॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

"ज्ञानतीर्थ" परिसर, विष्णुपुरी, नांदेड - ४३१६०६ (महाराष्ट्र)

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED

"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)

Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade

25 1994 - 2019 SILVER JUBILEE YEAR

ACADEMIC (1-BOARD OF STUDIES) SECTION

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संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक ०८ जून २०१९ रोजी संपन्न झालेल्या ४४व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/४४–२०१९** च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या **संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्यात येत आहेत.

1. Bioinformatics
2. Biotechnology
3. Boichemistry
4. Botany
5. Chemistry
6. Computer Management
7. Computer Science
8. Dairy Science
9. Environmental Science
10. Herbal Medicine
11. Information Technology
12. M.C.A.
13. Microbiology
14. Physics
15. Software Engineering
16. System Administration & Networking
17. Zoology

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक–१/परिपत्रक/पदव्युत्तर–सीबीसीएस अभ्यासक्रम/२०१९–२०/४६४
दिनांक : ११.०७.२०१९.

स्वाक्षरित/–
उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

SWAMI RAMANAND TEERTH MATHAWADA UNIVERSITY, NANDED

M. Sc. Physics (CBCS) Syllabus (Affiliated Colleges)

(Affiliated Colleges)

(effective from June 2019)

Disclaimer

*Syllabus of M. **Sc. Physics (Affiliated Colleges)** given in this document is prepared following the requirement of the **Choice Based Credit System (CBCS)** as adopted by **S.R.T.M. University, Nanded** as per guidelines of **UGC, New Delhi,** and has been duly approved by the Board of Studies in Physics, the Faculty of Science and Technology and the Academic Council of the University.*

Syllabus of **M Sc Physics** (Two Year, Four Semester) program given in this booklet was prepared by the faculty of the School of Physical Sciences, S.R.T.M. University, Nanded following the guidelines of the model curriculum developed by UGC, New Delhi and looking at the need of the students to compete with the recent trends in higher education at national and international level. The same has been finalized by inviting comments, suggestions from experts in individual papers from various universities, institutes, industries and alumni of the School.

Preamble:

Swami Ramanand Teerth Marathwada University, Nanded since its establishment has been trying hard to enhance the education quality in its jurisdiction. In this endeavor the University has taken several initiatives for improving its academic standard, which include periodic upgradation and revision of the curricula in tune with the requirement at global level, using innovative methods in teaching-learning process, imparting skill based value added education, improvisation in the examination and evaluation processes, etc. These measures have found to be very effective in achieving **3Es, the *equity, efficiency and excellence*** in higher education of this region.

Following the guidelines of UGC, New Delhi and looking at the better employability, entrepreneurship possibilities and also to enhance the latent skills of the students S.R.T.M.U. has adopted the ***cumulative grade point average*** **(CGPA)** based ***Choice Based Credit System*** **(CBCS)** system for assessing performance of the students from the academic year 2016-2017. The CBCS system offers flexibility to the students in choosing courses of their own choice from the exhaustive list comprising core, elective, skill based, specializations and minor components that are evaluated following the grading system. The university shall be implementing the revised syllabus of M. Sc. Physics First Year from the coming academic year i.e., 2019-2020. This document provides detailed information on methodology of choosing different components of M. Sc. Physics First & Second Year (Semester I through IV) theory and practical courses.

Master of Science (M Sc) Physics is a post graduation, two year, four semester course of S.R.T.M. University, Nanded. The Credit Based Grading System (CBCS) adopted under this course enables the students to develop a strong foundation of the fundamental Physics and also elevates their knowledge base to apply these foundations to the applied and advanced electives, specializations of their own choices. The students pursuing this course will develop in-depth understanding of various aspects of the core subjects of Physics by developing the deeper understanding level of different analogies, laws of the Nature through the subjects like classical mechanics, quantum mechanics, electrodynamics, statistical mechanics, condensed matter physics, atomic and molecular physics, nuclear physics, etc. The course also helps the students in enhancing their analytical skill through the embedded component of the problem solving skills, seminar activities and hands-on and minds-in activities of the course. The courses offered by the University are of student-centric nature and help them to understand the basic laws of nature and develop necessary skills to apply them to the advanced areas of studies.

There are **twenty core or mandatory courses (ten theory and ten lab courses)** meant to provide adequate knowledge on various aspects of physics discipline and to prepare the students for applying them for advanced courses. In addition, there will be skill based elective (specialization) as well as few open elective courses enabling cross-discipline movement to the students. The skill based elective courses are of more advanced nature and help the students to develop their skills in specific fields through more of the hands-on activities. The details of the courses and activities are as follows:

Outline of the M. Sc. Physics Program (Choice Based Credit System):

Students of M Sc Physics program are required to complete a total of 100 credits to acquire M. Sc. Physics degree. These required 100 credits constitute following components:

i. Core Courses: Every student completing post graduation in Physics from this university is required to have a comprehensive knowledge of few of the core or compulsory courses**, which includes classical mechanics, quantum mechanics, statistical mechanics, electrodynamics, nuclear physics, etc. and the related practical courses.** These courses are designed and upgraded looking at the recent developments in the subject and are inducted in the course so as to prepare the students to apply the acquired knowledge in various skill based advanced elective courses. This could form about **75%** of the total credits of M. Sc Physics Program.

ii. Elective: Students have freedom to earn remaining 25% credits by opting courses of their own choice. The available elective courses are of two different natures: **a.Discipline Specific Electives** or **Skill Enhancement courses** and **b. Open or Generic Electives**.

a. **Skill Enhancement or Specialization Courses:** These courses are aimed at providing advanced knowledge in specialized courses, where the students can employ the fundamental knowledge that they have acquired through the core courses. These courses are of advanced nature and enable the students to acquire highest level skills in the fields.

b. **Open Elective Courses:** Students have freedom to choose open elective courses of their interest and inclination from the pool of courses that are made available by the University for a particular semester. These courses are open for all the students and are of specific or introductory or fundamental nature and are designed so as to provide extended scope to the students or enable them to expand their knowledgebase. The students can also select these courses from the UGC recognized online courses like SWAYAM / MOOCS / NPTEL / Communication Skill / seminars etc.

Objectives of the M Sc Physics program:

1. To develop skills of critical thinking, hypothesis building and applying the scientific method of physics concepts, theoretical models and laboratory experiments
2. To develop problem solving skill for identifying and formulating problems independently and creatively employing the theoretical and/or experimental methods that he has acquired during the course
3. To train the students with a working knowledge of experimental/computational techniques and instrumentation required to work independently in research and industrial environments
4. To acquire advanced knowledge in specialized areas in physics that are in tune with the front-line research in physics
5. To prepare the students to successfully compete for current employment opportunities.

Program Outcome:

Students after completing their post graduation in Physics (M Sc Physics) will

1. be eligible to get employment as an assistant professor, teacher, etc. in private, semi-government, government in colleges and schools after fulfilling the requirements and can rise up to the top positions
2. pursue their higher studies in related fields including M Phil, Ph D in the national and international universities depending upon the eligibility conditions of the concerned universities
3. work as research fellow, scientist in research institutes and carry out research after qualifying the NET/SET/PET examinations
4. handle standard and advanced laboratory equipment, modern instrumentation and classical techniques to carry out experiments.
5. work as entrepreneurs

Duration:

The duration of M. Sc. Physics programme offered by the School is of 2 Years (4 semesters) with a total of 100 credits

Eligibility for Admissions to M Sc Physics Program:

- Any science graduate (B. Sc.) with Physics as main or one of the optional at B. Sc. from any recognized university is eligible to apply for admission to the M. Sc. Physics offered by this University. However, the candidate is required to have earned at least **24 credits in Physics at his graduation**.
- Admissions to this course shall be given strictly on the basis of the merit list prepared at individual college depending on the score of the student in Physics at B. Sc level.

Examination/Evaluation Rules:

- For all the courses, 1 credit corresponds to 25 marks and requires 15 contact hours, which includes teaching, tutorials, remedial classes and seminars
- A minimum of 75 % attendance for theory and practical courses is a pre-requisite for appearing for examinations and qualifying a particular course
- The assessment of each of the theory course shall be done in two modes: i. Continuous Internal Assessment or **Mid Semester Assessment (MSA)**, and ii. **End Semester Assessment (ESA)**
- The Mid Semester Assessment shall be done throughout the semester in the form of mid-semester examinations, tests, home assignments, group discussions etc.
- The **Semester End Assessment (ESA)** shall be usually conducted at the end of the respective semester in co-ordination with external examiners
- The MSA and ESA carry equal weightages of assessment i.e. **25:75** percent.
- There shall be no internal or Mid Semester Assessment (MSA) for the laboratory courses. Assessment of the laboratory courses shall be done at the end of the respective semester by a panel of examiners appointed by the University
- The minimum score required for passing a particular course is 40%
- There shall be independent passing for the MSA and ESA separately; otherwise the candidate shall be declared FAIL in that particular course. However, they shall be **Allowed-To-Keep-Term (ATKT)** at the most up to 25% and shall be eligible to get admission in to the third semester.
- A student passing end semester evaluation shall have to independently pass the internal assessment as per the schedule announced by the School. There shall be no provision of conducting the repeat examination either in MSA or ESA. If a student remains absent for the internal assessment he shall be declared FAIL for that particular course

- Failed candidates reappearing for the concerned SEA have to appear for the next regular examination conducted at the end of the following semester.
- Every student admitted to M Sc Physics final year has to complete one project work of 4 credits (100 marks) under the guidance of the faculty member. The performance of the student in project work shall be assessed in both the modes i.e., the MSA of 25 marks and the ESA of 75 marks. ESA will be conducted by a panel of external examinations, where the candidate shall give a presentation on the work that he has conducted throughout the year.
- The **evaluation and grading** of the courses shall be as per the guidelines of UGC, New Delhi and the modified **Grades and Grade Points** (As per UGC) shall be as follows:

UGC Letter Grade	UGC Grade Points	UGC Marks obtained
O : Outstanding	10	>80
A+: Excellent	9	70-79
A: Very Good	8	60-69
B+: Good	7	55-59
B: Above Average	6	50-54
C: Average	5	45-49
P: Pass	4	40-44
F: Fail	0	<40
Ab: Absent	0	---

M. Sc. Physics syllabus given in this document has been prepared by different subcommittees constituted in the meeting of the School of Physical Sciences and is finalized after inviting comments, suggestions from experts in the field in different universities, institutes, industrialists and alumni of the School. The same has been approved by the regular Board of Studies in Physics, the Faculty of Science & Technology and the Academic Council before implementation.

Course Structure and Marking Scheme of M. Sc. Physics Semester I

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 101	Mathematical Methods in Physics	04	05	60	25	75	100
PHY 102	Classical Mechanics	04	05	60	25	75	100
PHY 103	Atomic and Molecular Physics	04	05	60	25	75	100
PHY 104	Electronic Devices and Applications*	04	05	60	25	75	100
PHY 105	Communication Skill / Seminar /Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 106	General Physics Laboratory	04	04	60	25	75	100
PHY 107	General Electronics Laboratory	04	04	60	25	25	100
	Total Credits / Marks	25 credits	---	---	---	---	625

M. Sc. Physics Semester II

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 201	Quantum Mechanics	04	05	60	25	75	100
PHY 202	Statistical Mechanics	04	05	60	25	75	100
PHY 203	Numerical Techniques in Physics	04	05	60	25	75	100
PHY 204	Condensed Matter Physics*	04	05	60	25	75	100
PHY 205	Communication Skill / Seminar/Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 206	Solid State Physics Laboratory	04	04	60	25	75	100
PHY 207	Spectroscopy & Numerical Techniques Laboratory	04	04	60	25	25	100
	Total Credits / Marks	25 credits	---	---	---	---	625

M. Sc. Physics Semester III

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 301	Electrodynamics	04	05	60	25	75	100
PHY 302	Nuclear and Particle Physics	04	05	60	25	75	100
PHY 303	Basics of Lasers and Devices	04	05	60	25	75	100
PHY 304*	Elective Papers: PHY 304 (A / B / C)	04	05	60	25	75	100
PHY 305	Communication Skill / Seminar /Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 306	Nuclear and Lasers Laboratory	04	04	60	25	75	100
PHY 307	Thin Film and Nanophysics Laboratory	04	04	60	25	25	100
	Total Credits / Marks	25 credits	---	---	---	---	625

M. Sc. Physics Semester IV

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 401	Fiber Optics and Optical Fiber Communication	04	05	60	25	75	100
PHY 402	Microwaves and Measurements	04	05	60	25	75	100
PHY 403	Microprocessors & Microcontrollers	04	05	60	25	75	100
PHY 404*	Elective Papers: PHY 404 (A / B / C)	04	05	60	25	75	100
PHY 405	Communication Skill / Seminar /Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 406	Microwave and Fiber Optics Laboratory	04	04	60	25	75	100
PHY 407	Project Work	04	04	60	25	75	100
	Total Credits / Marks	25 credits	---	---	---	---	625

PHY 101 – Mathematical Methods in Physics (Core-1)

***Credits:* 04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:* 100** **[MSA: 25** *(T1+T2+HA)*; **ESA=75]**

Learning Objectives: *Objective of the course is to introduce the students to various mathematical methods that are needed for understanding and deriving various aspects of the core and applied courses of Physics. This course is also aimed to develop knowledge in mathematical physics and its applications, to develop expertise in mathematical methods required in the study of Physics, to develop critical thinking and problem solving skill, to enable the students to formulate, interpret and draw inferences from mathematical solution.*

Learning Outcomes: *After completion of this course students are capable of using the learned mathematical techniques to solve problems in physics such as the use and applications of matrices, the differential equations, the special functions, Fourier series and integral transform and complex functions. Students can apply these learned techniques not only to physics related problems but can extend the use and their applications to Engineering Science and Technology, Biotechnology, Biophysics etc.*

Module I: Vector Spaces and Matrices (15 Hrs)
Linear dependence and independence of vectors, Inner product, Schmidt's orthogonalization method. Matrices – Inverse, Orthogonal, Hermitian and unitary matrices, Transformation of vectors and matrices, System of linear equations, eigenvalues and eigenvectors of square matrix, diagonalisation of a matrix, rotation matrix.

Module II: Special functions (15 Hrs)
i) Legendre equation, Rodrigues formula for Pn(x), generation functions and recurrence relation, Associated Legendre polynomial.
ii) Bessel equation, Bessel function of first kind, generating functions and recurrence relation, Associated Legendre polynomial.
iii) Hermite Equation, generating function and recurrence relation for Hermite polynomial.
iv) Leguerre equation, generating function and recurrence relation, Rodrigue formula, Associated Lagurre polynomials.

Module III: Fourier Series and Integral Transform (15 Hrs)
Fourier series: General properties of Fourier series, Simple applications, properties of Fourier series, convergence, integration, differentiation.
Fourier Transform, Laplace Transforms, Properties of Fourier and Laplace transforms (Linearity, first shifting and second shifting property), Fourier sine and cosine transforms, Fourier and Laplace transform of derivatives, elementary Laplace transform, Inverse Fourier and Laplace transforms, shifting theorm, step function, Solution of simple differential equation using Laplace Transform technique.

Module IV: Complex function and Calculus of Complex function (15 Hrs)
Definition of complex function, exponential function and properties, circular function and properties, hyperbolic function and properties, Inverse hyperbolic function, logarithmic function, limit of a complex function, continuity, derivative (theorm), anlytic functions, harmonic functions, complex integration, Cauchy's theorm,

Cauchy's integral formula, Series of complex term-Taylor's series, Laurentz series. Zeros of an analytical function, Singularities of an analytical function (isolated, removable, poles and essential singularity), Residue Theorm-Calculus of residues.

Reference Books:

1. A. W. Joshi, Matrices and Tensors in Physics,
2. Mathematical Physics, B. S. Rajput
3. Higher Engineering Mathematics, By B. S. Grewal.
4. Mathematical Physics, S. L. Kakani.
5. Mathematical Physics, S. Chandra

PHY 102 – Classical Mechanics (Core-2)

***Credits:* 04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:* 100** **[MSA: 25** *(T1+T2+HA)*; **ESA=75]**

Learning Objectives: *The main objective of this course is to introduce the students to apply mathematical formulation of mechanics problems and to interprete the solutions physically, to apply the concepts of classical mechanics to the rigid systems and to develop the skill of critical thinking and problem solving.*

Learning Outcomes: *After completion of the course the students shall be able to apply Newton's laws of motion to solve complicated problems involving multiple bodies and use the concepts of classical mechanics to the classical rigid bodies.The knowlede acquired through this course will enable the students to lay the foundation of application of the classical dynamics, space dynamics and also for modern physics.*

Module-I: Elementary Principles (15 Hrs)
Review of Newtonian mechanics, Inertial reference frame; Galilean transformations; Motion of a charged particle in electromagnetic field; Conservative and non-conservative forces; Mechanics of a single particle; Mechanics of a System of particles; Motion in a resistive medium; Constraints and its types; Generalized coordinates, cyclic coordinates and degrees of freedom; Virtual displacement and virtual work; D' Alembert's principle.

Module-II: Lagrangian Formulation (15 Hrs)
Lagrangian equation of motion from D' Alembert's principle, procedure for formation of Lagrange's equation; Variation technique; Generalized momenta and cyclic coordinates; Kinetic energy in terms of generalized coordinates; Jacobi integral; Jacobi integral in terms of kinetic energy; Rayleigh's dissipation function; Gauge transformation for Lagrangian; Symmetry properties and conservation laws; Invariance of Lagrangian equations under Galilean transformation; Variational principle; Derivation of Lagrangian equation from Variational principle.

Module-III: Hamiltonian Formulation and Central Force (15 Hrs)
Hamiltonian Formulation
Transformation from Lagrangian to Hamiltonian; Derivation of Hamiltonian equations of motion from Hamiltonian principle; Δ Variation technique; Principle of least action; Canonical transformation; Condition for a transformation to be Canonical; Poisson brackets; Properties of Poisson's bracket; Poisson's bracket of Canonical variables; Jacobi identity; Poisson's theorem; Invariance of Poisson's bracket under canonical transformation; Hamilton-Jacobi method.
Central Force
Reduction of two-body problem into one-body problem; equation of motion under Central force; equation of Orbit; inverse square law; Kepler's laws of planetary motion; Virial theorem; Scattering in a central force field; Rutherford scattering cross section.

Module-IV: Rigid body dynamics and small oscillations (15 Hrs)

Rigid body dynamics

Coordinate systems; Euler's angles; Angular momentum and inertia tensor; Principle axes; Components of angular velocity; Rotational kinetic energy of a body; Euler's equation of motion for a rigid body; Torque free motion of a rigid body.

Small oscillations

Potential energy and equilibrium; Stable and unstable equilibriums; Small oscillations in a system with one degree of freedom; small oscillations in a system with more than one degree of freedom; Normal coordinates; Normal modes and normal frequencies of vibration.

Reference books:

1. Classical Mechanics by J. C. Upadhyaya, Himalaya Publishing House, New Delhi
2. Classical Mechanics by V. B Bhatia, Joag, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi
3. Classical Mechanics by P. V. Panat, Joag, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi
4. Classical Mechanics by S. L Gupta, V Kumar and H. V Sharma Pragati Prakashan Meerut.
5. Classical Mechanics by Suresh Chandra, Narosa Publishing House, New Delhi
6. Classical Mechanics by N. C. Rana and P. S. Joag, Tata Mc Graw Hill Publishing Co. Ltd.,New Delhi

PHY 103 – Atomic and Molecular Physics (Core-3)

***Credits:* 04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:* 100** **[MSA: 25** *(T1+T2+HA)*; **ESA=75]**

Learning objectives: *Atomic and molecular physics is of great importance and very basic field in physics. The basic of all matter, which exist in nature, is based on atomic and molecular structure. It is one of the most important subjects for the testing grounds of the quantum theory. It helps in understanding, many fields of science and technology, namely spectroscopy, Laser Physics & Technology, Plasma Physics, Nuclear physics, Particle Physics, Astrophysics, Condensed Matter Physics and Material Sciences, Metrology, Biosciences, Atmospheric Sciences, Chemical sciences, biological physics, energy research and fusion studies. Specific objectives are:*

1. To introduce the world of atoms and molecules to the students.

2. To focus on development of various atomic models and to explain the importance and application of Bohr atomic model for atomic spectra of hydrogen like atoms.

3. To shed light on various basic concepts like vector atomic model, introduction of spin, coupling schemes for many electron atoms, term symbols to designate quantum states.

3. To bring into notice the basic concepts of molecular spectroscopy and their types, origin of rotational, vibrational , electronic and Raman spectra of various molecules and to explain the importance of polymeric materials to humanity and molecules

4. To introduce the working principle of various spectroscopic techniques and instrumentation used for analyzing spectra of various types of molecules.

Learning outcomes: *Upon successful completion of these modules, students will be able to understand and explain the following;*

1. *The atomic spectra of one valance electron atoms.*
2. *what is meant by LS and JJ coupling in case of two valance electron atoms and the origin of spin-orbit interaction*
3. *Use appropriate quantum numbers for labeling of energy levels/terms symbols.*
4. *The change in behavior of atoms in external applied electric and magnetic field.*
5. *Diatomic molecules, the origin of electronic, vibrational and rotational energy levels, calculate energy levels,*
6. *Analyze rotational, vibrational, electronic and Raman spectra of molecules*
7. *To undertake simple calculations of bond lengths, rotational constant, dissociation energy, and relative level populations*

Module-I: Atomic structure and atomic spectra (15 Hrs)

Spectra of Monovalent atoms

Quantum mechanical results of hydrogen atom, Atomic spectra of Hydrogen, Quantum numbers and their role, atomic orbitals, orbital and spin angular momenta., spin orbit interaction, vector atom model, spectroscopic terms and their notations, Fine structure in hydrogen energy levels, spectra of alkali elements, different series in alkali spectra. The doublet fine structure.

Spectra of Divalent atoms
Coupling scheme, L-S and j-j coupling, Building up principle: the Aufbau principle, Equivalent and non-equivalent electrons: Pauli's exclusion principle, Hund's rules. spectral terms, Breit's scheme
Magnetic and electric field effects
Normal and anomalous Zeeman effect, Lande g factor, Interaction energies's, Paschen Back effect, interaction energy, co-relation between Zeeman and Paschen Back effects, Stark effect with weak and strong field, Hyperfine structure

Module-II: Microwave Spectroscopy of Molecules (15 Hrs)
Preliminaries, Types of molecules
Diatomic molecules -Rotational spectra of diatomic molecule, Rigid rotator and Non-rigid rotator, energy levels, selection rules and resulting spectra, the effect of isotopic substitution, Intensities of spectral lines in rotational spectra,
Polyatomic molecules - Linear molecules, determination of inter-atomic distances using isotopic substitution, Symmetric top molecules: calculation of energy, selection rule, spectra. Microwave spectrometer, problem solving

Module-III: Infrared and Electronic spectroscopy of molecules (15 Hrs)
Vibrational spectroscopy of diatomic molecules
Vibrational energy of diatomic molecule, the simple harmonic oscillator model energy The anharmonic oscillator, Morse potential curve, Energies, selection rules, spectra, frequencies of fundamental and overtones and hot band
The diatomic vibrating rotator with and without Born-Oppenheimer approximation, energy levels, selection rules, P, Q and R branches.
Polyatomic molecules
Fundamental vibrations and their symmetry, CO_2 and H_2O molecules, techniques and instrumentations, IR spectrometer
Electronic spectra of diatomic molecules
Born-Oppenheimer approximation, vibrational coarse structure of electronic bands, progressions and sequences, P, Q and R branches. The band head formation and shading of bands, Franck Condon principle, dissociation energy and dissociation products,

Module-IV: Raman spectroscopy of molecules (15 Hrs)
Introduction, quantum theory of Raman Effect, classical theory of Raman effect, molecular polarizability,
Pure rotational Raman spectra
linear diatomic molecules, intensity alteration in Raman spectra of diatomic molecules, Raman spectra of symmetric top molecule, R and S branches in Raman spectra
Vibrational Raman spectra
Raman activity of vibrations (H_2O and CO_2 molecules), rule of mutual exclusion, nature of polarized light, structure determination from Raman and infra-red spectroscopy, Experimental setup for Raman spectroscopy

Reference Books:

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell (Tata MacGrawHill, New Delhi)
2. Spectra of Atoms and Molecules by Peter Bernath (Oxford Uni. Press, USA)
3. Introduction to Atomic Spectra by H. E. White (Tata McGraw Hill, New Delhi)
4. Spectroscopy Vol. 1, 2 & 3 by Straughan B. P. and Walker M. A. (Chapman and Hall, London)
5. Atoms, Molecules and Lasers by K. P. Rajappan Nair (Narosa Publishing House, Delhi)
6. Atomic Spectroscopy by K. P. Rajappan Nair (MJP Publishers, Chennai)
7. Atom, Laser and Spectroscopy by S. N. Thakur, D. K. Rai (PHI Learning Private Ltd., Delhi) Faculty of Science, M.Sc. Physics Syllabus (2016) Page 18
8. Elements of Spectroscopy by Gupta-Kumar-Sharma (PragatiPrakashan, Meerut)
9. Atomic Spectra and Atomic Structure by G. Herzberg, New York Dover Publication 1944
10. Introduction to Molecular spectroscopy by C. M. Barrow

PHYCT 104 – Electronic Devices and Applications (Core-4)

Credits: **04**	***Contact Hours*****: 60** *(L+T+R)*	***Total Marks:*** **100** **[MSA: 25** *(T1+T2+HA)*; **ESA=75]**

Learning Objective: *This paper is aimed to enhance comprehension and application capabilities of the electronic devices that are being used in day to day life in the form of various gadgets like, mobile phone, television, microwave, calculators, computer, etc. This paper is designed with an objective to expose students to the basics and advancements in the electronic device technology and to inculcate them towards future device technology/research.*

Learning Outcome: *After completion of this course, students will be able to explain the working principles and application of various electronic devices used in various electronic gadgets of domestic uses. They will also understand the construction, working and operational characteristics of semiconductor devices and their applications in advanced electronics industries.The students will also understand the utility and functioning of the microprocessors, the heart of the advanced computing machines.*

Module-I: Semiconductor Devices (15 Hrs)

- Fundamentals of semiconductor: Classification based on band gap (insulator, conductor and semiconductor), n-type and p-type semiconductors, understanding p-n junction
- Devices: Structure and characteristics of diodes, bipolar transistors, field effect transistor, metal oxide field effect transistor, uni-junction transistors and silicon control rectifier
- Applications of semiconductor devices as amplifiers and oscillators

Module-II: Photonic Devices (15 Hrs)

- Basics of photonic devices: Direct and Indirect band gap of semiconductor, radiative transitions, photoconductors
- Photodiodes, Phototransistor and Photo-detectors (construction, working and application)
- Light emitting diodes (Visible and Infrared)
- Solar cells (Solar radiations and ideal conversion efficiency P-N junction solar cell, spectral response, I-V characteristics)

Module-III: Operational Amplifier & Its Applications (15 Hrs)

- OP-AMP parameters, ideal OP-AMP, differential amplifier
- OP-AMP as an 1) Inverting amplifier 2) Non –Inverting amplifier 3) Adder 4) Subtractor 5) Differentiator 6) Integrator 6) Schmitt trigger 7) Comparator
- Applications of OP-AMP as active filters: First order High pass, Low Pass & Band Pass Filters

Module-IV: Digital Electronics (15 Hrs)

- Number system: Binary, Decimal & Hexadecimal no. system and its algebra,
- Logic devices: AND, OR, NOR, NAND, XOR (Symbols, working and truth tables)
- Registers: Flip–flop-R-S, J-K, T, D (logic symbols, working and truth tables)
- Shift registers: 4-bit left to right and right to left
- Digital counters: Synchronous and asynchronous

- Encoder and decoder: 1:4 and 4:19 (logical diagram and truth table)
- Multiplexer and demultiplexer: Logical diagram and truth table
- DAC: R-2R ladder network
- ADC using comparators
- Monostable and astable multivibrators using IC555
- Application of Digital devices: Microprocessor

Reference Books:

1. Principles of electronics: V K Mehta
2. Digital Electronics: Malvino and Leech
3. Electronic devices: Milman and Halkias
4. Electronic devices: Thomas Flyod
5. Introduction to microprocessors: Gaonkar
6. Microprocessors: B.Ram
7. Digital and Microprocessor: Flyod

PHY 106 – General Physics Laboratory (Core-5) (Annual Pattern)

***Credits:* 04**	***Contact Hours*: 60** *(Hands-on)*	***Total Marks:* 100** **[MSA=25 (Test+Viva+Journal), ESA=75]**

1. Determination of Plank's constant by photo cell.
2. Determination of Accoustic impedence (z) and adiabatic compressibility β and intermolecular free length (L_f) of a given liquid by ultrasonic interferometer.
3. Determination of h/e by photo cell.
4. e/m by helical method.
5. Platinum resistance thermometer.
6. Determination of specific heat of a given liquid by the method of cooling.
7. Determination of Poisson's ratio for rubber rube.
8. Verification of law of Malus.
9. Temperature to frequency conversion.
10. Thickness of a given mica sheat by Freshnel's bi prism.
11. Surface tension of a given liquid by stalegnometer.
12. *Y*- by Cornu's fringes.
13. *e*- by Milikan oil drop method.
14. Characteristics of transformer.

(Every student has to perform at least 12 experiments from the list given above)

PHY 107 – General Electronics Laboratory (Core-6) (Annual Pattern)

Credits: **04**	***Contact Hours*: 60** *(Hands-on)*	***Total Marks:*** **100** **[MSA=25 (Test+Viva+Journal), ESA=75]**

1. CE – amplifier:

- **i)** Design and build a single stage CE amplifier.
- **ii)** Study its frequency response curve.
- **iii)** Find its 3db bank width.

2. SCR– Characteristics:

i) Draw and construct the circuit for plotting SCR characteristics.
ii) From the graph find the value of holding current IH and holding VH.

3. UJT Characteristics:

i) Draw and construct the circuit for plotting SCR characteristics.
ii) From the graph note draw the value of pinch off voltage VP and hence find intrinsic standoff ratio

4. FET Characteristics:

i) Draw and construct the circuit for plotting JFET characteristics.
ii) Plot its drain characteristics.
iii) Plot its trans conductance characteristics.
iv) From the characteristics find the values of r_d, g_m and μ.

5. Op-Amp:

i) Construct the circuit to study Op-Amp as an inverting amplifier.
ii) Verify the gain relation $A_\mu = -R_f/R_1$ for various values of R_f & R_1 by giving dc i/p.
iii) By fixing R_f & R_1 study the frequency response of the circuit.
iv) From the graph find 3dB band width.

6. Op-Amp:

i) Construct the circuit to study Op-Amp as an non-inverting amplifier.
ii) Verify the gain relation $A_\mu = 1+R_f/R_1$ for various values of R_f & R_1 by giving dc i/p.
iii) By fixing R_f & R_1 study the frequency response of the circuit.
iv) From the graph find 3dB-band width.

7. Op-Amp:

a) i) Construct the circuit to study Op-Amp as an adder.
ii) Study the circuit for different i/p voltages.

b) i) Construct the circuit to study Op-Amp as substractor.
ii) Study the response of circuit for different *i/p* voltages.
iii) Find error in actual *o/p* ad theoretical *o/p* ad comment.

8. Using IC 7400 construct:
i) And gate ii) OR gate iii) NOR gate iv) NAND gate v) NOT gate
vi) Verify the truth table for every gate.

9.
i) Using IC 7476 verify the truth table for JK flip-flop.
ii) Construct T type flip flop and verify truth table.
iii) Construct D type flip-flop and verify truth table.

10. Using IC 7476:
Design a Mod-5 synchronous counter and study it.

11. Using IC 7476:
Design a Mod-16 up counter and study it.

12. i) Construct the circuit to study wave forms of function generator IC 566.
ii) By varying the control voltage study the response of circuit.
iii) Show modulated wave forms.

13. i) Design and construct the circuit for high pass filter using IC 741.
ii) Study the response of the circuit.
iii) From the graph find cutoff frequency.

14. i) Design and construct circuit for low pass filter using IC 714.
ii) Study the response of the circuit.
iii) From the graph find cutoff frequency.

15. i) Construct a R-2R ladder network by using IC 741 to study D/A converter.
ii) By giving different digital *i/p* study the response of the circuit.
iii) Comment on error in theoretical *o/p* and actual *o/p*.

16. i) Draw the circuit diagram to study the truth table for MUX and DeMUX.
ii) Verify the truth table.

Books for Practical Work:
1. University Practical Physics, D.C. Tayal (Himalaya Publishing House)
2. Lab Manual in Solid State Physics, Dr.Arun S.Nigvekar (University of Poona)
3. Experiments in Solid State Physics, D.B. Sirdeshmukh and K.G. Subhadra (Published by Authors Warangal).
4. Advanced Practical Physics, Chauhan and Singh.
5. Advance Practical Physics, Kumar and Madan Lal.
6. A Lab Manual of Physics, F.Tyler (Edward Arnold Publisher Ltd.)
7. Advanced Practical Physics Vol. I & Vol. II S.P. Singh (Pragati Prakashan)
8. Practical Physics, C.L. Arora (S.Chand & Co.)

(Every student has to perform at least 12 experiments from the list given above)

PHY 201 – Quantum Mechanics (Core-7)

Credits: **04**	***Contact Hours*:** **60** *(L+T+R)*	***Total Marks:*** **100** **[MSA: 25** *(T1+T2+HA)*; **ESA=75]**

Learning objectives: *Quantum mechanics helps to understand of number of aspects of physics, chemistry, and modern technology.*
1. To introduce the physical principles and the mathematical background important to quantum mechanical descriptions.
2. To introduce the mathematical properties of the waves that describe free particles
3. To give basic understanding of the basic postulates of quantum mechanics which are helpful to formalize the rules of quantum mechanics.
4. To explain the importance and applications of quantum mechanics to various industries.

Learning outcome: *Upon successful completion of these modules, students will be able to understand that quantum mechanics is basic of many branches of Physics and will be able to apply quantum theory to other applied areas like nuclear physics, atomic and molecular physics, solid state physics, laser physics etc. The students will be able to relate the ideas and concepts from physics to chemistry, materials science and engineering. Students will be able to use quantum theory to model natural and physical phenomena in materials science, chemistry and nanotechnology. Students will be able to understand and explain the differences between classical and quantum mechanics. They will be able to understand the idea of wave function and to solve Schrodinger equation for simple potentials.*

Module-I: (15 Hrs)
Derivation of time dependent and time independent Schrodinger equation, Physical significance of wave function, Quantum numbers, Postulates of Quantum Mechanics, Commutation relations for position and momentum operator, Dirac Delta function and its properties, Ket and Bra notations, Completeness of eigen functions, Matrix representation of an operator, Unitary Transformation.

Module-II: Angular Momentum (15 Hrs)
Angular momentum and rotations, Orbital angular momentum, Spin angular momentum, Rotational symmetry and conservation of angular momentum, Commutation relations for Spin, orbital and total angular momentum, Ladder operators, eigen values of the angular momentum operators; L^2, L_z, J^2, J_z, J+ and J-, Reflection invariance and Parity, Addition of two angular momenta– Clebsch –Gorden Coefficient , calculation of C.G.coefficient

Module-III: Approximation methods **(15 Hrs)**
(a) **Time independent Perturbation Theory**
Stationary perturbation theory, Non-degenerate case; First order correction to energy, First order correction to wave function, Second order perturbation, and corrections, Stark effect in the ground state of hydrogen atom, Time independent perturbation theory: degenerate case, application for the He atom, degenerate case – Stark effect.
(b) **Time dependent perturbation Theory**
Zero order perturbation, First order perturbation, second order perturbation, Fermi Golden rule, adiabatic and sudden approximation.

(c) **Variational Method**
The basic Principle, expectation value of energy in ground state, application to excited state, application to two electrons atom,
(d) **WKB approximation**
The classical limit, One dimensional case, turning point, connection formulae, the application to bound state

Module-IV: Collision in 3-d and Scattering (15 Hrs)
Laboratory and Centre of Mass reference frames, scattering amplitude, differential scattering cross section, total scattering cross section, Asymptotic form of scattering states, Relation between angles and cross sections in the laboratory and center of mass systems, Scattering by spherically symmetric potentials, Integral equation of scattering, The Born approximation, Partial Waves and Phase shifts, Scattering by a perfectly rigid sphere and by square well potential, Complex potential and absorption. Identical particles, symmetric and asymmetric wave functions and their construction for N particle system, Slater's determinant, Collision of identical particles (Mathematical derivations are not expected)

Reference books:

1. Quantum mechanics - L. I. Schiff (McGraw Hill)
2. Quantum mechanics - Ghatak and Loknathan
3. Quantum mechanics - A. P. Messiah
4. Modern quantum mechanics - J. J. Sakurai (Addison Wesely)
5. Quantum mechanics - Mathews and Venkatesar.

PHY 202 – Statistical Mechanics (Core-8)

Credits: 04	*Contact Hours*: 60 *(L+T+R)*	*Total Marks:* 100 **[MSA: 25** (*T1+T2+HA*); **ESA=75]**

Learning Objective: *The main objective of this course is that students will be well aware of studying physical properties of matter "in bulk" on the basis of dynamical behaviour of its microscopic constituents. Fundamentals of heat and laws of thermodynamics with the help of statistics will be covered in order to obtain physical properties on the basis of distribution laws including their applications in view of classical and quantum statistics. The course also includes basics of phase transition with their applications*.

Learning Outcome: T*he main outcome after learning the course is that students can apply and extend concepts learned in this course to theoretical physics. Students will be well acquainted with the particle nature on the basis of distribution laws and their uses in order to illustrate propertis of most exotic systems like white dwarf stars, superfluid materials, etc.*

Module-I: **Classical Statistics** (15 Hrs)
Fundamentals
Foundation of statistical mechanics, specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox
Ensembles
Micro canonical ensemble; phase space; trajectories and density of states; Liouville's theorem; Canonical ensemble and Grand Canonical ensemble; partition function, Calculation of statistical quantities, Energy and density fluctuations.

Maxwell-Boltzmann System: Maxwell-Boltzmann distribution formula; evaluation of constants α and β, Maxwell-Boltzmann velocity distribution formula;

Module-II: Quantum Statistics (15 Hrs)
Density matrix, statistics of ensembles,statistics of indistinguishable particals Fermi-Dirac Gas:- Fermi Dirac distribution formula, ideal F.D. gas, Weakly degenerate Fermi gas; Strongly degenerate Fermi gas; thermodynamic functions of degenerate F.D. gas, Thermionic emission; electron gas, Free electron model, Photo electric emission, Pauli's theory of Para magnetism, Statistical equilibrium in a white dwarf star

Module-III: (15 Hrs)
Bose-Einstein Gas :-Bose-Einstein distribution formula, Ideal B.E. gas, Black body radiation, Photon statistics, Phonon statistics, B.E. condensation, liquid helium, London Theory, Tisza's two fluid model, Landau's theory.

Module-IV: (15 Hrs)
Cluster expansion for a classical gas, Virial equation of state, Ising model, mean field theories, Ising model in one, two, three dimensions, exact solution of one dimension.

Phase Transitions: Landau's theory of phase transition, Critical indices,
Fluctuations and transport phenomena, Brownian motion, Langevin's theory, fluctuation dissipation theorem, The Fokker-Plank equation.

Reference Books

1. Statistical Mechanics by R. K Patharia, Pregamon Press, Oxford
2. Statistical Mechanics by J. K Bhaltacharjee, Allied Pubishers Limited, New Delhi
3. Fundamentals of Statistical Mechanics and thermal Physics by F. Reif, McGraw- Hill International Editions
4. Statistical Mechanics by S. K Sinha, Tata M2 Graw-Hill Publishing Co. Ltd. New Delhi
5. Statistical Mechanics by Suresh Chandra, CBS Publishers & Distributors, New De

PHY 203 – Numerical Techniques in Physics (Core-9)

Credits: **04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:*** **100** **[MSA: 25** *(T1+T2+HA)*; **ESA=75]**

Learning Objectives: *The main objective of the course is to introduce students to the useful numerical methods and tools that are being adopted for handeling data in Physics. The course also aimed to introduce the students to C-Programing language, which is an essential tool for handeling and solving numerical problems in physics.*

Learning Outcomes: *After completion of the course students shall be able to employ the studied numerical techniques to solve problems in physics related to the applications like data handeling and fitting, finding solutions and root of equations, solving the differential and integral equations, simultaneous equations and partial differential equations. They shall also be well versed with writing their programmes using C-language of computer programming. Students can apply these learned techniques not only to physics related problems but can extend the use and their applications to Engeering science and technology, Biotechnology, Biophysics etc.*

Module-I: (15 Hrs)

Curve fitting and interpolation

The Principle of Least squares, fitting a straight line, fitting a parabola, fitting an exponential curve, fitting curve of the form $y=ax^b$, fitting through a polynomial, Cubic spline fitting, Linear interpolation, difference schemes, Newton's forward and backward interpolation formula.

Roots of equation

Polynomial and transcendental equations, limits for the roots of polynomial equation. Bisectional method, false position method, Newton Raphson method, direct substitution method, synthetic division, complex roots.

Module-II: (15 Hrs)

Numerical integration

Newton cotes formula, trapezoidal rule, Simpson's one third rule, Simpson's three eight rule, Gauss quadratics method, Monte Carlo method.

Solution of differential equation

Taylor series method, Euler method, Runge Kutta method, predictor-corrector method

Module-III: (15 Hrs)

Solution of simultaneous equation:

Gaussian elimination method, pivotal condensation method, Gauss-Jordan elimination method, Gauss-Seidal iteration method, Gauss-Jordan matrix inversion method, Gaussian-elimination matrix inversion method

Eigen values and eigenvectors of a matrix

Computation of real eigen values and corresponding eigenvectors of a symmetric matrix, power method and inverse power method.

Partial differential equations

Difference equation method over a rectangular domain for solving elliptic, parabolic and hyperbolic partial differential equation

Module-IV: (15 Hrs)

C- Programming

Elementary information about digital computer principles, compliers, interpreters, and operating systems, C programming, flow charts, integer and floating point arithmetic, expression, build in functions, executable and non-executable statements, assignment, control and input-output elements, user defined functions, operation with files: pointers

Random numbers:

Random numbers, Random walk, method of importance sampling.

Reference books:

1. H. M. Antia: Numerical methods for scientists and engineers.
2. Suresh Chandra Computer Applications in Physics with FORTRAN, BASIC and C, Narosa Publishers
3. Vetterming, Teukolsky, press and Flannery: Numerical recipes.
4. Sastry: Introductory method of numerical analysis.
5. Rajaraman: Numerical analysis.
6. Numerical Computational methods, P. B. Patil and U. P. Verma.
7. Numerical methods and computation – B. K. Bafna.
8. Advanced engineering mathematics – Erwin Kreszing 5^{th} or 7^{th} edition john Willey and sons inc.
9. C Programming : Balgurusamy
10. Suresh Chandra Applications of Numrical Techniques with C Narosa Publishers.

PHY 204 – Condensed Matter Physics (Core-10)

***Credits:* 04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:* 100** **[MSA: 25** *(T1+T2+HA)*; **ESA=75]**

Learning Objective: *The main objective is to provide an overview of different types of materials and illustrate how their properties depend on the microscopic structure. The course will deliver basic knowledge, but it should also serve as an orientation on the current issues in the different branches of condensed matter physics, providing additional arguments for the choice of master thesis topic.*

Learning Outcome: *After completing the course students will have knowledge of different types of solids and an understanding of how their microscopic structure affects their mechanical, thermal and electrical properties*

Module-I: Crystal structure, X-ray diffraction and Crystal imperfections (15 Hrs)

- **Crystal structure**
    - Basic of crystal structure, Bravais lattices in two and three dimension
    - Some important crystal structure: Simple cubic (SC), Body centered cubic (BCC), Face centered cubic (FCC), Hexagonal close packed (HCP), NaCl and diamond structure
    - Miller indices and spacing between set of a crystal planes
- **X-ray diffraction and Reciprocal lattice**
    - Generation and interaction of X-ray, Braggs law and experimental methods: Laue method, Rotating crystal method, powered method
    - Reciprocal lattice and diffraction condition
    - Atomic scattering factor and Geometrical structure factor
- **Crystal Imperfections**
    - Point defects, line defects and Surface defects
    - Energies of dislocations

Module-II: Band theory and Fermi Surface (15 Hrs)

- **Band theory**
    - Electron motion in crystal (one dimensional)
    - Bloch theorem and implementation in Kroning-penny model
    - Concept of effective mass, Concept of holes
    - Metals, insulators and semiconductor
    - Other model and methods
- **Fermi Surface**
    - Fermi surface and Brillouin zones,
    - Experimental determination of Fermi surface

Module-III: Semiconducting, Dielectric and optical properties of materials (15 Hrs)

- **Semiconductor:**
- Basics of semiconductors: Carrier concentration in semiconductors and impurity states, Fermi level position as a function of charge carrier concentration

- semiconductor, optical methods to determine the forbidden gap, Direct and indirect band gap
- Transport properties in semiconductor (resistivity, carrier concentration, mobility, temperature dependence, Hall Effect)

- **Dielectric and optical property of material**
    - The dielectric constant and polarizability, Sources of polarizability
    - Dipolar polarizability and Dipolar dispersion in solids
    - Ionic polarizability, Electronic polarizability, Piezoelecricity and Ferroelectricity

Module-IV: Superconductivity and Magnetic properties of materials (15 Hrs)

- **Superconductivity**
    - Introduction to superconductivity
    - Meissner effect, Critical temperature and persistent current
    - Type-1 & Type-II superconductors
    - The London theory, BCS theory, Cooper pair Flux quantization
- **Magnetic properties:**
    - Origin of Magnetic properties of materials, Magnetic susceptibility, Curie Weiss law for susceptibility,
    - Classification of magnetic materials,
    - Weiss molecular field theory of ferromagnetism,
    - Heisenberg model,
    - Ferromagnetic domain and Hysteresis, Closure domains,
    - Exchange interactions in Ferromagnets,
    - The Bloch wall and Bloch wall energy,
    - Antiferromagetism: two sublattice model,
    - Neel temperature, Susceptibility below Neel temperature,
    - Ferrimagnetism: Structure of ferrites, Spin arrangement in Ferrite,
    - Spin waves and magnons.

Reference Books:

1. Elementary solid state physics - Omar Ali
2. Solid state physics - C. Kittle.
3. Introduction to solids - Azaroft.
4. Solid state physics - Aschrott and Mermim
5. Solid state physics - Dekkar
6. Solid state physics - Ajay Kumar Saxena
7. Solid state physics - S.O. Pillai

PHY 206 – Solid State Physics Laboratory (Core-11)

***Credits:* 04**	***Contact Hours*: 60** *(Hands-on)*	***Total Marks:* 100** **[MSA=25(Test_Viva_Journal), ESA=75]**

Solid State Physics Laboratory Experiments

1. Determination of specific heat of graphite at different temperatures.
2. Measurement of Resistivity of Germanium by four probe method.
3. Measurement of ionic conductivity of sodium chloride.
4. Study of magnetic properties of MnSo4 by Guoy method.
5. Study of magnetic susceptibility in liquids.
6. Estimation of core loss and coercive force for a ferromagnetic core material of a transformer.
7. Measurement of Hall co-efficient of a given sample.
8. Energy band gap by using thermister.
9. Electrical conductivity of graphite rod.
10. Thermo e.m.f. and thermo electric power of a copper Iron thermo couple with temperature of hot junction using by LCRQ meter and function generator.
11. Dielectric constant of solid.
12. Energy band gap of semi conductor by four-probe method.
13. To study the variation of energy band gap (E_g) of diode with temp.
14. Determination of electronic charge by investigating rectifier equation of solid state diode.
15. Determination of Specific Heat of Solids.
16. Determination of Fermi energy of metals.

(Every student has perform at least 12 experiments of the list given above)

PHY 207 – Spectroscopy and Numerical Techniques Laboratory (Core-12)

***Credits:* 04**	***Contact Hours*: 60** *(Hands-on)*	***Total Marks:* 100** **[MSA=25(Test_Viva_Journal), ESA=75]**

1. Calibration of CDS and determine the unknown wavelength
2. Determination of Polarizability of a given liquid.
3. Calibration of Spectrometer by Talbot band/ Edser Butler plate.
4. Determination of Cauchy's Constants.
5. Verification of Beer's law.
6. Determination of thickness of plate /wavelength by Fabry Parrot etalon.
7. Michelson Interferometer determination of _ and d_.
8. Hartman's dispersion formula.
9. Determination of wavelength of He-Ne laser beam by Michelson interferometer.
10. Write a program to find zeros of a polynomial equation by using Bisection method. Write the algorithm and draw flow chart. Get hard copy of the result.
11. Write a program to find the roots of given polynomial equation using Newton- Raphson method. Write the algorithm and draw flow chart. Get hard copy of the result.
12. Write a program to find integration of a given equation by using Simpson's 1/3 rule. Write the algorithm and draw flow chart. Get hard copy of the result.
13. Write a program to find integration of a given equation by using Trapezoidal rule. Write the algorithm and draw flow chart. Get hard copy of the result.
14. Write a program to find solution of a differential equation by using Taylor series method. Write the algorithm and draw flow chart. Get hard copy of the result.
15. Write a program to find solution of a differential equation by using Euler's method. Write the algorithm and draw flow chart. Get hard copy of the result.
16. Write a program for interpolation by using Newton's forward difference formula. Write the algorithm and draw flow chart. Get hard copy of the result.
17. Write a program for interpolation by using Newton's backward difference formula. Write the algorithm and draw flow chart. Get hard copy of the result.

Books for Practical Work:

1) University Practical Physics, D.C. Tayal (Himalaya Publishing House)

2) Lab Manual in Solid State Physics, Dr.Arun S.Nigvekar (University of Poona)

3) Experiments in Solid State Physics, D.B. Sirdeshmukh and K.G. Subhadra (Published by Author Warangal).

4) Advanced Practical Physics, Chauhan and Singh.
5) Advanced Practical Physics, Kumar and Madan Lal.
6) A Lab Manual of Physics, F.Tyler (Edward Anrold Publisher Ltd.)
7) Advanced Practical Physics Vol. I & Vol. II, S.P. Singh (Pragati Prakashan).
8) Practical Physics, C.I, Arora (S.Chand & Co.)

(Every student has perform at least 12 experiments of the list given above)

Question Paper Pattern
Semester End Assessment
M. Sc. Physics First and Second Year (CBCS)

Time: 03 Hrs **Total Marks: 75**

Note: All questions are compulsory and carry equal marks

Question 1 – Single long answer type question **15 marks**

OR

Two sub-questions (*a* and *b* of 8 & 7 marks) **15 marks**

(Note: This question will be based on Module I)

Question 2 – Single long answer type question **15 marks**

OR

Two sub-questions (*a* and *b* of 8 & 7 marks) **15 marks**

(Note: This question will be based on Module II)

Question 3 – Single long answer type question **15 marks**

OR

Two sub-questions (*a* and *b* of 8 & 7 marks) **15 marks**

(Note: This question will be based on Module III)

Question 4 – Single long answer type question **15 marks**

OR

Two sub-questions (*a* and *b* of 8 & 7 marks) **15 marks**

(Note: This question will be based on Module IV)

Question 5 – Write Short Notes on ANY THREE (each of 5 marks) **15 marks**

a.
b.
c.
d.

(Note: This question shall be based on entire syllabus and must have one sub-question from each of the module)

Question Paper Pattern for Practical Course
End Semester Assessment
M Sc Physics (CBCS)

Time: 04 Hrs **Total Marks: 75**

Note: ***i. Every student is required to complete TWO experiments in the final examination***
ii. The distribution of the 75 marks will be as given below

Expt-1 (a) Experimental work	**30 *marks***
(b) Viva-voce	***05 marks***
Expt-2 (c) Experimental work	**30 *marks***
(d) Viva-voce	***05 marks***
(e) Journal	***05 marks***