D:\Acad\Sch. & Syllabi (2024)\Faculty of Physical Sci. & Technology\Letters.docx

GURU JAMBHESHWAR UNIVERSITY OF SCIENCE AND TECHNOLOGY, HISAR
(Established by State Legislature Act 17 of 1995)
'A+' Grade, NAAC Accredited State Govt. University

Acad./AC-III/ BOS&R-12/2025/ 4521
Dated: 01/8/25

To

The Controller of Examinations,
GJUST, Hisar.

Sub: **Approval of the scheme of examinations and syllabi of M.Sc. (Physics) – 1st and 2nd semester w.e.f. academic session 2025-26 as per NEP-2020 being run in University Teaching Departments and affiliated degree College(s).**

Sir,

I am directed to inform you that the Vice-Chancellor, on the recommendations of Dean, Faculty of Physical Sciences & Technology on 18.07.2025, is pleased to approve the scheme of examinations and syllabi of M.Sc. (Physics) – 1st and 2nd semester w.e.f. academic session 2025-26 as per NEP-2020 being run in University Teaching Departments and affiliated degree College(s), under Section 11(5) of the University Act, 1995 in anticipation of approval of the Academic Council.

A copy of the scheme of examinations & syllabi of above said programme(s) is enclosed herewith. You are therefore, requested to take further necessary action accordingly.

Yours faithfully

DA: As above

Assistant Registrar (Academic)
for Registrar

Endst. No. Acad./AC-III/BOS&R-12/2025/ 4522-26 Dated: 01/8/25

A copy of the above is forwarded to the following for information and necessary action:-

1. Dean, Faculty of Physical Sciences & Technology, GJUST, Hisar.
2. Chairperson, Department of Physics, GJUST, Hisar alongwith copy of scheme of examinations and syllabi of M.Sc. (Physics) – 1st and 2nd semester w.e.f. academic session 2025-26 as per NEP-2020 being run in University Teaching Departments and affiliated degree College(s). He is requested to arrange to upload the scheme of examinations & syllabi of above said programmes on the website of the University.
3. Principals, Concerned affiliated degree Colleges, GJUST, Hisar alongwith scheme of examinations and syllabi of M.Sc. (Physics) – 1st and 2nd semester w.e.f. academic session 2025-26 as per NEP-2020 being run in University Teaching Departments and affiliated degree College(s)
4. OSD to Vice-Chancellor (for kind information of the Vice-Chancellor), GJUST, Hisar.
5. P.A. to Registrar (for kind information of the Registrar), GJUST, Hisar.

Assistant Registrar (Academic)

Guru Jambheshwar University of Science and Technology, Hisar-125001, Haryana
('A+' NAAC Accredited State Govt. University)

Scheme of Examination and Syllabus

for

M.Sc. Physics

(*2 years programme spread over 4 semesters*)

(*University Teaching Department & Affiliated Colleges*)

Under Multiple Entry and Exit, Internship and CBCS-LOCF as per NEP-2020
For the session 2025-26 (in phased manner)

Department of Physics
Guru Jambheshwar University of Science and Technology Hisar-125001

Vision and Mission of the University

The University has drawn its Vision and Mission which has been defined keeping in view the objectives of the University enshrined in its Act.

Vision:

To develop the University as a Centre of Excellence for the quality teaching, research and extension services to produce the dynamic and the knowledgeable human resources and act as a knowledge power-house capable of contributing to the national development and welfare of the society.

Mission:

The University aspires to be a globally recognized Centre of excellence in the field of technical education and research. It strives to achieve this by introducing innovative job oriented courses, employing competent and motivated faculty, developing state-of-the-art infrastructure, striking purposeful linkages with industry and professional bodies, and promoting quality of work life on campus. The University focuses on the student community to imbue them with passion for knowledge and creativity and to promote sustainable growth in academic resources, student placements, and holistic human development with a strong conviction for professional ethical, social and environmental issues.

Objectives:

The objectives of the University as enshrined in the Act are to facilitate and promote studies and research in emerging areas of higher education with focus on new frontiers of and also to achieve excellence in these and connected fields.

The University has taken a number of steps to promote quality technical education and has already made a mark in certain areas that contribute to promote quality education in the present global competitive environment.

Chairperson
Deptt. of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

Vision and Mission of the Department

Vision:

To inspire the young students towards understanding and learning the fundamental concepts of Physics and their applications for the development of new technologies in the national interests.

Mission:

Physics is regarded as the most significant subject among all scientific and technical disciplines. The mission of Physics department at Guru Jambheshwar University of Science & Technology is to provide both the undergraduate and postgraduate students strong qualitative and quantitative knowledge along with developing a problem-solving attitude that may open up a wide range of career choices. In addition, the mission also includes encouraging the students to conduct cutting-edge research work resulting in new discoveries and innovations that expands the horizons of science and technology. This mission will be accomplished by providing students with rigorous and comprehensive knowledge as well as bringing exciting research perspectives to the student community of Physics Department at Guru Jambheshwar University of Science & Technology.

M.Sc. Physics (2 years or 4 semesters) programme:

The scheme and syllabus of Master of Science in Physics program is designed as per guidelines of the National Education Policy-2020 (NEP-2020) in accordance to the University Grants Commission (UGC) criteria. The program's syllabus is structured with discipline-specific core, discipline-specific elective, skill-enhancement, interdepartmental, value-added courses and among other course categories to attract young bright students to inculcate the culture of research and development in the areas of physical sciences. The scheme and syllabi of the programme highlight integrated learning, creative and critical thinking, new pedagogies and assessment techniques, multidisciplinary and cross-disciplinary education, and value-based courses that uphold ethical and constitutional principles. Students are also able to comprehend the basic elements of the subject through a variety of lab exercises, research projects, and seminars. The updated curricula is designed with an aim to produce a skilled manpower and students are expected to serve as scientists for conducting high impact research at various National/International laboratories, a good teacher in the academic institutes & may get good placement in research based industrial organizations. To fulfill the students' goals, the specializations in Materials Science, Condensed Matter Physics, Photonics, Computational Physics, Electronics and Nuclear Science are offered in this programme. Optional dissertation/ project work has been introduced in this course to provide research platform to enter in various scientific laboratories or research based industries. Furthermore, continuous assessment of the students is an integral part of the whole scheme, which will facilitate systematic and thorough learning towards better understanding of the subject.

Program Educational Objectives (PEOs)

The objective of the M.Sc. Physics program is to equip students with advanced theoretical and practical knowledge that will enable them to solve challenging real-world issues in academic and industry sectors. The M.Sc. Physics program aims to help students acquire professional abilities that are important in both academic and industrial life. It also generates the working ability as a team in the students. Additionally, this program enables the students to use their scientific knowledge in depth understanding of physical problems and try to find the solution for the betterment of society. The following educational objectives are: .

- To foster the scientific temperament among the young minds with the fundamentals of Physics
- To enhance the problems solving capability projects/assignments, seminars, laboratory experiments, participation in quiz and scientific events.
- To develop the experimental and computational skills through lab experiments and computational physics
- To enhance the communication skills through participation in lab viva and seminars
- To familiarize with the advanced technical and scientific developments in the Physics
- To build the foundation for future research and development in Physics for making self-reliant India
- To train students in skills related to research, education, and industry
- To inculcate students to build-up a progressive and successful career in Physics.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

Program Outcomes (POs)

Students enrolled in the Master Program offered by the Department of Physics will have the opportunity to learn and master the following components in addition to attain important essential skills and abilities. After the completion of program, the students will be able to:

Program Outcomes	
PO1	Describe the real life problems occurring around us scientifically and innovatively to design and create products and solutions to real life problems with the help of basic principles of Physics.
PO2	Generate a team spirit to collaborate effectively through lab experiments, projects and seminars.
PO3	Analyze scientific reasoning for various technical issues and improve programming skills through programming in Physics.
PO4	Apply scientific and logical thinking earned through advanced physics topics to any burning real world problems for doing future research work in physics.
PO5	Create effective communication and written skills through viva-voce or seminar, projects and any scientific activities in physics to express any industrial/national issues scientifically.
PO6	Develop experimental skills and independent work culture through a series of experiments in various physics labs during the programme.
PO7	Evaluate the concepts of various branches of Physics and apply to solve problems of relevance to society to meet the specified needs using the knowledge, skills and attitudes acquired from physics.

Scheme of Examination for UTD & affiliated colleges for the session 2025-26
Name of the Programme: M.Sc. Physics
According to National Education Policy-2020

SEMESTER-I

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
U25PHY101T	Discipline Specific Course-I	Quantum Mechanics-I	4	4	70	30	100
U25PHY102T	Discipline Specific Course -II	Analog Electronics	4	4	70	30	100
U25PHY103T	Discipline Specific Course-III	Classical Mechanics	4	4	70	30	100
U25PHY104T	Discipline Specific Course-IV	Mathematical Physics	4	4	70	30	100
U25PHY105P	Discipline Specific Lab-I	Physics Lab-I	3	6	50	25	75
U25PHY106P	Discipline Specific Lab-II	Physics Lab-II	3	6	50	25	75
	Value Added Course (VAC)	To be opted from pool of VAC	2	2	35	15	50
		Total	24	30	415	185	600

SEMESTER-II

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
U25PHY201T	Discipline Specific Course-V	Quantum Mechanics-II	4	4	70	30	100
U25PHY202T	Discipline Specific Course -VI	Digital Electronics	4	4	70	30	100
U25PHY203T	Discipline Specific Course-VII	Solid State Physics	4	4	70	30	100
U25PHY204T	Discipline Specific Course-VIII	Atomic and Molecular Physics	4	4	70	30	100
U25PHY205P	Discipline Specific Lab-III	Physics Lab-III	3	6	50	25	75
U25PHY206P	Discipline Specific Lab-IV	Physics Lab-IV	3	6	50	25	75
U25PHY201S	Discipline Specific	Seminar	2	2		50	50
U25PHY201I	Internship	Internship	4				100
		Total	28	30	380	220	700

* The Internship of 4 credits of 4 weeks (120 Hrs.) duration after 2nd semester is mandatory for each student either for enhancing the employability or for developing research aptitude. The marks of summer internship earned by a student will be credited in second semester.

**The minimum credit requirement for 2-year PG programme will be 84 including 4 credits of internship. Range of credits will be 84-100. In any case total credits in 2 years cannot exceed 100. Each semester should not be of less than 20 credits. PG Diploma in Physics will be awarded with minimum 44 Credits including 4 credit internship.

***The first semester will include a 2 credits Value Added Course from other department (including from Indian Knowledge System, Constitutional and moral values, etc.); the second semester will include a 2 credits Seminar; the third semester will include a 2 credits Open Elective Course offered by the other department of the university and the fourth semester will include a 2 credits Skill Enhancement Course/Employability and Entrepreneurship Skills Course/Vocational Course. All these courses of 2 credits of first, third and fourth semesters will be opted by the students

Chairperson
Department of Physics
Guru Jambheshwar University of Sc. & Tech., Hisar-125001

from the relevant Pools. **OEC/SEC/EEC/VOC/VAC can be carried out through SWAYAM/MOOC** also **minimum 2 credits. In case of more than 2 credits then only 2 credits will be counted**

Important Notes:

The scheme and syllabi of the M.Sc. Physics is framed as per University Ordinance which is based on National Education Policy-2020 (NEP-2020), Learning Outcome Based Curriculum Framework-Choice Based Credit System (LOCF-CBCS) and is according to the Curriculum and Credit Framework for PG Programmes (CCFPGP) and National Higher Education Qualification Framework (NHEQF) of University Grants Commission and as per Memo No. DHE-170005/5/2023-Deputy Director-NPE dated June 8, 2023 regarding implementation of the key components of NEP-2020 in Colleges and Universities.

The key points of the University Ordinance are

1. Scope

(i) The duration of the programme for the award of Post Graduate Diploma in Physics is one academic year and Postgraduate degree in the Science and or Physics will be one/two academic years. Each academic year will be divided into two semesters i.e., July to December and January to June. There shall be teaching of 15 weeks/90 days in each semester.

(ii) The nomenclature of the PG Diploma/Degree will be as under:

(a) PG Diploma in Physics

(b) Master of Science or Master of Science in Physics

2. Courses

(i) Discipline Specific Courses (DSC): A compulsory course of a subject/programme which aims at imparting essential fundamental, comprehensive and advanced knowledge of the subject/programme.

(ii) Discipline Elective Course (DEC): A course of choice which allows a student to study a specialized area(s) of subject/programme as per her/his interests and offered by the Department.

(iii) Open Elective Course (OEC): A course which a student opts to study for getting interdisciplinary knowledge in addition to her/his own subjects of programme.

(iv) Employability and Entrepreneurship Skills Course (EEC): A course which aims at enhancing the employability skills and developing key personal attributes which are essential for generating employment potential and preparing for the effective performance at workplace.

(v) Vocational Course (VOC): A vocational course is focused on practical work, preparing students for a particular skilled profession. Such courses develop capacities for sustenance, work, and economic participation and develop values and sensibilities towards physical work and the dignity of labour.

(vi) Skill Enhancement Courses (SEC): These courses aim at imparting practical skills, hands-on training, soft skills, etc. to enhance the employability of students.

(vii) Value-Added Courses (VAC): These courses aim at enabling the students to acquire and demonstrate the acquisition of knowledge and understanding of constitutional, human and moral values, Indian Knowledge System (IKS) and Intellectual Property Rights (IPR), etc.

3. Subjects/Courses of PG Programmes

(i) A student will study Discipline Specific Courses (DSC), Discipline Elective Courses (DEC), Practicum Courses (PC), Open Elective courses (OEC), Employability and Entrepreneurship Skill Courses (EEC), Value Added Course (VAC), Seminar as per Scheme for the PG Programme under Post Graduate Curriculum Frame-work.

(ii) The Department will decide and declare the number of seats for Dissertation/Project work of 12 credits in the beginning of each academic session, depending upon the availability of infrastructure and faculty in the Depart-ment. The Department shall also decide the criteria to allocate then course of Dissertation/Project work to the interested students, in the case when number of such applicants is more than the number of seats available.

(iii) The students, who opt for the Dissertation/Project work outside the Department, can complete other requisite courses i.e. DSC, DEC, and EEC in the 4th semester through online mode with the permission of Department through:

a. MOOCs through SWAYAM and other such portals approved by UGC and registered on ABC/APAAR. Fee for such online courses has to be paid by the student her/himself.

b. Online/ODL courses offered by the Centre for Distance and Online Education (CDOE), Guru Jambheshwar University of Science and Technology, Hisar and fee for such online courses has to be paid by the student her/him-self.

c. Online classes offered by the concerned Department for these courses.

Note: The student himself/herself has to pay the requisite fee and/or re-appear fee as applicable from time to time. Department shall not be responsible for any issue(s) related to MOOCs, online course(s) or else.

4. Internship

(i) A student for the PG Programme shall be required to undergo 4 credits internship of minimum of 4-6 weeks duration during summer vacation after second semester examination or after the fourth semester examination. If she/he opts to exit with 1-year PG Diploma after second semester of 2-year PG Programme, then she/he has to complete Internship course before exit. However, the student, who has taken lateral entry into the 2nd year (i.e. 3rd semester) of PG Programme, need not to repeat the Internship course.

(ii) A student will inform and get approval from the Chairperson of the Department before going for an internship. The internship will involve working with local industry (Government or Private organizations/ Institutions), busi-ness establishments, artists, craft persons, or a professional (individual/organization). Student will submit a copy of the report (a hard copy and a soft copy in PDF) to the Department within 15 days after the completion of internship. A student must submit a certificate of attendance and work done report from the organization/profes-sional where the internship was done. The evaluation of the internship shall be done by a committee comprising of at least two senior teachers appointed by the Chairperson of the Department. Marks will be awarded by the committee out of 100 marks on the basis of the report and viva-voce examination.

(iii) The internship will be governed by the prevailing rules of the University from time to time.

5. Project/Dissertation work

A student who opts for Dissertation/Project work of 12 credits in 4th/2nd semester of 2-year/1-year PG Programme will be required to do the research work based on systematic, scientific and rigorous investigations on the chosen and approved topic utilizing relevant research methods/techniques/innovations.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

(i) A student, who opts for Dissertation/Project work in 4th semester of PG Programme, shall submit a request for allotment of supervisor mentioning her/his research areas of interest in order of preference to the Chairperson/Principal/Director during 3rd semester. The Department shall allot a qualified supervisor to guide the student for doing research during Project/Dissertation work. A regular full-time teacher of that Department, who is eligible to supervise Ph.D. scholars as per ordinance of Doctor of Philosophy of the University, will be eligible to guide the students for Dissertation/Project work.

(ii) The student will submit the synopsis to the supervisor. In case of University Teaching Department (UTD), the synopsis will be approved by the Departmental Research Committee (DRC) after recommendation of the supervisor. External experts may be involved wherever sufficient qualified regular teachers are not available.

The Chairperson shall constitute a committee of at least three members of the concerned subject for this purpose at the Department level. The committee will consist of at least one subject expert from Guru Jambheshwar University of Science and Technology, Hisar to be nominated by the Chairperson. The request for external expert should reach to the Dean of the Faculty before 30th November of the concerned year. The list of students, their approved topics, and names of supervisors along with their synopsis will have to be submitted by the Department to the respective Dean of the Faculty latest by 31st January of the concerned year.

(iii) The student shall be required to submit three hard copies of her/his dissertation along with soft copy as PDF file to the Department by 30th May of the concerned year. The late submission can be allowed with late fees as decided by the university from time to time.

(iv) The Anti-plagiarism policy of the university is to be strictly followed by the candidate and the supervisor. Similarity report as per anti-plagiarism policy of the university is to be annexed with the dissertation/project report.

(v) Evaluation of the dissertation shall be done by an external examiner. The panel of examiners for evaluation of dissertations/project reports will be approved by the respective PGBOS. The dissertation work will be of total 12 credits (300 marks) and evaluation will be done in two components; report of dissertation (200 marks) and open viva-voce examination (100 marks).

(vi) The schedule as specified above is to be strictly followed by the student and DRC and any relaxation will not be allowed. However, in exceptional and genuine cases, late submission may be allowed with a late fee, as decided by the University from time to time.

6. Assessment and Evaluation

(i) Student Progression and Mentoring

Each student shall be examined in the course(s) to check their progression through the programme as laid down in the scheme, syllabus and learning outcomes through a system of Continuous Comprehensive Assessment (CCA) using a mix of Internal and End-Term evaluation.

- Internal Assessment will be broadly 30% of the total marks and weightage of 70% shall be given to evaluation of End-Term examination(s).
- Internal Assessment (30%) shall be broadly based on the following defined components: Class Participation; Seminar/Presentation/Assignment/Quiz/Class Test, etc. in case of Theory examination and Seminar/Demonstration/Viva-Voce/Lab record, etc. in case of Practical examination; Mid-Term Exam.
- The students who have failed in Internal Assessment/Minor Test will have to get aggregate forty percent marks in the End-Semester examination with no option of improvement of internal assessment.

• **Internal Assessment Marks will be further distributed as per following tables:**

Total Internal Marks (Theory)	Class participation	Seminar/Presentation/Assignment/ Quiz/Class Test, etc.	Mid-term exam
15	5	-	10
20	5	5	10
25	5	5	15
30	5	10	15

Total Internal Marks (Practicum)	Class participation	Seminar/Presentation/Assignment/ Quiz/Class Test, etc.	Mid-term exam
10	5	5	-
15	5	10	-
25	5	10	10
30	5	10	15

• Absence from Internal Assessment test and/or Mid-Term examination will lead to award of zero marks in that component of Internal Assessment.

(ii) Every candidate shall be examined according to the scheme of examinations and syllabus of concerned PG programme as approved by the Academic Council from time to time. A candidate, who fails in an examination, or, having been eligible fails to appear in an examination, shall, unless approved otherwise by the Academic Council, will take the examinations according to the syllabus prescribed by the university for regular students appearing for that examination.

(iii) The pass percentage will be 40% (Grade 'P') both for theory and practicum End-Term Examination. A student has to obtain minimum 40% marks (Grade 'P') in End-Term Examination and in aggregate (sum of the Internal Assessment and End-Term Examination marks) separately to qualify a course.

(iv) The Chairperson of the Department shall ensure uploading of the Internal Assessment marks before the commencement of the End-Term Semester Examinations on the examination portal of the University or as notified by the Controller of Examinations of the University. A late fee, as prescribed by the university from time to time, shall be charged from the Department for if awards are not submitted in time.

(i) Internal Assessment marks of a course shall be carried forward in case of re-appear examination of that course.

(ii) The Chairperson of the Department shall preserve the record on the basis of which the Internal Assessment awards have been prepared, for inspection, if needed by the university for one year from the date of declaration of semester examination results.

7. Eligibility for Examination

End-Term Examination shall be open to a regular student who

(i) has been on the rolls of the Department during the semester.

(ii) has passed the requisite qualifying examination as laid down above, if she/he is a candidate for the First Semester Examination.

(iii) has her/his examination form submitted to the Examinations Branch through the Chairperson of the concerned Department.

(iv) has attended not less than 75% of the lectures in a course. This requirement shall be fulfilled separately for each course of the programme. A deficiency in the prescribed course (Lectures/Practicum, etc.) may be condoned by the Chairperson of the Department in deserving cases up to 15% (excluding 2% additional for Girl/Women student).

(v) These shall also include loss of attendance due to participation in the cultural and sports assignments, etc. Provided that, a student who participates in the Inter-University Tournaments or Inter University Youth festivals or Republic Day Parade may be allowed additional condonation on this ground up to 10% in each paper on a certificate from the Dean/Director, Sports/Youth Welfare/Cultural Affairs, Placement Cell, NSS, ANO, NCC, YRC as the case may be, subject to the condition that such a student shall not be allowed to appear in the examination if his/her attendance, after condonation on all counts, falls below 50%.

(vi) Provided that a candidate who has not attended the requisite percentage of lectures/practicum shall not be eligible to take the End-Term Examination in the concerned theory/practicum unless she/he repeats the course and obtains requisite attendance.

Semester-I

U25PHY101T: Quantum Mechanics-I

Marks (Theory): 70 **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objectives: *The course content covers foundations of quantum mechanics, Schrodinger wave equation and applications to 1D & 3D problems, angular momentum and system of identical particles.*	***Course Specific Outcomes:*** *The students will be equipped with basics of quantum Mechanics, Schrodinger wave equation and its applications, knowledge of angular momentum and about system of identical particles.*

UNIT -I

Formulation of Quantum Mechanics: origin of quantum mechanics, de Broglie's hypothesis, Young's double slit experiment with waves and particles, wave-particle duality: complementarity, Indeterministic nature of microphysical world, Properties of linear vector spaces, Hilbert space, Dirac's bra and ket notation, operators, Hermitian operators, Commutator algebra, Inverse and Unitary operators, eigenvalues and eigenvectors of an operators, infinitesimal and unitary transformation, Matrix representation of kets, bras, and operators, Change of basis and unitary transformation, Matrix representation of eigenvalue problems, Parity operator, Solution of simple harmonic oscillator problem by the operator method

UNIT-II

Quantum Dynamics: Postulates of quantum mechanics, Expectation value, Time evolution operators, stationary states: Time independent potential, Schrodinger equation (time dependent and time independent), wave packets: localised wave packets, wave packets and the uncertainty relations, motion of the wave packets, conservation of the probability, time evolution of expectation value for an observable, symmetries and conservation laws, Poisson Brackets and Commutators, Ehrenfest theorem, solution of 1D Schrodinger equation (free particle, tunnelling effect & harmonic oscillator) and Schrodinger equation in spherical coordinates (H-atom).

UNIT –III

Angular Momentum: Orbital angular momentum, the angular momentum operators and their representation in Cartesian and spherical polar coordinates, commutation relations, matrix representation of angular momentum, Ladder operators and their matrix representations, spin angular momentum, theory of spin, Stern-Gerlach experiment, spin ½ and Pauli's matrices, Connection between spin and statistics, eigenfunction of orbital angular momentum, spherical harmonics, Addition of angular momentum, Calculation of Clebsch-Gordan coefficients, Coupling of orbital and spin angular momentum. Isospin, Wigner-Eckart theorem and its applications.

UNIT -IV

Identical particles: many particle systems, Schrodinger equation, interchange symmetric and system of distinguishability of noninteracting particles.

System of identical particle: identical particles in classical and quantum mechanics, exchange degeneracy, symmetrization postulate, constructing symmetric and antisymmetic functions, system of identical noninteracting particles, wave function of multiparticle systems, Incorporation of spin, Slater determinants, exclusion principles and periodic table, Atomic levels of Helium atoms as an example of two electron system.

Reference Books:

1. Quantum Mechanics: N. Zettili, Wiley.
2. Quantum Mechanics, L.I. Schiff, McGraw-Hill
3. Quantum Mechanics: J.L. Powell and B. Crasemann
4. Quantum Mechanics, D.J Griffith, Pearson publication
5. Quantum Mechanics, A. Ghatak&Loknathan, Mackmilan India Ltd.
6. Quantum Physics ,S.Gasiorowicz , Wiley

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Familiar with the main aspects of the historical development of quantum mechanics and be able to discuss and interpret experiments that reveal the wave properties of matter, as well as how this motivates replacing classical mechanics with a wave equation.

CO2. Understand the mathematical tools of quantum mechanics, including linear algebra, differential equations (especially the Schrödinger equation), and Dirac notation.

CO3. Solve the time-independent and time-dependent Schrödinger equation for simple potentials like the particle in a box, the harmonic oscillator, and the hydrogen atom. .

CO4. Analyze angular momentum, spin, and their quantization, and nature of identical particle.

CO5. Explore applications of quantum mechanics in areas like atomic physics, condensed matter physics, and quantum computing.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY102T: Analog Electronics

Marks (Theory): 70 | **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 | **Time: 3 hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objective: The course enables students to develop an in-depth understanding about the semi-conductors, transistors, concept of feedback and small signal amplifier, power amplifier, junction field effect transistors, operational amplifiers and oscillators.	*Course Specific Outcomes: After completion of this course, students will be able to understand the basics of semiconductors, transistors, concept of feedback and small signal amplifier, power amplifier, operational amplifiers and oscillators along with applications in various electronic devices.*

UNIT – I

Network theorem: Thevenin theorem, Norton theorem, Mesh & Node Analysis, Superposition theorem, Maximum Power Transfer theorem.

Semiconductor Diodes and Bipolar Junction Transistors (BJT): PN junction Diode, V-I characteristics & diode equation, Rectifiers; half and full wave rectifier (Center-tapped and Bridge rectifiers), and filters (Capacitor, Inductor, Choke and Π filters), Breakdown Diodes, Tunnel Diode, Clipping and clamping circuits, Transistor, Types of transistors and their configurations, Ebers-Moll BJT Model, Biasing for transistor, Voltage divider biasing

UNIT – II

Concept of feedback: Type of feedback, effect of feedback on stability, nonlinear distortion input and output impedance, bandwidth.
Amplifiers: Small signal amplifiers, Analysis of stage amplifier by Graphical and Equivalent Circuit methods, Gain of multistage amplifier, Coupling of two stages, Frequency response of RC- coupled amplifiers, Distortions in amplifier, Power amplifier-Push Pull Amplifier.
Multivibrators: Astable, monostable and bistable.
Hybrid parameters: Definition of H-parameters, H-parameter model; BJT, CE Configuration, Analysis of Amplifier (Current gain, voltage gain, input impedance, output impedance) in CE, CB and CC configurations, approximate CE, CB, CC hybrid models.

UNIT – III

The Junction Field Effect Transistor: Basic structure & Operation, pinch off voltage, single ended geometry of JFET, volt–ampere characteristic, Transfer Characteristics. FET parameters, Biasing of the FET and setting of Q point using load line. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, Biasing of MOSFET, comparison of p & n channel FETs, FET small signal model, JFET low frequency common source and common drain amplifiers, FET application as Voltage Variable Resistor (VVR), UJT.

Chairperson
Department of Physics
Guru Jambheshwar University of Sc. & Tech. Hisar-125001

UNIT – IV

Operational Amplifier: Differential amplifiers, Common mode rejection ratio, Transfer characteristics, OPAMP configurations, Open loop and close loop gain, Inverting, non-inverting and differential amplifier, Basic characteristics with detailed internal circuit of IC OPAMP, Slew rate, Comparators, Summing amplifier, Analogue computation, Logarithmic and anti-logarithmic amplifiers, Current-to-voltage and Voltage-to-current converter, Voltage regulation circuits, Instrumentation amplifiers,

Oscillators: Principle of Oscillator, Barkhausen condition, Phase shift Oscillator, Wein Bridge Oscillator, Crystal oscillator-frequency stability, LC oscillators; Hartley Oscillator, Colpitts Oscillator

Reference Books:

1. Semiconductor Physics and Devices: Donald A Neaman and Dhrubes Biswas, 4th Edition, McGraw Hill, India
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill, India
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn.,2009, PHI Learning
6. OPAMP and Linear Integrated Circuits by Ramakant A Gayakwad.

Course Outcomes (COs)

After completing this course, the students will be able to:

- CO1. Use the network theorems to analyse the complex electronic circuits and understand the working of diodes, transistors, and other components in both DC and AC conditions.
- CO2. Demonstrate the construction and properties of different types of junction field effect transistor.
- CO3. Analyze different types of amplifiers for specific gain, input/output impedance, and frequency response characteristics and understand the different types of feedback (positive and negative, voltage and current) and their effects on amplifier.
- CO4. Understand the characteristics of op-amps and designing circuits like inverting and non-inverting amplifiers, comparators, and also familiar with the working of oscillators.
- CO5. Design different circuits using semiconductor devices and demonstrate their usage for any practical usage in real life.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY103T: Classical Mechanics

Marks (Theory): 70 **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objectives: The objective of the course is to provide a basic knowledge of Lagrangian formulation, theory of small oscillations and central force problems, Hamiltonian formulation so that they can apply these methods to solve real world problems. The multi-disciplinary topic 'Chaos' will enable the students to learn the techniques to handle the problems from the field of non-linear dynamics.	*Course Specific Outcomes: After completion of this course, students will be able to understand the basics of Lagrangian formulation, theory of small oscillations and central force problems, Hamiltonian formulation. In addition to this student will be familiar with the basic of non- linear dynamics.*

UNIT –I

Lagrangian Formulation: Systems with constraints and generalized coordinates, Principle of virtual work, D' Alembert's principle and Lagrange's equations, Hamilton's principle, Lagrange's equation from Hamilton's principle, Cyclic or ignorable coordinates, Energy function and Energy conservation, Simple applications of Lagrangian formulation, Advantages of variational principle formulation, Symmetries of space and time and conservation theorems: Noether's theorem, Velocity-Dependent Potentials and the Dissipation Function

UNIT –II

Central Force Motion and Theory of Small Oscillations: Two-body central force problem: Equivalent one body problem, Equation of motion and first integrals, Classification of orbits, Differential equation for the orbit, stability of orbit under central force, conditions for closed orbits, Kepler's laws of planetary motion and their deduction, Virial theorem, Scattering in a central force field: Rutherford scattering.

Theory of small oscillations: Formulation of the problem, Eigenvalue equation and the principle axis transformation, frequencies of free vibrations and normal modes, free vibrations of a linear triatomic molecule.

UNIT –III

Hamiltonian Formulation: Legendre transformations and the Hamilton equations of motion, Routh's procedure, Cyclic coordinates, Hamilton's equations from variational principle, Principle of least action, Canonical Transformations, Poisson brackets, Jacobi's identity, Poisson theorem, Lagrange brackets and their relationship with Poisson brackets, Infinitesimal Canonical Transformations, Angular momenta and Poisson bracket Relations, Liouville's Theorem.

Hamilton-Jacobi equation for Hamilton's principal function, Harmonic Oscillator problem, Action-Angle variables, Harmonic Oscillator using Action-Angle variables.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

UNIT –IV

Introductory non-linear dynamics: Classical Chaos, Linear and nonlinear systems, periodic motion, Perturbation and Kolmogorov- Arnold Moser (KAM) theorem, dynamics in phase space; Phase Trajectories-Singular Points, Phase Trajectories of Linear Systems, Phase Trajectories of Nonlinear Systems, Attractors, Chaotic Trajectories and Liapunov exponents, Poincare Maps, Bifurcation.

Reference Books:

1. Classical Mechanics, by H. Goldstein, C. Poole and J. Safko (3rd Ed., Pearson Edition, 2002).
2. Mechanics, L. D. Landau and E. M. Lifshitz (3rd Ed., Pergamon, 1976).
3. Classical Mechanics of particles, by John R. Taylor (University Science Books, 2005).
4. Analytical Mechanics, by L. Hand and J. Finch (Cambridge University Press, 1988)
5. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor
6. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Define and understand basic classical mechanical concepts, including Newtonian mechanics, Lagrangian mechanics and their application to advanced problems.

CO2. Describe the central force problems and theory of small oscillations in various branches of Physics.

CO3. Apply the Lagrangian and Hamiltonian methods to analyse the motion of mechanical systems, including deriving equations of motion and understanding conservation laws.

CO4. Analyse the chaotic trajectories in non-linear systems.

CO5. Explore research-oriented problems and develop innovative solutions within the framework of classical mechanics.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY104T: Mathematical Physics

Marks (Theory) : 70 | **Credits : 4 (60 Hrs)**

Marks (Internal Assessment) : 30 | **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objectives: This course has been formulated to introduce students to some important topics of mathematical physics which are relevant to other papers of M. Sc. Physics course. It includes group theory and tensors, special functions, functions of a complex variable and calculus of residues and integral transforms.	*Course Specific Outcomes: After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.*

UNIT I

Group theory and Tensors: Definition of a group and examples, Group-multiplication table, conjugate elements and class structure, Subgroups, Isomorphism and homomorphism, Groups representation by matrices, reducible and irreducible representations, the great orthogonally theorem and its geometric interpretation, Schur's Lemmas (Only statements), character of a representation, Topological groups and Lie groups.

Tensors in index notation, Kronecker and Levi Civita tensors, inner and outer products, contraction, symmetric and antisymmetric tensors, quotient law, Noncartesian tensors, metric tensors, covariant and contravariant tensors, Covariant differentiation. Applications.

UNIT II

Special Functions: Solution of Bessel differential equation, Second solution of Bessel's equation using Wronskian, Generating function, Recurrence relations, Integral representation, Application to single slit diffraction; Legendre Polynomials and its solution, Second solution of Legendre's equation using Wronskian, Generating function, Recurrence relations and special properties, Rodrigues formula, Orthogonality, Application to electric multipoles; Associated Legendre Functions; Parity and orthogonality; Hermite and Laguerre's functions. Hilbert-Schmidt theory. Green's functions in one dimension and three dimension.

UNIT III

Complex Variables: Cauchy-Riemann conditions, analyticity, Cauchy-Goursat theorem, Cauchy's Integral formula, branch points and branch cuts, multivalued functions, Taylor and Laurent expansion, singularities and convergence, calculus of residues, evaluation of definite integrals, Dispersion relation, Optical dispersions, Causality.

Fourier Series: Fourier series, Dirichlet conditions. General properties. Convolution and correlation, Advantages and applications, Gibbs phenomenon.

UNIT IV

Integral Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms. 3D Fourier transforms with examples. Application of Fourier Transforms to differential equations: 1D Wave and Diffusion/Heat Flow Equations.

Laplace Transforms: Laplace Transform (LT) and its Properties, LTs of Derivatives and Integrals, LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of LT to Differential Equations: Damped Harmonic Oscillator, Forced Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform.

Reference Books:

1. Group Theory for Physicists : A.W. Joshi (Wiley Eastern, New Delhi) 2011.
2. Group Theory and Quantum Mechanics by Michael Tinkham.
3. Mathematical Methods for Physicists (6th edition) by G.B. Arfken & H. J. Weber
4. Matrices and Tensors in Physics : A.W. Joshi (Wiley Eastern, New Delhi) 2005.
5. Mathematical Physics : P.K. Chatopadhyay (Wiley Eastern, New Delhi) 2011.
6. Introduction to Mathematical Physics : C. Harper (Prentice Hall of India, New Delhi) 2006.

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Describe and solve problems involving group theory and tensor analysis, including those encountered in advanced physics courses and research.

CO2. Develop a strong understanding of mathematical tools and techniques, specifically special functions like Legendre, Bessel, and Hermite polynomials, and their applications in solving physics problems.

CO3. Understand about contour integration, Cauchy's integral theorem and formula, and the calculus of residues that may helpful in solving the electromagnetic field problems.

CO4. Apply the knowledge of Fourier and Laplace transforms in analyzing spectroscopic data for determining the frequency and intensity of light emitted or absorbed by molecules.

CO5. Evaluate the more advanced topics in physics, such as quantum field theory, statistical mechanics, and condensed matter physics with the support of this course.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY105P: Physics Lab –I

Marks (External) : 50 **Credits : 3 (90 Hrs.)**

Marks (Internal Assessment) : 25 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To Study the characteristics of Solar Cell.
2. Study of Franck-Hertz experiment.
3. Determination magnetic susceptibility with a Gouy Balance.
4. Study of energy loss from B-H Loop of ferrite sample and Curie temperature.
5. To determine material constant, band-gap and temperature variation of characteristics of a semiconductor material
6. Determination of Young Modulus and ultrasonic velocity in solids
7. Study of Absorption coefficients
8. Determination of Planck's constant.
9. To Study I-V & P-I characteristics of LED and Diode Laser.
10. Determination of power distribution within the laser beam and its spot size.
11. To measure the divergence of laser beam.
12. Distance measurement by triangularisation method using laser.

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Understand that electrons in atoms can only occupy discrete energy levels, as demonstrated by the energy losses in electron collisions with mercury atoms using Franck-Hertz experiments.

CO2. Describe the conversion of light energy into electrical energy using solar cell.

CO3. Analyse the various physics concepts through experimentation like B-H Loop, energy band gap and Planck's constant determination etc.

CO4. Develop experimental skills in setting up and conducting experiments, analysing data, and interpreting results.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY106P: Physics Lab –II

Credits : 3 (90 Hrs.)

Marks (External) : 50

Time : 3 Hrs

Marks (Internal Assessment) : 25

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Study of OP AMP as Inverting, Non-inverting, Adder and Subtractor.
2. Study of OP AMP as Square wave generator, Differentiator and Integrator.
3. Study of OP AMP as Current Controlled Voltage Source (CCVS) and Voltage Controlled Current Source (VCCS).
4. To determine Common Mode Rejection Ratio (CMRR) in differential Amplifier.
5. To determine Open Loop Gain in differential Amplifier.
6. Study of OP AMP as RC Phase Shift Oscillator and to determine frequency of oscillation.
7. To study and Plot the V- I Characteristics of MOSFET.
   (a) Drain Characteristics
   (b) Transfer Characteristics
8. To study and plot the V- I characteristics of JFET and to evaluate following parameters:
   (c) DC Drain resistance
   (d) Transconductance
   (e) Amplification factor
9. To study and plot the V- I characteristics of UJT and to evaluate following parameters:
   (f) Intrinsic Stand- off Ratio.
   (g) Inter base resistance.
10. To study the frequency response of Active Low pass, High pass filter circuits.
11. To study the frequency response of Active Band Pass Filter and Narrow Reject T- Notch filter circuits.

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Analyse various OP-AMP based circuits, such as amplifiers (inverting, non-inverting, differential), comparators, oscillators, filters, and more.

CO2. Understand the V-I characteristics and applications of MOSFET, FET and UJT.

CO3. Apply their understanding of filter circuits to other areas of physics and engineering, potentially exploring applications in areas like signal processing or communication systems.

CO4. Develop and test electronic circuits, developing practical skills in circuit construction, soldering, and component identification.

Chairperson
Department of Physics
University
125001

Semester-II

U25PHY201T: Quantum Mechanics-II

Marks (Theory): 70 **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objectives: The primary objective of this course is to develop familiarity with various approximation methods applied to atomic, nuclear and solid-state physics and to scattering, which include: Time-independent perturbation theory and Variational method. The students also gain the knowledge about the scattering and relativistic quantum mechanics.	*Course Specific Outcomes: The students will be aware of the formal structure of the subject and will get equipped with the techniques of approximation methods, perturbation theory, scattering theory and relativistic quantum mechanics so that they can use these in various branches of physics as per their requirements.*

UNIT-I

Stationary State Approximate Methods: Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator, Application to excited states, Ground state of helium.
The WKB approximation: Classical limit, Approximate solutions, Asymptotic nature of solutions, Solution near a turning point, Special case of linear turning point, Connection at the turning point, Asymptotic connection formulae, Application to energy levels of a quantum well, tunneling through a potential barrier and alpha decay

UNIT-II

Time Dependent Perturbation: Schrodinger picture, Heisenberg picture, Heisenberg equation of motion, classical limit, Interaction picture, General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light. Adiabatic and sudden approximations.

Semiclassical theory of radiation: Transition probability for absorption and induced emission, Electric dipole and forbidden transitions, Selection rules.

UNIT-III

Scattering Theory: Basic concept of scattering, scattering amplitude, differential and total scattering cross sections, connecting the lab and CM cross section, scattering by spherically symmetric potentials, Born approximation and its validity, partial waves analysis for elastic and inelastic scattering, phase shifts, Optical theorem, scattering by a perfectly absorbing sphere and by square well potential, application to Yukawa potential and other simple potentials, Scattering of identical particles.

UNIT-IV

Relativistic Quantum Mechanics: Klein-Gordon equation, Dirac equation and its plane wave solutions, Properties of Dirac matrices, Significance of negative energy solutions, Spin angular momentum of the Dirac particle, The nonrelativistic limit of Dirac equation, Electron in electromagnetic fields, Spin and magnetic moment of electrons, spin-orbit interaction, Dirac equation for a particle in a central field, Fine structure of hydrogen atom, Lamb shift.

Reference Books:

1. Quantum Mechanics, NouredineZettili, Wiley
2. Quantum Mechanics: E. Merzbacher (John Wiley, Singapore), 2004
3. Relativistic Quantum Mechanics: J.D. Bjorken and S.D. Drell.
4. Relativistic Quantum Fields: J.D. Bjorken and S.D. Drell.
5. A First Book on Quantum Field Theory: Amitabha Lahiri and P.B. Pal.
6. Quantum Mechanics, A. Ghatak&Loknathan, Mackmilan India Ltd.

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Explain the need of approximation methods and its types for solving the complex problems on atomic scale.

CO2. Describe the use of time dependent perturbation theory and semiclassical theory of radiation for atomic transition in various physical problems.

CO3. Develop problem-solving skills in the context of quantum scattering, including the ability to handle both analytical and numerical calculations.

CO4. Analyse about the Klein-Gordon and Dirac equations, which are relativistic generalizations of the Schrödinger equation, and understand their significance in describing particles with relativistic speeds.

CO5. Tackle research problems in various fields, including atomic, molecular, nuclear, and condensed matter physics, as well as related areas like materials science and chemistry.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY202T: Digital Electronics

Marks (Theory): 70 | **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 | **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objectives: *The course enables students to develop an in-depth understanding about the digital electronics, semiconductor memories, optoelectronics devices, noise and IC fabrication technology.*	***Course Specific Outcomes:*** *After completion of this course, students will be able to understand the basics of semiconductor memories, optoelectronics devices, noise and IC fabrication technology. The students will be able to understand binary number systems and logic gates used in digital electronics.*

UNIT-I

Number system & Logic Gates: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, representation of signed and unsigned numbers, Binary Coded Decimal code, Boolean Algebra and Boolean operators: De Morgan's Theorems, Boolean Laws, simplifications of Logic Circuits using Boolean Algebra, Positive and negative logic, Truth Tables of OR, AND, NOT, construction and symbolic representation of XOR, XNOR, Universal NOR and NAND gates, TTL gates.
Combinational logic design: Binary Adders, Subtractors, Digital Comparator, Parity generators, Decoders/ Demultiplexers, Data selector/Multiplexer-Encoder

UNIT-II

Sequential logic circuits: Flip-Flops – RS, JK, D, T, clocked, preset and clear operation, RAC in JK Flip-flops, master-slave JK flip-flops, Shift registers, Synchronous and Asynchronous counters, Applications of counters, A/D Converters, D/A converter
Semiconductor Memories and its applications: ROM, PROM and EPROM, RAM, SRAM and DRAM.
Microprocessor: Definition, Key features, ALU, CU, Registers, and Bus System.
Microcontroller: Definition, Key features, CPU, RAM, ROM, I/O Ports, Timers/Counters, ADC/DAC. Main Differences between microprocessors and microcontrollers, Applications in modern electronics and embedded systems.

UNIT-III

Optoelectronic Devices: Radiative transition and optical absorption, LED, heterostructure and quantum well devices, charge coupled devices, photodetector, Schottky barrier and p-i-n photodiode, avalanche photodiode, photomultiplier tubes, Solar cells, Piezoelectric sensors and actuators, Transducers (temperature, pressure, vacuum, magnetic field, vibration, particle detector), OLED, solid state battery and LCD.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

UNIT-IV

Noise: 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.

Integrated Circuits (IC): Fabrication and Characteristics: Integrated circuit Technology, Basic monolithic IC, Epitaxial Growth, Masking and Etching, Diffusion of impurities, Transistors for Monolithic circuits, Monolithic diodes, Integrated resistors, Integrated capacitors and inductors, Large scale and medium scale integration (LSI and MSI), Metal Semiconductor contacts: ohmic and rectifying.

Reference Books:

1. Semiconductor Physics and Devices: Donald A Neaman and Dhrubes Biswas, 4th Edition, McGraw Hill, India
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill, India
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Discrete Time Signal Processing, A.V. Oppenheim and R. W. Schafer (2nd Ed., Pearson, 2006)
6. Electronic Communication systems, W. Tomasi (5th Ed., Peason, 2008)

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Define, and learn different number systems, understand and apply Boolean algebra, design and analyze combinational logic circuits using logic gates, and implement these circuits using both basic and universal gates.

CO2. Understand the working of flip-flops, registers, counters, and other sequential circuits, familiar with different types of semiconductor memories like RAM, ROM, use of microprocessor and microcontrollers for basic operations and simulation. .

CO3. Analyse the behaviour of basic optoelectronic circuits, including those involving photodiodes, LEDs, and other optoelectronic components.

CO4. Develop skills in understanding of clean room environments, wafer cleaning processes, various fabrication techniques, and process integration for IC fabrication.

CO5. Demonstrate an understanding of the ethical and societal implications of digital circuits and optoelectronics technologies. .

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY203T: Solid State Physics

Marks (Theory): 70 | **Credits: 4(60 Hrs)**

Marks (Internal Assessment) : 30 | **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objective: *The aim of the course is to familiarize the students with the concepts of crystal structure, lattice vibrations and free electron theory, Band theory, and Superconductivity.*	***Course Specific Outcomes:*** *After completion of this course, students will be able to understand the concepts crystal structure, lattice vibrations and free electron theory, Band theory, and Superconductivity.*

UNIT – I

Crystal Structure: Introduction to solids, Unit cell and basis, Primitive and non-primitive lattices, Symmetry operations, Bravais lattices in 2D and 3D, Miller Indices, Structural determination by X-ray diffraction, Crystal structures: NaCl, CsCl, Diamond and ZnS structure. Reciprocal lattice: Bragg's law, Fourier analysis of electron density, reciprocal lattice, Diffraction condition in reciprocal space, Laue's equations, Ewald construction, Brillioun zones and Weigner Seitz cell concepts, Brillioun zones construction, Reciprocal lattice (sc, bcc, fcc), Fourier analysis of basis, Atomic scattering factors, Geometrical structure factor, X-ray diffraction method: Laue, Rotating and powder crystal methods.

UNIT – II

Lattice vibrations: Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity, Two atoms per primitive basis- acoustical and optical modes; Quantization of lattice vibration: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons, Phonon heat capacity, Planck distribution, Density of states in 1D and 3D, Dulong and Petit's law, Debye and Einstein theories of Density of states, Debye T^3 law. Anharmonic crystal interaction, Thermal expansion and conductivity, Resistivity of phonon gas, Umklapp processes.

UNIT – III

Free electron theory of metals: Free electron gas models: energy levels and density of orbitals in 1D and 3D, Fermi Dirac distribution, Heat capacity of the electron gas, Experimental heat capacity of metals, Thermal effective mass, Electrical conductivity and Ohm's law, Matthiessen's rule, Umklapp scattering, Motion in magnetic fields and Hall effect, Wiedemann-Franz's law, Measurement of conductivity (Four probe method), Magnetoresistance.

Energy Band theory: Nearly free electron model, Origin of energy gap, Bloch functions,Kronig Penny model, wave equation of electron in a periodic potential, Number of orbitals in a band, Velocity and Effective mass of electron, Distinction between metals, semiconductors and insulators.

UNIT – IV

Superconductivity: Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's Equation and Penetration Depth, Thermodynamically and optical properties: energy gap, heat capacity and entropy, Isotope effect, BCS theory, BCS ground state, Flux quantization, persistent current, Josephson effect, Macroscopic quantum interference, High TC superconductors; Critical fields and critical currents, Hall number

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar 125001

Marks (

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. K.V. Keer, Principles of solid state physics, Wiley - Eastern, 1993.
3. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
5. Introduction to Solid State Physics, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Learn about the various types of crystal structure, X-ray methods and able to explain how the arrangement of atoms in a crystal lattice affects properties like electrical conductivity, thermal conductivity, and optical properties of the materials.

CO2. Understand the dynamics of atomic vibrations in solids, including the concept of phonons and their role in heat capacity and thermal conductivity.

CO3. Apply the free electron model, understand the concept of Fermi energy, and explain phenomena like electrical conductivity based on the quantum mechanical behaviour of electrons.

CO4. Analyse the formation of energy bands and band gaps in solids, understanding how these arise from the periodic potential of the crystal lattice.

CO5. Design and conduct experiments, analyse data, and interpret results related to solid-state physics phenomena.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY204T: Atomic and Molecular Physics

Marks (Theory): 70 | **Credits: 4(60 Hrs)**

Marks (Internal Assessment) : 30 | **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. All questions carry equal marks. The question paper shall contain 20% numerical problems in the relevant papers.

Course Specific Objectives: *In this course, students will learn important concepts of atomic and molecular physics. IR, Raman and electronic band spectra of diatomic molecules will be studied. In addition to this LASER, NMR and ESR spectroscopy techniques will be introduced.*	***Course Specific Outcomes:*** *The expected outcome is that student is familiar with different types of atomic and diatomic models and their spectra. Student will also be familiar with LASER, NMR and ESR spectroscopy techniques.*

UNIT- I

Atomic Physics: Bohr model of hydrogen atom, Somerfield modification, Fine structure of hydrogen atoms, Mass correction, electron spin, spin-orbit term, Darwin term. Intensity of fine structure lines. Vector model for atoms, Angular momentum and magnetic moments of atoms, Coupling of angular momenta, Term symbol and derivation from electronic configuration, Two electrons systems: L-S and J-J coupling, Interaction energy in L-S and J-J coupling (sp, pd configuration), Lande interval rule, Pauli principal, General selection rules, Hyperfine structure of spectral lines: Isotope effect and effect of Nuclear spin, Effect of magnetic and electric fields: Zeeman, Paschen-Bach and Stark effects. Auger process.

UNIT- II

Molecular Physics: Born-Oppenheimer approximation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Spectroscopic terms, Rotational spectra of diatomic molecules-rigid and non-rigid rotors, isotope effect, Vibrational spectra of diatomic molecules- harmonic and anharmonic vibrators, Intensity of spectral lines, dissociation energy, vibration-rotation spectra, Electronic spectra of diatomic molecules-vibrational structure of electronic transitions (coarse structure)-progressions and sequences. Rotational structure of electronic bands (Fine structure)-P,Q,R branches.

UNIT- III

Fortrat parabola; Intensity distribution in the Vibrational structure: The Franck-Condon principle-Absorption and Emission (Condon parabola), Raman Spectra of diatomic molecule: Classical and Quantum Mechanical Explanation.

Resonance Spectroscopy: NMR: Basic principles, Classical and quantum mechanical description, Bloch equations, Spin-spin and spin-lattice relaxation times, chemical shift and coupling constant, Experimental methods, single coil and double coil methods, High resolution methods; ESR: Basic principle, ESR spectrometer, nuclear interaction and hyperfine structure, relaxation effects, g-factor, Characteristics, Free radical studies and biological applications.

UNIT- IV

LASER: Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, spatial and temporal coherence, Cavity modes: Number of modes in 1D, 2D and 3D cavities; line-broadening mechanisms; Homogeneous and inhomogeneous (Basic Description only), rate equations for three and four level laser systems (Threshold Population, threshold pump rate, Laser power output with suitable examples), Variation of laser power around threshold, Optimum output coupling. Open Resonators; Q-factor of Resonator; Losses in Resonators: Diffraction losses types of lasers: solid-state (ruby, Nd:YAG, semi-conductor), gas (He- Ne, CO_2).

Chairperson
Department of Physics
Guru Jambheshwar University
of Sci. & Tech., Hisar-125001

Reference Books:

1. Introduction to atomic spectra by H.E. White, McGRAW Hill Book.
2. Atomic & Molecular spectra by Raj Kumar, KedarNath Ram Nath, Meerut
3. Spectra of diatomic molecules by G. Herzberg.
4. Ghatak and Thyagrajan: Lasers
5. B.B.Loyd: Lasers

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Understand the fundamental concepts of atomic structure, including the vector atom model, quantum states of one-electron atoms, and the arrangement of electrons in orbitals. .

CO2. Analyse atomic spectra, including the fine and hyperfine structure of spectral lines, and understand the effects of external fields like the Zeeman and Stark effects and analysis of molecular spectra, particularly focusing on vibrational, electronic and rotational spectra of diatomic molecules.

CO3. Apply the basic knowledge of various spectroscopic techniques i.e., NMR and ESR for understanding the spectroscopy data, evaluate the reliability of results, and draw meaningful conclusions based on experimental evidence.

CO4. Describe the underlying physics of laser operation, including population inversion, stimulated emission, and various laser types (e.g., Ruby, He-Ne etc.).

CO5. Develop practical skills with hands-on experience on laser systems, and spectroscopic experiments for using in future real world's problems.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY206P: Physics Lab –IV

Marks (External) : 50
Marks (Internal Assessment) : 25

Credits : 3 (90 Hrs.)
Time : 3 Hrs

1. ***Each student should perform at-least eight experiments.***
2. ***The students are required to calculate the error involved in a particular experiment.***
3. ***List of experiments may vary.***

List of Experiments:

1. Analysis of operation of Counter Converter.
2. Testing the working of a Monolithic converter.
3. Study of R-S, J-K, D- and T- Type Flip Flop.
4. Study of IC555 as an astable and monostable multivibrator.
5. i) Functional verification and recording of transfer characteristics of weighted resistor D/A converter
   ii) Functional verification of D/A converter with Ladder network and recording of transfer characteristic of Ladder Network D/A converter.
   iii) Functional verification of an integrated D/A converter.
6. Determination and verification of input frequency by Wein Bridge using DPM.
7. Study of Wein Bridge Oscillator and visualize effect on output frequency with variation in RC combination.
8. Addition, Subtraction, Multiplication & Division using 8085/8086.
9. BCD to Seven Segment display

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Analyse various types of counters (ripple counters, synchronous counters) and understand their applications in timing and counting circuits.

CO2. Understand about different types of flip-flops (SR, JK, D, and T) and their triggering mechanisms (edge-triggered, level-triggered) and how flip-flops are used as memory elements and for data storage.

CO3. Apply the principles of analog-to-digital (ADC) and digital-to-analog (DAC) converters and their role in interfacing digital and analog systems.

CO4. Design and develop digital electronic systems that incorporate counters, converters, and flip-flops etc.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY205P: Physics Lab –III

Credits : 3 (90 Hrs.)

Marks (External) : 50

Time : 3 Hrs

Marks (Internal Assessment) : 25

1. *Each student should perform at-least eight experiments.*
2. *The students are required to calculate the error involved in a particular experiment.*
3. *List of experiments may vary.*

List of Experiments:

1. Hall Effect Experiment
   a) To determine the Hall voltage developed across the sample material, b) to calculate the Hall coefficient and the carrier concentration of the sample material.
2. Study of magneto- resistance.
3. To study ESR
4. Study of Thermoelectric effect.
5. Study of Zeeman effect
6. Determination of dielectric constant and Curie's temperature in ferroelectrics sample.
7. Determination of transition temperature in high T_c superconductors.
8. Determination of transition temperature in ferromagnetic materials.
9. Study of heat capacity of solids like Aluminium, Brass and Copper.
10. Study of lattice dynamics
11. Study of Fourier Analysis

Course Outcomes (COs)

After completing this course, the students will be able to:

CO1. Understand how the Hall Effect provides information about the type (electron or hole) and density of charge carriers in a material.

CO2. Interpret ESR spectra, identify different paramagnetic species, and determine parameters like g-factor and hyperfine splitting.

CO3. Analyse the various physics concepts through experimentation like thermoelectric effect, Zeeman effect, Curies temperature, lattice dynamics and Fourier Analysis etc.

CO4. Develop the ability to identify problems, formulate hypotheses, and design experiments to test them.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY201S: Seminar

Total Marks: 50 **Credits: 2 (60 Hrs.)**

Note: This paper is evaluated internally. The seminar topic is given to the student by the seminar committee (two or three teachers) during the starting of semester first for assessing the all students carefully. The marks of the students will be credited in second semester. The seminar marks i.e., 50 marks is divided by the committee as follows:

15 marks out of 50 is given to students by the committee based on the seminar attendance, internal performance etc. 35 marks will be awarded by the committee out of 50 marks on the basis of report submission and seminar presentation on a particular topic.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

U25PHY201I: Internship

Total Marks: 100 **Credits: 4 (120 Hrs.)**

Note: A student will inform and get approval from the Chairperson of the Department before going for an internship. The internship will involve working with local industry (Government or Private organizations/ Institutions), business establishments, artists, craft persons, or a professional (individual/organization). Student will submit a copy of the report (a hard copy and a soft copy in PDF) to the Department within 15 days after the completion of internship. A student must submit a certificate of attendance and work done report from the organization/professional where the internship was done. The evaluation of the internship shall be done by a committee comprising of at least two senior teachers appointed by the Chairperson of the Department. Marks will be awarded by the committee out of 100 marks on the basis of the report and viva-voce examination.

The internship will be governed by the prevailing rules of the University from time to time.

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001