper-1 (B010301T)

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

Chemistry / Computer Science / Mathematics / Statistics

Suggested Continuous Internal Evaluation (CIE) Methods

15 marks for Record File (depending upon the no. of experiments performed out of the total assigned experiments)
05 marks for Viva Voce
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.
- The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List.
- 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: **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 **Introduction to Solid State Physics**	
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.	7
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.	7
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.	7

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.	9
	PART B **Introduction to Nuclear Physics**	
V	**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.	9
VI	**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.	9
VII	**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.	6
VIII	**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.	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.

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 V, Theory Paper-2 (B010502T)
This course can be opted as an Elective by the students of following subjects
Chemistry / Computer Science / Mathematics / Statistics
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05 marks for Class Interaction
Suggested Equivalent Online Courses
1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 4. edX, https://www.edx.org/course/subject/physics 5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
• Other Digital Platforms / Web Links and Equivalent Online Courses may be suggested / added to the respective lists by individual Universities. • **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: **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 **Analog Electronic Circuits**	
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. 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. Tunnel Diode, I-V characteristics and applications	9
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).	8
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 D-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of D-MOSFET and E-MOSFET; Comparison of JFET and MOSFET.	8

IV	**Other Devices** SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; and its Applications. UJT: Construction; Equivalent Circuit; Working (Cut-off, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); and its Applications.	5
	PART B **Digital Electronics**	
V	**Number System** Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray & ASCII Codes and their advantages & disadvantages. Data representation.	6
VI	**Binary Arithmetic** 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** 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** Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Subtractor, Full Subtractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders. Sequential Circuits: SR, T, D, JK & M/S JK Flip-Flops, Shift Register (SISO, SIPO, PISO & PIPO), and Asynchronous & Synchronous counters, Modified 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.

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 IV, Theory Paper-1 (B010401T)
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 05 marks for Class Interaction
Suggested Equivalent Online Courses
1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics 2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html 3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 4. edX, https://www.edx.org/course/subject/physics 5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/
• Other Digital Platforms / Web Links and Equivalent Online Courses may be suggested / added to the respective lists by individual Universities. • **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: **Degree**	Year: **Third**	Semester: **Sixth**
Subject: **Physics**		
Course Code: **B010603P**	Course Title: **Analog & Digital Circuits**	

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.

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 1. To study the characteristics of a tunnel diode 2. Hybrid parameters of transistor 3. Characteristics of FET 4. Characteristics of MOSFET 5. Characteristics of SCR 6. Characteristics of UJT 7. FET Conventional Amplifier 8. FET as VVR and VCA 9. Study and Verification of AND gate using TTL IC 7408 10. Study and Verification of OR gate using TTL IC 7432 11. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400 12. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402 13. Study and Verification of NOT gate using TTL IC 7404 14. Study and Verification of Ex-OR gate using TTL IC 7486 15. To plot F-D distribution function in the neighborhood of Fermi energy for different temperature values	60
	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 Serial In - Parallel Out Shift Registers 11. Implementation and verification of decoder or demultiplexer and encoder using logic gates 12. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates 13. Design and verify the 4-Bit Synchronous or Asynchronous Counter using JK Flip Flop 14. Verify Binary to Gray and Gray to Binary conversion using NAND gates only 15. Verify the truth table of 1-Bit and 2-Bit comparator using logic gates	

Suggested Readings

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
6. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
7. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
8. 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.

Suggestive Digital Platforms / Web Links

1. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/ssd/#
2. Virtual Labs an initiative of MHRD Govt. of India, https://de-iitr.vlabs.ac.in/List%20of%20experiments.html
3. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

Course Prerequisites

Opted / Passed Semester VI, Theory Paper-2 (B010602T)

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

Chemistry / Computer Science / Mathematics / Statistics

Suggested Continuous Internal Evaluation (CIE) Methods

15 marks for Record File (depending upon the no. of experiments performed out of the total assigned experiments)
05 marks for Viva Voce
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. • The institution may suggest a minimum number of experiments (say 6) to be performed by each student per semester from the Lab Experiment List. • 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.

Fourth YEAR

DETAILED SYLLABUS

DEGREE

IN BACHELOR OF SCIENCE WITH HONS.

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VII**
Subject : **Physics**		
Course Code : **B010701T**	Course Title: **Mathematical Physics-I**	

Course Outcomes

1. Gain knowledge about special type of matrices that are relevant in physics and then learn about tensors.
2. Get introduced to special functions like Gamma function, Beta function Delta function, Dirac Delta function, Bessel functions and their recurrence relations.
3. Learn different ways of solving second order differential equations and familiarized with singular points and Frobenius method.
4. Learn the fundamentals and applications of Fourier series, Fourier and Laplace transforms, their inverse transforms etc. These mathematical concepts are widely used in various physics derivations.
5. Knowledge about special type of matrices that are relevant in physics and then learn about tensors.

Credit: **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
	Mathematical Physics-I	
1	**Complex Analysis**: Continuity and differentiability of complex functions, Analytic (regular) functions, The Cauchy- Riemann equations, Entire function, Branch cuts and branch points, Line integral in complex plane, Cauchy's integral formula, Taylor's and Laurent's expansions, Liouville's theorem, singularities, Zeroes and poles Residue theorem and contour integration of simple functions, Jordan's lemma, Problems on the above topics.	15
2	**Linear Differential Equation and special Function:** Ordinary point and singularities of a linear differential equation Power series, solution of second order differential equations (Hyper- geometric, Bessel, Legendre, Laguerre and Hermite equations Orthonormality, Rodrigue's formula and other properties of Legendre, Associated Legendre, Bessel Hermite and Laguerre polynomials, its applications in Physics.	15
3	**Linear Vector Space**: A brief review of linear vector spaces, Inner product, norm, Schwarz inequality, linear operators, Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors, adjoint of a linear operator, Hermitian or self-adjoint operators and their properties, unitary operators, ortho-normal basis – discrete and continuous.	15
4	**Probability statistics and Elementary Tensor Analysis**: Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem, Hypothesis Testing and Data Analysis in Statistics. Coordinate transformations, Contravariant and covariant vectors, Contravariant, covariant and mixed tensors, symmetric and skew symmetric tensors, fundamental operations with tensors, metric tensor, conjugate tensors, and associated tensors, Examples of tensors in physics.	15

Suggested Readings

1. Advanced Engineering Mathematics: Erwin Kreyszig
2. Applied Mathematics for Engineer & Physicists: Louis A. Pipes & Lawrence R Harvill
3. Mathematical Methods for Physicists: G. Arfken
4. Mathematical Physics: V. Balakrishnan

5. Mathematical Physics: B.D. Gupta
6. Mathematical Physics: B.S. Rajput
7. Mathematical Physics: H.K. Das & Rama Verma

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VII**
Subject : **Physics**		
Course Code : **B010702T**	Course Title: **Classical Mechanics**	

Course Outcomes

1. This paper enables the students to understand the Lagrangian and Hamiltonian approaches in classical Mechanics.
2. The classical background of Quantum mechanics and get familiarized with poisson brackets and Hamilton-Jacobi equation.
3. Kinematics and dynamics of rigid body in detail and ideas regarding Euler's equation of Motion.
4. Theory of small oscillations in detail along with basis of free vibrations.
5. This paper enables the students to understand the Lagrangian and Hamiltonian approaches in classical Mechanics.

Credit: **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
	Classical Mechanics	
1	Review of Newtonian mechanics, Mechanics of a system of particles, Constraints, Classification of Constraints, Generalized Co- ordinates, Virtual displacement and principle of virtual work, D'Alembert Principle, Lagrange's Equations, Generalized momenta, Cyclic Co-ordinates, Conservation Laws.	15
2	Central forces, definition and characteristics, Two body problems, General analysis of orbits, Keplar's laws and equation,closure and stability of circular orbits Calculus of variation- Euler- Lagrange Equation, Application of Variational Principle, Shortest distance problem, Geodesics of a Sphere, Variation under constraints- Lagrange's multipliers, Hamilton's principle, Lagrange's equations from Hamilton's principle, Problems based on Lagrange's equations, Principle of least action.	15
3	Hamilton's equations and Problems based on it, Canonical Transformation, Generating function, Conditions for canonical transformation and problems, Poisson Brackets and their properties, Invariance of Poisson Bracket under canonical transformation. Symmetry invariance and Noether's theorem.	15
4	Hamilton-Jacobi Equations, Hamilton's principal and characteristic function, Action and Angle Variables, The rigid body motion- Euler Angles, Inertia Tensor and Moment of Inertia, Euler's Equation of motion, Torque free motion of a rigid body, Motion of heavy symmetrical Top, Theory of small oscillations, normal modes.	15

Suggested Readings

1. Classical Mechanics: Herbert Goldstein, Addison-Wesley.
2. Introduction to Classical Mechanics: David Morin, Cambridge University Press
3. Mathematical methods of Classical Mechanics: V.I. Arnold, Springer
4. Classical Mechanics: G. Aruldhas, PHI learning Private Ltd.

5.	Classical Mechanics: Systems of Particles and Hamiltonian Dynamics: Walter Greiner, Springer.

Programme/Class: Degree	**Year: Fourth**	**Semester: VII**
Subject : **Physics**		
Course Code: **B010703T**	Course Title: **Electromagnetic Theory**	

Course Outcomes

1. Apply Maxwell's equations in both vacuum and material media to analyze static and dynamic electromagnetic fields, including the concept of displacement current and Maxwell's correction to Ampere's Law.
2. Derive and apply boundary conditions for electric and magnetic fields at interfaces and utilize Poynting's theorem to understand energy and momentum conservation in electromagnetic systems.
3. Formulate electromagnetic phenomena using scalar and vector potentials, understand the wave equation, and analyze the implications of gauge freedom, including Coulomb and Lorenz gauges.
4. Evaluate the behavior of plane electromagnetic waves in various media (vacuum, dielectric, conductor, and plasma), and analyze reflection, refraction, and polarization using Fresnel's equations and the concept of dispersion.
5. Analyze wave propagation in rectangular and cylindrical waveguides, identify TE and TM modes, determine cutoff frequencies, and compute power transmission and attenuation characteristics.
6. Describe the operation of cavity resonators and calculate radiation fields due to electric and magnetic dipoles, understanding their applications in antenna theory and electromagnetic radiation.

Credit: **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**
	Electromagnetic Theory	
1	Maxwell's Equations in vacuum and matter, Maxwell's correction to Ampere's law for non-steady currents and concept of Displacement current, Boundary conditions for electromagnetic fields, Poynting's theorem, Conservation of energy and momentum for a system of charged particles and electromagnetic field.	15
2	Vector and scalar potentials, Maxwell's Equations in terms of Electromagnetic Potentials, Electromagnetic wave equation, Non-uniqueness of Electromagnetic Potentials and Concept of Gauge. Gauge Transformations: Coulomb and Lorenz Gauge, Transformation Properties of Electromagnetic Fields and Sources under Rotation, Spatial Inversion and Time-Reversal.	15
3	Propagation of Electromagnetic Plane Waves in Vacuum, Non-conducting Medium, Conducting Medium and Plasma, Reflection, Refraction and Polarization of Electromagnetic Waves, Fresnel Formulae, Total internal reflection and critical angle, Frequency Dispersion Characteristics of Dielectrics and Conductors; Normal and Anomalous Dispersion, Kramer Kronig Relations.	15
4	Basic concept of waveguide, Propagation of Electromagnetic Waves in Rectangular Waveguides, TE and TM Modes, Cut off frequency, Energy Flow and Attenuation. Modal Analysis of guided modes in a cylindrical waveguide, Cavity resonator, Radiation due to electric and magnetic dipoles.	15

Suggested Readings

1. Introduction to Electrodynamics: David J. Griffiths (Prentice-Hall of India, New Delhi).

2. Classical Electrodynamics: John David Jackson (Wiley India).
3. Theory and Problems of Electromagnetics: Joseph A. Edminster (Tata Mc Graw Hill).
4. Electricity and Magnetism: E.M. Purcell (Berkeley Physics Course , Vol II, Mc Graw- Hill).
5. Foundations of Electromagnetic Theory: J. R. Reitz, F. J. Milford and R. W. Christy (Pearson).

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VII**
Subject : **Physics**		
Course Code: **B010704T**	Course Title: **Quantum Mechanics-I**	

Course Outcomes

1. Linear vector spaces, Hilbert space, concepts of basis and operators and bra and ket notation.
2. Both Schrodinger and Heisenberg formulations of time development and their applications.
3. Theory of angular momentum and spin matrices, orbital angular momentum and Clebsh Gordan Coefficient, space time matrices and conservation laws, Theory of identical particles.
4. Theory of scattering and calculations of scattering cross section, optical theorem, partial wave analysis.
5. Linear vector spaces, Hilbert space, concepts of basis and operators and bra and ket notation.

Credit: **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
	Quantum Mechanics-I	
1	Mathematical properties of linear vector spaces. Dirac's bra and ket notation. Hermitian operators, eigenvalues and eigenvectors. Orthonormality, completeness, closure. Postulates of quantum mechanics. Matrix representation of operators. Position and momentum representations – connection with wave mechanics. Commuting operators. Generalised uncertainty principle. Change of basis and unitary transformation. Expectation values. Ehrenfest theorem.	15
2	Schrodinger picture, Heisenberg picture, Heisenberg equation of motion, classical limit, Solution of simple harmonic oscillator problem by the operator method, general view of symmetries and conservation laws, Symmetries in Quantum Mechanics : hydrogen-like atoms and spherical harmonics. Spatial translation – continuous and discrete, time translation. parity, time reversal, Density matrices - properties, pure and mixed density matrices, expectation value of an observable, time-evolution, reduced density matrix.	15
3	Commutation relations of angular momentum operators. Eigenvalues, eigenvectors. Ladder operators and their matrix representations. Spin angular momentum and Pauli matrices. Identical particles: Many-particle systems, Exchange degeneracy, symmetric and anti- symmetric wave functions. Pauli exclusion principle. Addition of angular momenta. Clebsch- Gordan coefficients. Wigner - Eckart theorem.	15
4	Identical Particles: Symmetric and anti-Symmetric wave functions, Pauli exclusion principle	15

Suggested Readings

1. Quantum Mechanics: B.H. Bransden & C.J. Joachain (Pearson, 2000)
2. Quantum Mechanics: Concepts and Applications: Nouredine Zettili (Wiley, 2016)
3. Introduction to Quantum Mechanics: David J Griffiths (Pearson,2015)
4. Quantum Mechanics -Theory and Applications: Ajoy Ghatak (Trinity, 2015)
5. Principles of Quantum Mechanics: R. Shankar (3rd Ed., Springer, 2008)

6. Modern Quantum Mechanics: J.J. Sakurai (Addison-Wesley, 1993)
7. Quantum Mechanics: Eugen Merzbacher (3rd Ed., Wiley, 1997)

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VII**
Subject : Physics		
Course Code : **B010705P**	Course Title: **Practical Lab**	

Course Outcomes

1. Understand and analyze the working and performance of a regulated power supply, including voltage regulation and ripple reduction.
2. Measure inductance and capacitance accurately, and analyze the behavior of LCR circuits in both series and parallel configurations under resonant conditions.
3. Plot and interpret the I-V characteristics of a Silicon Controlled Rectifier (SCR) and understand its applications in power control.
4. Understand the operation of a Uni-junction Transistor (UJT) and analyze its I-V characteristics, with focus on negative resistance behavior and triggering applications.
5. Analyze the characteristics of a MOSFET, understanding its regions of operation and use in analog and digital electronics.

Credit: **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 Hours: 120**

Lab Experiment List

1. Measurement of inductance and capacitance and study of LCR series and parallel resonance circuits
2. Study of low pass. high pass and band pass filters
3. Measurement of inductance and capacitance using AC bridges
4. Measurement of Stephan's constant of radiation
5. Study of transistorized multivibrators
6. Energy band gap of semiconductor by reverse saturation current method
7. Study of L-C and R-C transmission line
8. Verifying RAM
9. FET common source amplifier with sine wave oscillator
10. SCR characteristics,
11. experiments using opto-electronic kit etc.
12. BH- curve

Suggested Readings

1. B.S. Arora – Practical Physics
2. S.L. Gupta & V. Kumar – Practical Physics
3. C.L. Arora – B.Sc. Practical Physics
4. "Basic Electronics (Solid State)" – B.L. Theraja

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VIII**
Subject : **Physics**		
Course Code : **B010801T**	Course Title: **Mathematical Physics-II**	

Course Outcomes

1. Understanding of methods of determination of zeroes of linear and nonlinear algebraic and transcendental equations, convergence of solutions.
2. Know about Green Function and Fourier series etc.
3. Knowledge of numerical differentiation and integration.
4. To learn numerical solution of ordinary differential equation.

Credit: **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
	Mathematical Physics-II	
1	Partial differential equations, Lagrange's linear equation, Method of multipliers Solutions of Laplace, Poisson, Diffusion and wave equations in cartesian, spherical and cylindrical co-ordinates Physical applications of the above topics.	15
2	In-homogeneous equations, Green's function for a free particle, Fourier series, Dirichlet's conditions, Even and odd functions, Parseval's identity for Fourier series Fourier integral, Dirac Delta Function, Properties and applications, Fourier and Laplace Transforms. Physical applications of the above topics.	15
3	Groups, subgroups, cosets, invariant subgroups, factor groups, homomorphism and isomorphism, Representations: reducible and irreducible, unitary representations, Schur's lemma and orthogonality theorems, characters of representation, direct product of representations, Continuous groups with special reference to SO(3), SU(2),SU(3).	15
4	Methods of numerical analysis: Finite difference with equal and unequal intervals, Interpolation formulae, Errors and accuracy tests in numerical analysis, the iterative algorithms for solving equations and finding roots Discrete Fourier Transform, Fast Fourier Transform with its advantages in sciences integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods.	15

Suggested Readings

1. Advanced Engineering Mathematics: Erwin Kreyszig
2. Applied Mathematics for Engineer & Physicists: Louis A. Pipes & Lawrence R Harvill
3. Mathematical Methods for Physicists: G. Arfken
4. Mathematical Physics: V. Balakrishnan
5. Mathematical Physics: B.D. Gupta
6. Mathematical Physics: B.S. Rajput
7. Elementary Ideas of Group Theory: A.W. Joshi
8. A Friendly Introduction to Group Theory: David Nash
9. Group Theory: W.R. Scott
10. Introductory methods of Numerical Analysis: S.S. Sastry
11. An Introduction to Numerical methods and analysis: Jmes F. Eppeson

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VIII**
Subject : **Physics**		
Course Code : **B010802T**	Course Title: **Solid State Physics**	

Course Outcomes

1. Describe various crystal structures and identify symmetry elements such as rotation axes, mirror planes, inversion centers, screw axes, and glide planes.
2. Differentiate between different Bravais lattices and understand concepts like close-packed structures, Wigner-Seitz cells, and Miller indices.
3. Explain the principles of X-ray, electron, and neutron diffraction and their suitability for crystal structure determination.
4. Explain the formation of energy bands in periodic potentials using Bloch theorem, nearly free electron approximation, and tight-binding models.
5. Understand the fundamental concepts of superconductivity, including Meissner effect, energy gap, isotope effect, and London equations.

Credit: **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
	Solid State Physics	
1	Crystal structure, symmetry elements in crystals, proper rotation axis, plane of symmetry, inversion centre, screw axis, Glide plane, Type of Bravais lattices, closed packed structures, diamond structure, Zinc blend structure, Weigner-Seitz cell, Miller indices.	15
2	Choice of x-ray, electron and neutron for crystal structure determination, Bragg's diffraction, Reciprocal lattice, The Braggs condition and Ewald construction, Brillouin zones of SCC, BCC and FCC lattices, Atomic Scattering factor, Geometrical structure factor, Laue method, Rotating crystal method, Powder method.	15
3	Drude theory, DC conductivity, magneto-resistance, thermal conductivity, thermoelectric effects, Fermi-Dirac distribution, thermal properties of an electron gas, Wiedemann- Franz law, critique of free-electron model.	10
4	Electron in a periodic lattice, Bloch theorem, Band theory, Effective mass, Nearly free electron approximation, tight binding approximation, Fermi surfaces, Cyclotron resonance. Semiconductors: General properties and band structure, carrier statistics, impurities, intrinsic and extrinsic semiconductors, drift and diffusion currents, mobility, Hall effect. Superconductivity: Concept of superconductivity, Meissner effect, Type I and type II superconductors, Energy gap, Isotope Effect, London equations, Penetration depth, Coherence length, Super-conductivity ground state.	20

Suggested Readings

1. Charles Kittel:Solid StatePhysics
2. Caikin and Lubensky: Principles of Condensed Matter Physics
3. Aschroft and Mcrmin: Solid state physics
4. Azaroff: Introduction to Solids
5. Verma and Srivastava: Crystallograpby for Solid state Physics

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VIII**
Subject : **Physics**		
Course Code: **B010803T**	Course Title: **Statistical Mechanics**	

Course Outcomes

1. Explain statistical physics and thermodynamics as logical consequences of the postulates of Statistical mechanics, Apply the principles of statistical mechanics to selected problems.
2. Grasp the basis of ensemble approach in statistical mechanics to a range of situation.
3. To learn the fundamental differences between classical and quantum statistics.

Credit: **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
	Statistical Mechanics	
1	Foundation of Statistical Physics: Phase space, microstates and macro states; Liouville's equation, Postulates of statistical mechanics, Review of probability concepts; Random walk problem in one dimension-binomial distribution, Specification of state of system, Concept of statistical equilibrium, Fundamental postulates of equal a priory probability.	15
2	Ensembles: Micro-canonical, Canonical and grand canonical ensembles and their comparative study, Partition function, Calculation of statistical quantities in terms of partition function (connection to thermodynamics), Entropy of mixing of gases (Ising partition function), Gibbs paradox and its resolution; Derivation of equation of state of classical ideal gas using partition function.	15
3	Quantum statistics: Ideal quantum gas, Indistinguishability, Maxwell-Boltzman, Bose-Einstein and Fermi-Dirac statistics, Photon statistics, Ideal Bose gas, Bose-Einstein condensation, Ideal Fermi gas, Correlation function.	10
4	Interacting systems and phase transitions: Interacting spin systems. The Ising model,Exact solution of Ising model in 1-dimension, mean-field solution in higher dimensions, Paramagnetic and ferromagnetic phases. Critical exponents. Order parameter, Landau theory.	10

Suggested Readings

1. Statistical Physics of Particles, Mehran Kardar (Cambridge University Press, 2007).
2. Statistical Mechanics, Kerson Huang (2ndEdition, Wiley-India, 2008).
3. Statistical Mechanics, R.K. Pathria (Butterworth-Heinemann, 1996).
4. Statistical Mechanics:An Advanced course with problems and solutions, Ryogo Kubo (North-Holland, 1965).

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VIII**
Subject : **Physics**		
Course Code : **B010804T**	Course Title: **Electronics**	

Course Outcomes

1. Power bipolar junction transistor, Power MOSFET, Junction Transistor, Silicon controlled rectifier applications
2. Schottky Barrier FET (MES FET) avalanche and transit time Tunnel diode.
3. Electron – Hole pair generation, Light emitting diode, Photoconductivity Cell, Photodiode applications
4. Complementary metal oxide semiconductor, Static random access memory

Credit: **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
	Electronics	
1	Operational Amplifier: Differential Amplifier, circuit configurations, dual input., balanced output differential amplifier. DC analysis, AC analysis, inverting and non-inverting inputs, CMRR, constant current bias level translator. Block diagram of a typical Op-Amp analysis. Open loop configuration. inverting and non- inverting amplifiers. Op-Amp with negative feedback, voltage series feedback, effect of feedback on closed loop gain input persistance output resistance bandwidth and output offset voltage, voltage follower. Practical Op-Amp input offset voltage, input bias current, input offset current, total output offset voltage, CMRR frequency response.	15
2	Adder, Subtractor, Summing amplifier, Integrator and differentiator, Logarithmic and anti logarithmic amplifier, Oscillators principles, oscillator types, frequency Stability, response, Phase shift, Weinbridge,LCtunable oscillators, Square wave and Triangular wave generators, VCO, Comparators, Schmitt trigger, V/F and F/V converter, A/D and D/A converters, Sample and hold circuit, multivibrators.	15
3	Optoelectronic devices: Radiative and non-Radiative transition, photon absorption and emission in semiconductors, Electron- Hole pair generation rate, Light emitting diode (LED} construction, working principle, generation of light and external quantum efficieney, high frequency limit, effect of surface and indirect r e c o mb in a tio n current in LED. Photodiodes, Phototransistors, Solar Cell- open circuit voltage, short circuit current, Fill factor.	15
4	Fiber Optics: Structure and Classification, Single & Multimode, Step & Graded Index, light propagation through optical fiber, acceptance angle andnumerical aperture, fiber fabrication techniques, Transmission characteristics of optical fibcr, Attenuation pulse broadening mechanism, intermodal dispersion, material dispersion. Fiber Loss.	15

Suggested Readings

1. Ghatak and K. Thyagrajan Optical Electronics
2. M. S. Tyagi: Introduction to semiconductor devices
3. S. M. Sze:Physics and Technology of Semiconductor Devices

Programme/Class: **Degree**	Year: **Fourth**	Semester: **VIII**
Subject : **Physics**		
Course Code : **B010805P**	Course Title: **Practical lAB**	

Course Outcomes

1. Understand the concept of laser interference and diffraction to measure the wavelength of coherent light sources using simple tools.
2. Analyze diffraction phenomena and verify theoretical intensity distributions using laser light and photodetectors.
3. Apply the concept of optical path difference and fringe shift to determine thickness of transparent thin films.
4. Use deviation and birefringence principles to measure the thickness of anisotropic optical materials.

Credit: **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 Hours: 120**

List of Experiments

1. Thickness of quartz plate using constant deviation
2. Resolving power of prism
3. Young's Modulus and Poisson's ratio of glass by Comu's fringes
4. Michelson Interferometer
5. Febri-Perot Interferometer
6. Study of Voltage regulation of power supply using Zener diode and transistor.
7. Electronic spin resonance (ESR)
8. Study for multivibrator /transistorized multivibrator
9. Measurement of resistivity of semiconductor by four probe method and determination of band Gap
10. h- parameters, differential FET amplifier
11. Susceptibility
12. Operational amplifier application trainer

Suggested Readings

1. B.Sc./M.Sc. Practical Physics – C.L. Arora (especially good for step-by-step lab work)
2. Practical Physics – S.L. Gupta & V. Kumar
3. Advanced Practical Physics for Students – B.L. Worsnop & H.T. Flint
4. Engineering Practical Physics – B.S. Arora

DEGREE

IN BACHELOR OF SCIENCE WITH RESEARCH

Programme/Class: **Degree**	Year: Fifth	Semester: **IX**
Subject : Physics		
Course Code: **B010901T**	Course Title: **Classical Electrodynamics & Plasma Physics**	

Course Outcomes

1. Explain the structure and classifications of Lorentz groups including homogeneous and inhomogeneous , proper, improper, orthochronous, and antichronous transformations.
2. Formulate Maxwell's equations in covariant tensorial form using the field-strength tensor and its dual.
3. Analyze the transformation behavior of electric and magnetic fields under Lorentz transformations and the role of canonical and symmetric stress tensors.
4. Derive and apply the Lagrangian and Hamiltonian formulations for a relativistic charged particle in an electromagnetic field.
5. Describe the fundamental properties of plasma and derive moment equations from the Boltzmann equation.

Credit: 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
	Classical Electrodynamics & Plasma Physics	
1	Homogeneous and inhomogeneous (Poincare) Lorentz groups, Pseudo-Euclidean spacetime, Spacetime rotations, rapidity, Proper, improper, orthochronous, antichronous Lorentz groups, Light cone and Matrix representation of Lorentz transformations, Spacelike, time like and light like Four-vectors, orthogonality, Four-tensors, four- velocity, four-momentum, four-acceleration, Minkowski force.	15
2	Covariant form of continuity equation, 2-Form electromagnetic field-strength tensor, dual field- strength tensor, Covariant formulation of Maxwell's field equations with gauge invariance, Lorentz force equation in covariant form, Transformation of electromagnetic fields as tensor components, Proca Lagrangian with Photon mass, Canonical approach to electrodynamics, Lagrangian and Hamiltonian formulation for a relativistic charged particle in external electromagnetic field, Canonical and Symmetric Stress Tensors, Solution of the wave equation in covariant form.	15
3	Retarded and advanced potentials, Lienard-Wiechert potentials for a moving point charge, Fields produced by a charge in uniform and accelerated motion, Radiation from an accelerated charge, Radiated power, Larmor's formula and its relativistic generalization, Thomson scattering of radiation, Thomson cross section.	15
4	Elementary concepts of plasma, derivation of moment equations from Boltzmann's equation. Plasma oscillation, Debye shielding, plasma confinement, magneto plasma. Fundamental equations, hydromagnetic waves: magnetosonic waves, Alfven waves, wave propagation parallel and perpendicular to magnetic field.	15

Suggested Readings

1. Classical Electrodynamics: John David Jackson (Wiley India).
2. Introduction to Electrodynamics: David J. Griffiths (Prentice-Hall of India, New Delhi).
3. An Introduction to Relativity: J. V. Narlikar (Cambridge Univ Press).
4. Introducing Einstein's Relativity: Ray D'Inverno (Clarendon Press, Oxford)
5. Electromagnetic Field Theory for Engineers and Physicists: G. Lehner (Spinger).
6. Modern Electrodynamics: A. Zangwill (Cambridge University Press)

Programme/Class: **Degree**	Year: **Fifth**	Semester: **IX**
Subject **: Physics**		
Course Code : **B010902T**	Course Title: **Quantum Mechanics- II**	

Course Outcomes

1. The primary goal of this course is to develop an understanding of some of the more advanced topics and techniques used in quantum mechanics.
2. Students should have knowledge about: - Fundamental concepts and the mathematical formalism used in the general formulation of quantum mechanics (QM)
3. Understand the concept of cross section and Born approximation
4. Understand the significance of Relativistic wave equations

Credit: **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
	Quantum Mechanics- II	
1	Approximation Methods for Stationary Systems: Time-independent perturbation theory - (a)non- degenerate and (b) degenerate, Variational Method; WKB method and its applications.	15
2	Time Dependent Perturbation theory, Transition to a continuum of final states- Fermi Golden Rule, Applications, Semi-Classical theory of radiation.	15
3	Scattering: Non-relativistic scattering theory, differential and total scattering cross section, Born approximation method with examples of scattering by Coulomb, Gaussian, Square well and Yukawa potentials. Partial wave analysis, optical theorem, phase shift, example of scattering by square well potential.	15
4	Relativistic QM: Klein-Gordon equation, Dirac equation. Properties of Dirac matrices, Plane wave solution of Dirac equation, spin and magnetic moment of the electron, non-relativistic reduction to Dirac equation.	15

Suggested Readings

1. Principles of Quantum Mechanics: R Shanker
2. Quantum Mechanics by B.H. Bransden & C.J. Joachain (Pearson Education, 2000)
3. Quantum Mechanics (vol 1): Tannoudji
4. Modern Quantum Mechanics by J.J. Sakurai (Addison-Wessley, 1993)
5. Quantum Mechanics: Concepts and Applications, Nouredine Zettili (Wiley 2nd edition 2009)
6. Quantum Mechanics: E Merzbacher
7. Introduction to Quantum Mechanics: Griffiths
8. Quantum Mechanics: Schiff
9. Quantum Mechanics :Liboff
10. Quantum Mechanics Theory and Applications: Ghatak and Loknathan
11. Relativistic Quantum Fields, Vol.II, J.D. Bjorken and S.D. Drell (McGraw-Hill, 1978)
12. Relativistic Quantum Fields, Vol.I, J.D. Bjorken and S.D. Drell (McGraw-Hill, 1964)

Programme/Class: **Degree**	Year: **Fifth**	Semester: **IX**
Subject : **Physics**		
Course Code : **B010903T**	Course Title: **Nuclear Physics- I**	

Course Outcomes

1. Describe the basic properties of nuclei such as mass, binding energy, spin, magnetic moment, and electric quadrupole moment.
2. Explain the Fermi theory of beta decay, differentiate between allowed and forbidden transitions, and analyze beta spectra using Kurie plots and Sergeant's law.
3. Differentiate between Fermi and Gamow-Teller transitions and extract the Fermi constant from beta-decay data.
4. Analyze gamma-ray emission processes, including multipolarity, selection rules, and theoretical transition probabilities using Weisskopf estimates.
5. Describe the basics of the optical model and mechanisms of direct nuclear reactions.

Credit: **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
	Nuclear Physics- I	
1	Basic facts about nuclei, Mass and binding energy, Semi-empirical mass formula, Nuclear size determination using mu-mesic X-rays and scattering of fast electrons, Nuclear spin and magnetic moment of nuclei, Molecular beam resonance method, Nuclear induction method, Electric quadrupole moment.	15
2	Alpha decay, Alpha spectra, Selection rules, Geiger-Nuttall relation, Theory of alpha decay, Beta- spectra, Fermi's theory of beta decay, Sergeant's law, Kurie Plot, Allowed and forbidden transitions, Fermi and Gamow Teller Transition, Extraction of Fermi constant, Parity violation in beta-decay, Detection of neutrino.	15
3	Gamma emission, Multi-polarity of gamma rays, Selection rules, Theoretical prediction Transition probability, estimation of transition probability for single particle (Weisskopf unit), Internal conversion, Angular correlation, Nuclear isomerism, Mossbauer Effect and its applications.	15
4	Nuclear reactions, Conservation laws, The Q-equation and deduction of nuclear energy, Compound nucleus, Bohr hypothesis, Resonance phenomenon, Breit-Wigner single level formula, Optical model, Simple discussion of direct reactions. Nuclear fission, Bohr-Wheeler theory of nuclear fission, Controlled chain reaction, Nuclear reactors, Nuclear Fusion.	15

Suggested Readings

1. Nuclear Physics: Krane K.S., Wiley India Pvt. Ltd., (2008).
2. Nuclear physics principles and applications: Lilley J.S., John Wiley & sons Ltd.,
3. The Atomic Nucleus: Evans R. D. Tata McGraw Hill, 1955.
4. Atomic and Nuclear Physic: S N. Ghoshal, Vol. II.,2000.
5. Nuclear Physics: R. R. Roy and B. P. Nigam, Wiley-Eastern Ltd. 1983.
6. Introduction to Nuclear Physics: Wong, PHI.
7. Introduction to Nuclear and Particle Physics: A Das and T Ferbel.

Programme/Class: **Degree**	Year: **Fifth**	Semester**: IX**
Subject : **Physics**		
Course Code : **B010904T**	Course Title: **Electronics I**	

Course Outcomes

1. Explain the propagation of EM waves through ground, space, and sky waves; analyze wave behavior in transmission lines including coaxial cables using the line equation and concepts of characteristic impedance, reflection coefficient, and standing wave ratio (SWR).
2. Demonstrate understanding of fiber optics and wireless communication principles and their role in modern communication systems.
3. Analyze the working principles of different types of antennas, including linear dipole and antenna arrays; understand antenna matching techniques and basic antenna characterization.
4. Explain the working principle, operation, and applications of radar systems in communication and remote sensing.
5. Evaluate signal-to-noise ratio (SNR) and explore techniques for enhancing SNR in communication and instrumentation systems; understand noise reduction strategies in electronic circuits.
6. Understand the principles of phase-locked loops (PLLs), lock-in amplifiers, and sample-and-hold circuits and their application in precise signal processing.

Credit: **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
	Electronics I	
1	Communication: EM wave propagation- transmission lines, line equation, coaxial cable, Propagation of ground wave, space wave and Sky wave, Characteristic impedance, reflection coefficient, Standing wave ratio and measurement of impedance in various media, Antennas: Linear dipole antennas, Antenna array techniques, Systems and characterization antenna matching and basic antenna types, Radar-principle, operation and application.	15
2	Noise: Introduction to Noise, types, Signal to noise ratio (SNR) and enhancement of SNR in instrumentation and communication. Noise reduction in electronic circuits. Principles of phase locking and lock-in amplifier, Sample and hold circuits.	15
3	Microprocessor: Introduction to microcomputers, memory, input/output interfacing devices. 8085 microprocessor, Architecture, Microprocessor initiated operations, 1nternal data operation, Externally initiated operations, Instruction set and addressing modes, 8085 programming, Writing simple progmns of addition, subtraction, multiplication and division of two numbers.	15
4	Microwave Devices & Communication: Klystrons, Magnetrons and Travelling Wave Tubes, Velocity modulation, Basic principles of two cavity Klystrons and Reflex Klystrons, principles of operation of Magnetrons. Helix Travelling Wave	15

	Tubes, Wave Modes. Advantages and disadvantages of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem. ground reflection, Fading sources, detectors, components, antennas used in microwave communication systems.	

Suggested Readings

1. Digital Principles and Applications, A. P. Malvino and D. P. Leach, Tata McGraw Hill. Digital Integrated Electronics, Taub and Schilling, McGraw Hill Co.
2. Principles of Communication Systems, Taub and Schilling, McGraw Hill Co. Communication Systems, Simon Haykin, John Wiley & Sons, Inc.
3. Modem Digital and Analog Communication Systems, BP Lathi, Oxford Univ. Press
4. Microprocessor Architecture, Programming and Application with 8085, Ramesh S. Gaonkar,Willey-Eastern Ltd.
5. Electronic Communications, Dennis Roddy & John Coolen, Pearson Education.
6. Electronic Communication System, George Kennedy & Bernard Davis, McGraw Hill Pub.
7. Computer Networks. Andrew S. Tanenbaum, Prentice Hall Inc.

Programme/Class: **Degree**	Year: **Fifth**	Semester: **IX**
Subject : **Physics**		
Course Code : **B010905T**	Course Title: **Condensed Matter Physics-I**	

Course Outcomes

1. Interpret the concept of Fermi surfaces and explain experimental techniques for their determination.
2. Explain quantum phenomena such as Landau quantization, de Haas–van Alphen effect, and the integral quantum Hall effect.
3. Understand the macroscopic and microscopic electric fields in dielectric materials and their relationship to polarization and dielectric constant.
4. Differentiate between ferroelectric, antiferroelectric, piezoelectric, and ferroelastic materials based on their physical behavior and symmetry properties.
5. Apply models of local fields and polarizability to describe dielectric behavior in various solid-state systems.

Credit: **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
	Condensed Matter Physics-I	
1	Transport Properties of Solids: Boltzmann transport equation, resistivity of metals and semiconductors, Fermi surfaces –determination, Landau levels, de Hass van Alphen effect, Quantum Hall effect- Integral quantum Hall effect and Magnetoresistance.	15
2	Dielectric Properties of Solids: Dielectrics and ferroelectrics, macroscopic electric field, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, piezoelectric crystals, ferroelasticity, electrostriction.	15
3	Optical properties: Optical constants and their physical significance, Reflectivity in metals, plasmonic properties of metals, determination of band gap in	15

	semiconductors: direct and indirect band gap, defect mediated optical transitions, excitons, photoluminescence, Electroluminesence	
4	Magnetism: Types of magnetic materials, Quantum theory of paramagnetism, Hund's rule, Ferromagnetism, antiferromagnetism: molecular field, Curie temperature. Domain theory, Magnetic Anisotropy, Magnetic interactions, Heitler-London method, exchange and superexchange, magnetic moments and crystal-field effects, spin-wave excitations and thermodynamics, antiferromagnetism, Magnetostriction.	15

Suggested Readings

1. Solid State Physics, N. W. Ashcroft and N.D. Mermin(Ist Ed., Cengage Learning, 2003)
2. Elementary Excitations in Solids, D. Pines (CRC press, 1999)
3. The Wave Mechanics of Electrons in Metals, S. Raimes (North-Holland, 1970)
4. Lecture Notes on Electron Correlation & Magnetism, P. Fazekas (World Scientific, 1999)
5. Condensed Matter Physics,M. Marder(2nd Ed., John Wiley & Sons, 2010)
6. Principles of Condensed Matter Physics,P.M. Chaikin and T.C. Lubensky (Cambridge University Press, 1995)
7. Crystal Structure Analysis by Buerger
8. Elementary Solid State Physics by M. Ali Omar
9. Physics of Quasi Crystals by Steinhard and Oustlan
10. Quantum theory of Solids by Callaway

Programme/Class: **Degree**	Year: **Fifth**	Semester: **IX**
Subject : **Physics**		
Course Code : **B010906P**	Course Title: **Practical Lab**	

Course Outcomes

1. Analyze crystal structures using powder X-ray diffraction data to determine lattice parameters and index diffraction peaks.
2. Evaluate carrier concentration and mobility in semiconductors through Hall effect measurements and analyze the type of majority carriers.
3. Correlate thermal and electrical properties of conductors using the Wiedemann–Franz law, and calculate the Lorentz number.
4. Verify Curie-Weiss behavior in ferroelectric materials and relate dielectric constant variations to phase transitions.
5. Investigate thermal relaxation behavior and validate theoretical models such as Debye relaxation in electrical components like light bulbs.
6. Analyze the characteristics of operational amplifiers (OP-AMPs) including input offset voltage, input bias current, CMRR, and slew rate.
7. Understand and evaluate the performance of transistorized differential amplifiers.
8. Use OP-AMPs as comparators and Schmitt triggers, and analyze their switching behavior and hysteresis
9. Study and explain the operation of **Voltage-to-Frequency (V/F)** and **Frequency-to-Voltage (F/V)** converters, exploring their applications in data conversion and sensing.

Credit: **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 Hours: 120**

Lab Experiment List (Condensed Matter Physics-I)

1. Determination of lattice parameter and indexing of powder photographs/ X-ray diffraction simulation
2. Study of dispersion curves of mono atomic lattice using given transmission lines.
3. Study of dielectric constant
4. Measurement of Hall coefficient of given semiconductor to estimate charge carrier Concentration.
5. Measurement of thermal and electrical conductivity of copper and determination of Lorentz number.
6. Measurement of thermal conductivity of poor conductor (Perspex)
7. Measurement of thermal diffusivity of brass
8. Verification of Curie-Weiss law for ferroelectric material
9. Measurement of thermal relaxation time of a serial light bulb and verification of Debye relaxation formula.
10. Magneto resistance

AND/OR

Lab Experiment List (Electronics-I)

1. To study OP-AMP characteristics
2. To study OP-AMP applications
3. To study transistorized dilferential amplifier.
4. To study OP-AMP as a Comparator and Schmitt Trigger.
5. Wave shaping circuits, data processing circuits, Active filters
6. To study the operation of V/F & F/V converter.
7. Fiber optic trainer
8. To study Wien Bridge, Phase-Shift and Colpitt Oscillators.
9. To study A stable, Mono-stable and Bi-stable multivibrators.
10. To study the operation of PLL and VCO.
11. To study BCD to 7 segment Decoder, BCD to Excess-3 code, Binary to Gray and Gray to Binary conversion.
12. To study 4 Bit R-2R ladder DAC and 4 Bit Counter type ADC.
13. To study 4 Bit Synchronous and Ripple Counter.

Suggested Readings

1. M.N. Avadhanulu and P.G. Kshirsagar,A Textbook of Engineering Physics (Experiments and Theory), S. Chand, 2020.
2. B.D. Cullity and S.R. Stock, Elements of X-ray Diffraction, 3rd Edition, Pearson Education, 2001.

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code: **B011001T**	Course Title: **Atomic And Molecular Physics**	

Course Outcomes

1. Explain the principles of quantum theory, spin-orbit interaction, and the spectroscopic description of atomic electronic states using term symbols and intensity rules.
2. Analyze the fine structure of hydrogen and alkali metal spectra, including the effects of penetrating and non-penetrating orbits, and apply empirical laws such as Rydberg-Schuster, Runge's Law, and the Ritz Combination Principle.
3. Evaluate atomic spectra of alkaline earth metals and interpret singlet and triplet terms using coupling schemes for two-electron systems, applying Hund's rules and Lande's interval rule.
4. Understand and distinguish between the Normal and Anomalous Zeeman Effects, Paschen-Back effect, Stark effect, hyperfine structure, isotope effect, and Lamb shift in atomic spectra.
5. Describe and analyze microwave, infrared, and Raman spectra of diatomic and polyatomic molecules, including selection rules, rotational-vibrational transitions, and isotopic shifts.
6. Apply the Franck-Condon principle to understand vibrational-electronic spectra, dissociation energies, and the breakdown of the Born-Oppenheimer approximation in molecular spectra.

Credit: **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
	Atomic And Molecular Physics	
1	Introduction to Quantum theory, Spin-Orbit interaction energy, Doublet separation, Spectroscopic Description of Atomic Electronic States – Term Symbols, Intensity rules for fine structure doublet, Fine structure of Hydrogen lines. Optical spectra of alkali metals, Non-penetrating and penetrating orbits, Rydberg-Schruster law, Runge's Law, The Ritz Combination Principle, Optical spectra of alkaline earth elements, Singlet and triplet terms.	15
2	Coupling scheme for two electron systems – non-equivalent and equivalent electron cases, Hund's rule, Lande's interval rule. Normal and Anomalous Zeeman Effect, Paschen-Back effect of one electron system, Stark effect, Hyperfine structure, Isotope effect in atomic spectra, distinction between Isotope effect and hyperfine structure, Lamb Rutherford Shift.	15
3	Microwave Spectroscopy – Rotational spectra, Diatomic and polyatomic molecules, Infrared Spectroscopy – Vibrating diatomic molecule, the diatomic vibrating rotator, Rotation- Vibration spectra of diatomic molecules, Raman Spectroscopy- Pure rotational Raman spectra, Vibrational Raman spectra, Structural determination from Raman Spectroscopy, Selection rules, P.Q and R branches, Isotopic shift	15
4	Electronic Spectra of Diatomic molecules -Breakdown of Born Oppenheimer Approximation, Intensity of Vibrational -Electronic Spectra-The Franck Condon Principle, Dissociation energy and Dissociation Products, Rotational Fine Structure of Electronic-Vibration transitions, Coherence-spatial and temporal, He-Ne gas laser, ruby laser, Raman spectroscopy, uses of lasers in Raman spectroscopy, Principle of Electron Spin Resonance (E.S.R), Nuclear Magnetic Resonance (N.M.R) and their applications.	15

Suggested Readings

1. Introduction to Atomic Spectra: H.E. White (McGraw Hill, 1934)
2. Atomic Spectra and Atomic Structure, G. Herzberg (Dover Publications, 2003)
3. Molecular Spectra and Molecular Structure, G. Herzberg (Van Nostrand, 1950)
4. Atoms, Molecules and Photons, W. Demtroder (Springer, 2006)
5. Fundamentals of Molecular Spectroscopy, C. N. Banwell (McGraw Hill, 1983)
6. Basic atomic & Molecular Spectroscopy, J. M. Hollas (Royal Society of Chemistry, 2002)
7. Principles of Lasers, O. Svelto (5th Ed., Springer, 2010)
8. Laser Spectroscopy, W. Demtroder (3rd Ed., Springer, 2003)
9. Molecular Quantum Mechanics, P Atkins & R. Friedman (Oxford Univ. Press, 2005)
10. Quantum Chemistry, I. N. Levine (7th Ed., Pearson, 2016)
11. Physics of Atoms and Molecules, B. H. Bransden and C. J. Jochain (2nd Ed., Pearson Education, 2003)
12. Molecular Spectroscopy by G.M. Barrow

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code : **B011002T**	Course Title: **Nuclear Physics- II**	

Course Outcomes

1. Understand and analyze the nuclear two-body problem using the simple theory of the deuteron, and explain the spin dependence and non-central nature of nuclear forces.
2. Apply partial wave analysis to low-energy neutron-proton and proton-proton scattering, and interpret scattering parameters such as scattering length and effective range.
3. Discuss charge symmetry and charge independence of nuclear forces and explain the meson exchange theory of nuclear interactions.
4. Compare and contrast the liquid drop model and the shell model; explain magic numbers and the evidence for nuclear shell structure.
5. Use the extreme single-particle shell model and Nilsson model (qualitative) to predict nuclear properties such as spin, parity, and magnetic moments.
6. Describe the collective model of nuclei and analyze the rotational and vibrational spectra, energy levels, and band structure in different nuclei.

Credit: **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
	Nuclear Physics- II	
1	Nuclear two-body problem, Simple theory of deuteron, Spin dependence and non-central feature of nuclear forces, Partial wave analysis, Low energy n-p scattering, Low energy p-p scattering, Existence of two nucleon bound system, Scattering length and effective range theory, Charge symmetry and charge independence of nuclear forces, Meson theory of nuclear forces.	15
2	liquid drop model, Magic numbers and evidence of shell structure, Extreme single particle shell model, Predictions of spin, parity and electromagnetic moments,	15

	Nilsson Model (Qualitative), Collective model, Rotational and Vibrational Hamiltonian, Energy levels and band structure due to single particle; Vibrational and rotational behaviour of different nuclei.	
3	Classification of elementary particles Exact conservation laws, Approximate conservation laws: Isospin and Isospin wave functions for pion-nucleon system, strangeness, parity, time reversal and charge conjugation, CP violation.	15
4	Eight fold way, Quarks, Quark-Quark interaction, SU(3) quark model, Gellmann-Nishijima formula, Magnetic dipole moment of baryons, Masses of hadrons. Basic ideas about the standard model. Mass generation.	15

Suggested Readings

1. Nuclear and Particle Physics: W. Burcham and M. Jobes.
2. Quarks and Leptons: Halzen and Martin, Jon Willey and Sons
3. Unitary symmetry and Elementary Particles: D.B.Lichtenberg.
4. Symmetry Principles in particle Physics: Emmerson.
5. Introduction to High Energy Physics: Donald H. Perkins, University of Oxford.
6. Nuclear Physics: S. N. Ghoshal, First edition, S. Chand Publication.
7. Nuclear & Particle Physics: An Introduction : B. Martin (Willey, 2006)
8. Introduction to Elementary Particles: D. Griffiths (Academic Press, 2nd Ed. 2008)

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code: **B011003T**	Course Title: **Electronics II**	

Course Outcomes

1. Explain the principles and techniques of amplitude modulation (AM), including DSBSC, SSB, and Vestigial Sideband modulation, and analyze their generation and demodulation methods.
2. Describe frequency and phase modulation techniques, analyze their spectral characteristics, and differentiate between FM and PM.
3. Design and analyze FM transmitter and receiver circuits, including modulators (varactor diode, reactance), and demodulators (Foster-Seeley discriminator, ratio detector, PLL).
4. Understand and apply concepts like automatic frequency control (AFC), pre-emphasis and de-emphasis in FM systems.
5. Apply the sampling theorem to low-pass and bandpass signals and evaluate various pulse modulation techniques (PAM, PWM, PPM), including sampling methods and signal reconstruction.
6. Understand and implement quantization processes, and analyze digital pulse modulation techniques such as PCM, DPCM, Delta Modulation, and their adaptive variants.
7. Compare and analyze line encoding techniques (unipolar, polar, bipolar, Manchester) and their effect on signal transmission and bandwidth.
8. Explain and differentiate digital modulation techniques including ASK, FSK, BPSK, DPSK, QPSK, QAM, and MSK, and evaluate their performance in communication systems.

Credit: **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
	Electronics II	
1	Analog Communication Electronics: Amplitude modulation, generation of AM	15

	waves. demodulation of AM waves, DSBSC modulation, generation of DSBSC waves, coherent detection of DSBSC waves, SSB modulation, generation and detection of SSB Waves, Vestigial sideband modulation.	
2	Frequency modulation, Frequency spectrum for sinusoidal FM. Non-sinusoidal modulation, Phase modulation, equivalence and difference between PM & FM. Varactor diode modulators, Reactance modulator, FM transmitter, Armstrong indirect method, FM detectors, Foster-Seeley discriminator, Ratio detector., PLL demodulator, Automatic frequency control, pre-emphasis and de-emphasis, difference between FM & PM	15
3	Digital Communication: Sampling theorem, sampling of Low Pass and Band - pass signals, Pulse Modulation-PAM, PWM, PPM, Channel BW for a PAM signal, ideal sampling, Natural sampling, Flat-top sampling, Signal recovery through Holding. Quantization of signals; Quantization, PCM, Differential PCM, Delta Modulation, Adaptive Delta modulation, CVSD, Line encoding; unipolar, polar, bipolar, Manchester encoding.	15
4	Digital Modulation Techniques: Binary Amplitude Shift Keying (BASK), Phase Shift Keying (PSK) - Binary (BPSK), Differential (DPSK), Quadrature (QPSK) & M-ARY Quadrature Amplitude Shift Keying (QASK), QAM, Frequency Shift Keying (FSK), Minimum Shift keying (MSK).	15

Suggested Readings

1. Op-Amp &Linear Integrated Circuits, Ramakanth A.Gayakwad , Printice Hall of India.
2. Electronic Devices and Circuit Theory, Robert Boylested and Louis Nashdsky, Printice-Hill Inc.
3. Optoelectronics: Theory and Practice, Alien Chappal, McGraw Hill Book Co., NY.
4. Principles of Communication System- Taub and Schilling, McGraw Hill Co.
5. Communication Systems- Simon Haykin, John Wiley & Sons, Inc.
6. Electronic Communications, Dennis Roddy & John Coolen, Pearson Education.
7. Modern Digital and Analog Communication systems- B P Lathi, Oxford Univ Press
8. Electronic Communication system- R Blake, Cengage india edition
9. Communication System Engineering- Proakis and Salehi, PHI Learning
10. Advance Electronics Communications Systems, Wayne Tomasi, Pill, Edn.
11. Electronic Communication System, George Kennedy & Bernard Davis, McGraw HillPub

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code : **B011004T**	Course Title: **Condensed Matter Physics II**	

Course Outcomes

1. Identify and explain various types of crystal imperfections including point defects (vacancies, interstitials, Schottky and Frenkel defects), dislocations, stacking faults, and grain boundaries.
2. Analyze mechanical deformation mechanisms in solids such as slip, critical resolved shear stress, Frank-Read sources, and the role of whiskers; describe techniques for observing dislocations and defects.
3. Describe the formation and structure of glasses, including radial distribution function, glass transition,

and the electronic structure of amorphous semiconductors.

4. Interpret electronic transport mechanisms in amorphous solids, including mobility edges, density of states, and optical properties of disordered systems.
5. Understand the structure, polymerization mechanisms, and physical properties (optical, thermal, electrical, and dielectric) of polymers; explain the properties and significance of liquid crystals and quasi-crystals
6. Describe and apply surface and film characterization techniques such as SEM, TEM, STM, and AFM for structural and topographical analysis.
7. Apply the Boltzmann transport equation to thin films, describe different scattering mechanisms, understand surface states in semiconductors, localized vibrational states, and the concept of excitons.

Credit: **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
	Condensed Matter Physics II	
1	Imperfections in Crystal: Point imperfections, Vacancies, Interstitial, Schottky and Frenkel defect. Colour centres, Dislocation of elastic and plastic deformation of solids, Slip planes, Critical resolved shear stress, Elastic energy, Frank and Reid source, Stacking faults, Grain boundaries, Tilt boundaries, and Twin boundaries, Whiskers, Observations of dislocation and other defects.	15
2	Exotic Solids: Glass formation, types of glasses and glass transition, radial distribution function and amorphous semiconductors, electronic structure of amorphous solids, localized and extended states, mobility edges, Density of states and their determination, transport in extended and localized states, Optical properties of amorphous semiconductors. Structure of polymers, polymerization mechanism, characterization techniques, optical, electrical, thermal and dielectric properties of polymers, Liquid Crystals, Quasi Crystals.	15
3	Nano structural materials: Introduction, Methods of synthesis and experimental characterization techniques, Quantum size effect and its applications, C60, C80 and C240, Fullerene, Graphene, Single wall and multi wall carbon nanotubes, their formation, charactarization and applications, Introduction to photonic crystal.	15
4	Thin films and surfaces: Study of surface topography by multiple beam interferometry, Determination of film thickness (Fizeau and FECO method), Elementary concepts of surface crystallography, SEM, TEM and STM, AFM, Thin film prepration methods, Boltzman transport equation for different scattering expression for electrical conductivity, Elementary ideas of surface states in semiconductors, localized viibrational states, Elementary idea of Excitons.	15

Suggested Readings

1. Introduction to Dislocations by D. Hull
2. Introduction to Solid State Theory by Madelung
3. Quantum theory ofsolid State byCallaway
4. Theoretical Solid State Physics by Huang
5. Quantumtheoryofsolidsby Kittel
6. PhysicsofThinFilms byK.L.Chopra
7. Multiple beam intcrferometry by Tolansky
8. Transmission Electron Microscopy by Thomas
9. Solid State Physics by C. Kittel

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code: **B011005T**	Course Title: **Physics of Liquid Crystals**	

Course Outcomes

1. Classify different types of liquid crystals, including thermotropic and lyotropic types.
2. Differentiate between various LC phases such as nematic, smectic (SmA, SmC), chiral nematic, discotic, bent-core, and polymeric LCs.
3. Interpret optical textures and polymorphism in liquid crystals using polarized light microscopy.
4. Understand the unique optical anisotropy (birefringence) and its relationship with molecular order.
5. Explain phase transitions using the Maier–Saupe theory and van der Waals model.

Credit: **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
	Physics of Liquid Crystals	
1	**Classification of Liquid Crystals:** Historical Outlook, Classification of Liquid Crystals, Polymorphism in LC, Optical Textures, Thermotropic Liquid Crystals, Calamitic Liquid Crystals: Nematic (N} Phases, Smectic phases (SmA and SmC), Chiral Nematic (N°) Phase/Cholesteric Phase. A review of Discotic Liquid Crystals and Bent-Core Liquid Crystals, Polymer Liquid Crystals, Lyotropic Liquid Crystals.	15
2	**Theory of Liquid Crystal and Phase Transitions:** Nature of Phase Transition and critical phenomenon in liquid crystals, hard particle model. Maier-- Saupe Theory and Van der Waals theories for isotropic-nematic and nematic- Smectic A transitions; Landau theory: essential ingredients, application to isotropic-nematic, nematic-smectic A/C transitions and other smectics.	15
3	**Nematic Liquid Crystals**: Elastic Continuum Theory, Dielectric Constant and Refractive Indices, Flows and hydrodynamics, Alignment of Liquid Crystals (Planar and homeotropic), Field induced director reorientation, Threshold Voltage for Switching. Estimation of Elastic Constants (Splay Twist and bend coefficients), Birefrengance and Order Parameter.	15
4	**Application of Liquid Crystals**: Display Applications: Principle, design and working of LC displays, Nematic Liquid Crystals Switches, 7-segment display. Non -Display Applications: Temperature Sensor, Spatial Light Modulators, Optical Shutters, Tunable Photonic Crystals, Biomedical Applications.	15

Suggested Readings

1. Liquid Ctystals, S. Cbandrashekhar, Cambridge University Press, Second Edition, 1992. Liquid Crystals, lam-Oloon Khoo, Willey, Second Edition, 2007.
2. Introduction to Liquid Crystals, PJ Collings and M. Hird, Taylor Francis, Bristol, PA 1997.
3. J. Prost J. The physics of Liquid Crystals, Clarendon Press, Oxford, 1993.
4. Liquid Crystal Devices: Physics and Applications, VG Chigrinov Artech House, Boston, London,1999.

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code : **B011006T**	Course Title: **Laser Physics and applications**	

Course Outcomes

1. The students will learn about introductory concepts of lasers and interaction of radiation with matter and various types of lasers and laser spectroscopy and their applications.
2. Provide students with a basic understanding of laser operation
3. Describe how pulsed laser beams can be obtained from a laser cavity.
4. Describe optical components that can be used to tailor the properties of the laser
5. Understand the laser applications in daily life.

Credit: **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
	Laser Physics and applications	
1	Laser Characteristics: Spontaneous and stimulated emission, Einstein's quantum theory of radiation, theory of some optical processes, kinetics of optical absorption and emission, line broadening mechanisms, Basic principle of lasers, population inversion, laser pumping, Optical resonator, losses in cavity, Q-factor, threshold condition for Lasing, three level and four level lasing schemes, coherence and monochromaticity.	15
2	Laser Systems: Solid state lasers- the ruby laser, Nd:YAG laser; semiconductor Diode laser, quantum well laser; Gas lasers - He-Ne laser, CO_2 laser; Liquid lasers-dye lasers; and Excimer lasers.	15
3	Advances in laser Physics: Production of giant pulse - giant pulse dynamics, Q-switching, Methods of Q-switching, mode locking, Methods of Mode Locking, amplification of short pulses. Non-linear optics: Harmonic generation, second harmonic generation, third harmonic generation, Phase matching, optical mixing, parametric generation and self-focusing of light.	15
4	Laser Applications: laser applications in material processing, medical applications, Military applications of Lasers, astronomy, Lasers in everyday life, Holography and Interferometery, Lasers in Science and technology, Laser Raman spectroscopy and its applications, lasers in communication: fiber Optic Communication, Optical fibers, numerical aperture, propagation of light in an Optical fiber.	15

Suggested Readings

1. Lasers by A. E. Siegmann. University science books
2. Laser Physics by P. W. Milonni and J. H. Eberly
3. Laser Spectroscopy by W. Demtroder
4. Principles of Laser by O. Swelto
5. Lasers, Theory and Applications by K. Thyagarajan and A. K. Ghatak

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code: **B011007T**	Course Title: **Physics of Nano materials**	

Course Outcomes

1. Describe various crystal structures and interpret their geometric and physical significance.
2. Explain band theory, free electron theory, and density of states in solids.
3. Analyze diffusive transport and common scattering mechanisms in bulk materials.
4. Analyze how dimensionality affects density of states and band gap in low-dimensional systems.
5. Describe the optical response of semiconductor and metallic nanomaterial

Credit: **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
	Physics of Nano materials	
1	**Physics of the Solid State**: Crystal structures, Band and free electron theory of solids, Idea of band structure, Density of state in bands, Diffusive transport, scattering mechanisms, Surfaces, Interfaces and Layered Systems.	15
2	**Quantum Nature of Nanoworld**: Introduction of Nanomaterials, Characteristic or Critical lengths in mesoscopic systems e.g. mean free path, scattering length, coherence length etc; Idea of quantum well, Quantum wire & and Quantum dots; One and Two dimensional electron systems: general properties, Quantum confinements, Variation of density of states andband gap with dimensionality, Optical properties of semiconductor and metal nanomaterials, Surface Plasmon Resonance in Metal Nanoparticles. Carbon Nanostructures (Fullerenes, Carbon Nanotubes and Graphene) and their Renewable Energy Applications.	15
3	**Nano fabrication**: Synthesis of nanomaterial (0, 1& 2 Dimensional) by Top down and Bottom-up Approaches; Ball Milling. Lithography, etching. epitaxial growth, physical and chemical vapour deposition (PVD & CVD) methods, Microwave, Hydrothermal and Solvo-thermal synthesis methods, Chemical synthesis of nanomaterial etc.	15
4	**Characterization of Nano materials**: Structure (X-Ray and electron Diffraction}; Determination of Particle size, Crystallography, atomic and surface structures, Microscopy (Scanning and Transmission electron microscopy, atomic force microscopy, Scanning tunneling microscopy); Spectroscopy (X-ray Photoelectron Spectroscopy, lnfrared and Raman Spectroscopy).	15

Suggested Readings

1. Introduction of Nanotechnology by Charles P Poole Jr and F J Owens Wiley India
2. Nanotechnoology for Microelectronics and optoelectronics by JMM Duart, RJM Palma and F A Rueda Elsevier
3. Introduction to Solids by Kittel
4. Physics of semiconductor nanostructure by KP Jain, Narosa
5. Physics of low dimensional semiconductors by John H. Davies
6. Nano particles and nanostructured films: Preparation, Characterization and Application, Ed. J. H. Fendler, John Wiley

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code : **B011008T**	Course Title: **Elements of Atmospheric and Space Science**	

Course Outcomes

1. Describe the chemical composition and physical constituents of the lower atmosphere.
2. Analyze diurnal and seasonal variations of temperature, pressure, and humidity.
3. Explain the formation and characteristics of sunspots.
4. Understand the Babcock model of the solar magnetic cycle and sunspot generation.
5. Describe the structure and extent of the heliosphere and the solar magnetic field.

Credit: **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
	Elements of Atmospheric and Space Science	
1	Lower atmosphere: Composition, constituents, dynamics; diurnal and seasonal variations of Temperature, Pressure and Humidity; Ozone hole and its impact on climate.	15
2	Ionosphere and magnetosphere: structure and formation, Density profile of upper atmosphere. Storm – substorm phenomena.	15
3	Structure of the Sun: Solar interior, solar atmosphere, photosphere, chromosphere, corona; Sunspots and their properties, Babcock model of sunspot formation.	15
4	Solar cycle and solar activity: Solar Wind, Solar Flares, Coronal Mass Ejections (CMEs); heliosphere and solar magnetic field. Space Weather: causes and consequences.	15

Suggested Readings

1. Meteorology: Understanding the Atmosphere: Steven A. Ackerman and John A. Knox
2. An introduction to Meteorology: S. Petterssen, McGraw-Hill Book Company, USA
3. Element of Space Physics: R.P. Singhal, Prentice Hall of India, New Delhi
4. Astrophysics of the Sun: Harold Zirin, Cambridge University Press, Cambridge, U.K.
5. Guide to the Sun: Kenneth J. H. Philips, Cambridge University Press, U.K.

Programme/Class: **Degree**	Year: **Fifth**	Semester: **X**
Subject : **Physics**		
Course Code : **B011009P**	Course Title: **Practical Lab**	

Course Outcomes

1. Analyze and determine the polarizability of non-polar liquids and dipole moment of polar liquids, understanding molecular interactions in electric field
2. Measure the magnetic susceptibility of paramagnetic substances using Quincke's method, gaining practical knowledge of magnetic properties and their temperature dependence.
3. Determine the dielectric constant of solid materials (e.g., wax) **using** Lecher wire, applying concepts of dielectric media and electromagnetic wave propagation.
4. Understand and experimentally evaluate signal losses in optical fibers, identifying factors affecting attenuation and transmission quality.
5. Demonstrate amplitude modulation (AM) and understand modulation index, bandwidth, and power considerations.
6. Demonstrate frequency modulation (FM) and analyze the frequency deviation and bandwidth requirements.

Credit: **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 Hours: 120**

List of Experiments (Condensed Matter Physics-II)

1. Measurement of polarizability of nonpolar liquid and dipole moment of polar liquid.
2. Determination of Lande's g factor of DPPH using Electron Spin Resonance spectrometer
3. Determination of magnetic susceptibility of paramagnetic substance by Quincke's method
4. Measurement of dislocation density of a crystal by etching
5. Determination of magnetoresistance
6. Specific of solids, internal friction
7. Study of thermoluminescence

AND/OR

List of Experiments (Electronics-II)

1. To study losses in an Optical Fibre.
2. To measure Numerical Aperture (NA) of an optical fibre.
3. Addition, Subtraction, Multiplication and Division using 8085 microprocessor.
4. Signal Sampling and Generation in PAM.
5. Study of amplitude modulation and demodulation
6. Study of frequency modulation and demodulation
7. Pulse modulation and demodulation,
8. Study of flip-flop, counter, register circuits.
9. Performing operations using A/D & D/A converters
10. Study of basic operations using linear ic trainer.
11. Study of Gunn diode
12. Experiments based on microwaves
13. Study of Electronic devices

Suggested Readings

1. Ramakant A. Gayakwad Op-Amps and Linear Integrated Circuits, 4th Edition, Pearson Education, 2002.
2. Boylestad & Nashelsky Electronic Devices and Circuit Theory, 11th Edition, Pearson, 2012.
3. H.S. Kalsi Electronic Instrumentation, 3rd Edition, McGraw-Hill, 2010.