K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 01/08/2023

NOTIFICATION

Sub :- CBCS Syllabi of M.Sc. Physics (Sem. I & II)

Ref. :- Decision of the Academic Council at its meeting held on 26/07/2023.

The Syllabi of M.Sc. in Physics (First and Second Semesters) as per **NATIONAL EDUCATION POLICY - 2020** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2023-24.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College"

Affiliated to

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon-425001

Structure and Syllabus
M.Sc. Honours with Research
in
Physics

F.Y.M.Sc. – Physics

Under Choice Based Credit System (CBCS)

and

as per NEP-2020 Guidelines

[w.e.f. Academic Year: 2023-24]

Preface

Welcome to the Master of Physics program, all-inclusive and demanding academic journey designed to equip students with a deep understanding of the principles and applications of physics. This program is centered around a thoughtfully crafted syllabus, carefully curated to encompass the breadth and depth of the field.

In this program, we place a strong emphasis on the syllabus, recognizing its pivotal role in shaping the educational experience. Our aim is to provide you with a comprehensive foundation in theoretical concepts, practical skills, and advanced topics that are crucial for a successful career in physics.

The syllabus of our Master of Physics program has been meticulously designed to cover key areas such as classical mechanics, quantum mechanics, electromagnetism, statistical mechanics, and thermodynamics. Additionally, we offer a range of specialized elective courses, allowing you to delve deeper into specific areas of interest, such as condensed matter physics, particle physics, astrophysics, or optics.

Each course within the syllabus has been carefully crafted to provide a balance between theoretical knowledge and hands-on experience. Our dedicated faculty members, who are experts in their respective fields, will guide you through engaging lectures, laboratory experiments, and research projects that foster critical thinking, problem-solving abilities, and a deeper understanding of the subject matter.

Furthermore, we understand the importance of staying updated with the latest advancements in physics. Therefore, our syllabus is regularly reviewed and updated to incorporate cutting-edge research and emerging trends in the field. We believe that staying at the forefront of scientific knowledge is crucial for your success as a physicist.

We are confident that the syllabus-centric approach of our Master of Physics program will provide you with a solid foundation and prepare you for a rewarding career in academia, research, industry, or other related fields.

We wish you the best as you embark on this exciting educational journey and encourage you to make the most of the opportunities and resources available to you. Your dedication, passion, and curiosity will undoubtedly contribute to the advancement of knowledge and the betterment of our world.

Program Outcomes (PO) for M.Sc. Program:
Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO
1	Student possess an in-depth understanding of advanced theories, concepts, and methodologies in their specific field of study.
2	Student should demonstrate advanced technical skills and proficiency in utilizing specialized equipment, software, and methodologies relevant to their field of study.
3	Student should be capable of critically analyzing complex problems and synthesizing information from various sources.
4	Student should be proficient in effectively communicating scientific information to both technical and non-technical audiences. They should be able to present their experimental findings through oral presentations, scientific writing, and the use of appropriate visual aids.
5	Student should demonstrate leadership qualities and the ability to work effectively as part of a team.
6	Student should have developed advanced research skills and the ability to independently design and conduct rigorous scientific investigations. They should be able to analyze scientific literature,formulate research questions, develop research plans, collect and analyze data, draw valid conclusions and know about IPR.
7	Student should understand and adhere to ethical principles and professional standards in their field.
8	Student should recognize the importance of continuous learning and professional development. They should have the skills and motivation to stay updated with advancements in their field, engage in lifelong learning, and pursue further academic or professional opportunities.

Program Specific Outcome PSO (M.Sc. Physics):

After completion of this course, students are expected to learn/understand the:

PO No.	PSO
1	Graduates will posses a deep understanding of fundamental concepts and theory in physics
2	Students will deloped advanced research skill, including the ability to design and conduct experiments, collect and analyse data.
3	Students will gain proficenciency in using sophisticated laboratory equipments.
4	Student will enhanance problem solving skills using logical reseasoning using mathematical modeling and computational techniques.
5	Students will aquire in depth knowledge and expertise in the field of specialization.
6	Students will delop communication skills both written and oral to present their scientific concepts to the audiences.

Credit distribution structure for two years/one-year PG MSc programme

Level	Sem	Major (Core) Subjects		Minor Subjects	OJT/Int, RP	Cumulative Credits/Sem	Degree/ Cumulative Cr.
		Mandatory (DSC)	Elective (DSE)				

6.0	**I**	**DSC-1 (4T) DSC-2 (4T) DSC-3 (4T)**	**DSE-1(2T) A/B**	**RM (4T)**		**22**	**First year PG OR One year PG diploma after 3year UG**
	II	**DSC-5 (4T) DSC-6 (4T) DSC-7 (4T)**	**DSE-3(2T) A/B**		**OJT/Int (4)**	**22**	
	Cum. Cr.	**28**	**8**	**4**	**4**	**44**	
	Exit option: PG diploma (44 Credits) after three year UG degree						
6.5	**III**	**DSC-9 (4T) DSC-10 (4T) DSC-11 (4T)**	**DSE-5(2T) A/B**	**--**	**RP (4)**	**22**	**Second year PG after 3 year UG OR PG degree after 4 year UG**
	IV	**DSC-13 (4T) DSC-14 (4T) DSC-15 (2P) DSC-16 (2P)**	**DSE-7(2T) A/B DSE-8 (2P) A/B**	**...**	**RP (6)**	**22**	
	Cum. Cr.	**54**	**16**		**4+10**	**88**	
2 Years-4 Sem. PG Degree (80-88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (40-44 credits) after Four Year UG Degree							

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **T**-Theory, **P**- Practical, **RM**- Research Methodology, **OJT**- On Job Training, **Int**- Internship, **RP**-Research Project, **Cum. Cr.**:Cumulative Credits

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of three-year degree+ hounorsdepending upon the number of credits secured;

Levels	Qualification Title	Credit Requirements	Semester	Year

		Minimum	Maximum		
6.0	Bachelor's Degree- Honours **Or** Bachelor's Degree- Honours with Research	160	176	8	4

F. Y. M. Sc. Physics Course Structure

Semester	Course Module	Credit	Hours/ week	TH/ PR	Code	Title
I	DSC	4	4	TH	PHY-DSC-511	Mathematical Methods for Physics
	DSC	4	4	TH	PHY-DSC-512	Condensed Matter Physics
	DSC	4	4	TH	PHY-DSC-513	Classical Mechanics
	DSE	2	2	TH	PHY-DSE-514A	Material Science
	DSE	2	2	TH	PHY-DSE-514B	Vacuum Technology
	DSC	2	4	PR	PHY-DSC-515	Practicals on Mechanics and Condensed Matter
	DSE	2	4	PR	PHY-DSE-516A	Practical course on Material Science
	DSE	2	4	PR	PHY-DSE-516B	Practical course on Vacuum Technology
	DSC	4	4	TH	PHY-RM-517	Research Methodology for Physics
II	DSC	4	4	TH	PHY-DSC-521	Special Theory of Relativity
	DSC	4	4	TH	PHY-DSC-522	Atomic and Molecular Physics-II
	DSC	4	4	TH	PHY-DSC-523	Quantum Mechanics-I
	DSE	2	2	TH	PHY-DSE-524A	Optical Fibre Communication
	DSE	2	2	TH	PHY-DSE-524B	MATLAB Programming
	DSC	2	4	PR	PHY-DSC-525	Practicals on Quantum and Molecular Physics
	DSE	2	4	PR	PHY-DSE-526A	Practical course on Optical Fibre Communication
	DSE	2	4	PR	PHY-DSE-526B	Practical course on MATLAB Programming
	DSC	4	8	OJT	PHY-OJT-527	Intership / On Job Training

DSC: Department-Specific Core course **DSE:** Department-Specific elective
TH : Theory **PR:** Practical **OJT:** On Job Training

Examination Pattern for M.Sc

Theory Question Paper Pattern:

- 60 (External) +40 (Internal) for 4 credits
    - External examination will be of three hours duration

- There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
- Q1 Attempt any 3 out of 4 sub-questions; each 4 marks
- Q 2, Q3, Q4 and Q5Attempt any 2 out of 3 sub-question; each 6 marks.

- 30 (External) +20 (Internal) for 2 credits
  - External examination will be of 1½ hours duration
  - There shall be 3 questions Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. while the tentative pattern of question papers shall be as follows;
  - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
  - Q 2 and Q3 Attempt any 2 out of 3 sub-question; each 6 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE):CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course.Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT):IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course.IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs.The subject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT.

The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks

for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations. The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.
- Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule for 2 consecutive days in case of practical where incubation condition, allied aspects are essential.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

F.Y.M.Sc.
Semester- I
PHY-DSC-511: Mathematical Methods for Physics

Total Hours: 60 **Credits: 4**

Course objectives	• This course has been developed to introduce various topics of Mathematical Methods for Physics. • This course has direct relevance in other core subjects of Physics. • The aim at understanding the various relation which remain valid on change ofcoordinate system.

	• It emphasises utilitarian aspect and intended to help the learners of relativity, differential geometry engineering mathematics, etc.	
Course outcomes	After successful completion of this course, students are expected to: • To solve real definite integrals in theoretical Physics. • To use special functions and matrices for solving Quantum Mechanical Problemsanffor solving linear algebraic equations and to use group theory for understanding of crystallography. • To use Fourier series and integral transforms for analysis of wave mechanics and electrical circuit analysis. • To use Tensor Analysis within modelling of continuous media, field equations in physics, electromagnetism, elasticity theory and theory of general relativity.	
Unit	**Contents**	**Hours**
Unit I	**Vector Spaces and Matrices:** • Definition of a linear vector space, • Linear independence, basis and dimension, scalar product, inner product • Orthonormal basis, Schwartz Inequality, • Matrices, o Orthogonal, Unitary, Eigen values and Eigen vectors of matrices, Matrix diagonalization, o trace and normalization of matrix, • Cayley-Hamilton theorem.	15
Unit II	**Fourier Series,Transform and Special functions:** • Fourier series: periodic function, Euler Fourier formula, Dirichilete conditions, half range Fourier series, Change of interval, Parseval‟s identity, Application of Fourier series- Vibrating string, RLC circuit and Square Wave. • Integral transform, Fourier Integral Theorm, Fourier Sine and Cosine Integrals, Fourier Transforms, Fourier Sine and Cosine transform, Properties of Fourier Transform, Parseval's Identity of Fourier Transforms. • Special Functions: Generating functions for Bessel function of integral order Jn(x), Legendre polynomials Pn(x), Hermite Polynomials Hn(x), Recurrence Relations, their differential equations and Orthogonal properties.	15
Unit III	**Complex Integration and Function of Residue:** • Introduction, Cauchy's Integral Theorm, Extension of Cauchy's theorm to Multiple Connected Region, Cauchy Integral Formula, Cauchy Integral Formula For the Derivative of an Analytic Functions, Taylor's and Laurent's Series, Zero of Analytic function, Singular Point, Theorm, • Definition of Residue at Pole, Residue at Infinity, Method of finding Residue, Residue by Definition, Formula : Residue = $\lim_{z\to a}(z-a)f(z)$, Residue Formula: Residue =$\frac{\emptyset(a)}{\Psi'(a)}$, Formula : Residue = $coefficient\ of\ \frac{1}{t} in\ f(t+1)$, Residue theorm, Evaluation of real Definite Integrals by Counter Intrgration.	**15**
Unit IV	**Tensor Analysis:** • Introduction, Co-ordinate Transformation, Summation Convension, summation Co-ordinates, Relation between the directions cosines of three mutually perpendicular Straight lines, • Rank of Tensor, First order Tensors, Second order Tensor, Tensor of any Order, Zero order Tensor, Algebric Operations on Tensor, Product of Two Tensors, Quotient law of Tensors, Contraction Theorm, Symmetric and Antisymmetric Tensors, Symmetric and Skew Symmetric Tensors, A fundamental Property of Tensors, Zero Tensors, Two Special Tensors, Kronecker Tensor, Isotropic Tensor, Relation Between Alternate and	**15**

	Kronecker Tensor, • Matrices and Tensor of First and Second order, Scalar and Vector Product of Two Vectors, Three scalar Invarient of Second order Tensor, Singular and Non Singular Tensor of Second Order, Reciprocal of Nonsingular Tensor, Eigen Values and Eigen Vectors of a Tensor of Second Kind, Gradient of Tensor Fields, Divergence and Curl of Vector Point Functions, Second Order Differential Operators, • Tensorial form of Gauss's and Stoke'stheorm, Three Scalar Invarient of Second Order Tensor, Tensor Analysis, Conjugate or Reciprocal Tensors, Christofell Symbols, Transformation Law of Second Kind, Contrvarient, Covarient and Mixed Tensor.	
Study Resources	• Tai L. Chow, (2000). 1st Edition, Mathematical Methods for Physicists: Cambridge University Press 2. • Riley, Hobson And Bence, (1997). 1st Edition, Mathematical Methods For Physics And Engineers, C,ambridge University Presses. • Das H. K., Dr. R. Verma, (2018). 8th edition, Mathematical Methods in Physical Sciences, S Chand Publications and company Ltd. • Joshi A.W. (1995). 3rd Edition Matrices and Tensors in Physics, New Age International (P) Ltd. • Arfken G.B, Weber H. J., (2001). 5th Edition, Mathematical Methods for Physicists Harcourt Pvt. Ltd. (Academic Press). • Brown J. W, Churchill R. V., (2009). 8th Edition, Complex Variables and Application- McGraw Hill. • Lipschutz S., (2009). 2nd Edition, Complex Variables, McGraw Hill, • Boas M., (1966). 2nd Edition Mathematics for Physical Sciences, John Wiley and Sons	

F.Y.M.Sc.
Semester- I
PHY-DSC-512: Condensed Matter Physics

Total Hours: 60 **Credits: 4**

Course objectives	• To study several basic properties of the condensed phase of matter especially solids. • To understand Condensed Matter Physics (CMP) is the fundamental science of solids and liquids. • To study and understand the crucial role of energy bands in solids. • To study an emerging applicable property likewise, superconductivity & superfluidity.

Course outcomes	After successful completion of this course, students are expected to: • get details knowledge about basic structures of solid & liquid. • able to understand basic properties and applications of solid and liquid matter. • Be able to explore the various material properties. • needs will be fulfilled by applications in an emerging fields of tech era.	
Unit	**Contents**	**Hours**
Unit I	**Crystal Structure & Atomic Disorder in Materials** • **Basic Structures;** o symmetry properties, packing fractions, directions and position-orientation of planes in crystal, o concept of reciprocal lattice, o concept of Brillouin zones, closed packed structure, and structures of some binary/ternary compounds. o Elementary concepts of polycrystalline, nanocrystalline and amorphous materials. • **Imperfections or defects in solids:** o Point defects: vacancies, Frenkel defect, Schottky defect, o Line defects (Dislocation): Edge dislocation, screw dislocation, o Surface defects or interfacial defects and o Volume defect.	15
Unit II	**Concept of Energy bands and Semiconductors** • **Energy bands:** o Electron in periodic potential, Bloch function, o solution of wave equation of electron in periodic potential, reduced, periodic and extended zone schemes. o Construction of Fermi surfaces in Brillouin zones for two - dimensional lattices, o Introduction to methods for calculations of energy bands and their features. • **Semiconductors:** o Direct and indirect band gap semiconductors effective mass, intrinsic carrier concentration, o impurity conductivity thermal ionization Revision on p-n junction and rectification, o metal- semiconductor contacts, Schottky barrier.	15
Unit III	**Electrical Conductivity, Free Electron Fermi gas** • Drude theory, DC conductivity, Hall effect and magneto-resistance, AC conductivity, thermal conductivity, • Fermi-Dirac distribution, Dielectric properties of insulators, • Types of polarizations: electronic, ionic, orientational, polarizabilities, Local field, • Claussius-Mossotti equation, Dielectric constant and loss, Free electron gas in three-dimension, thermal properties of an electron gas, Wiedemann-Franz law, static dielectric constant for gases.	15
Unit IV	**Magnetism & Mysterious Properties of matter** • **Magnetism:** Types of magnetism, Susceptibility, Permeability and their relation. Crystal field Splitting and quenching of orbital angular momentum. Paramagnetism of conduction electrons. Curie point and exchange integral, saturation magnetization. Ferromagnetic Domains and their origin. • **Superconductivity:** Superconductivity, critical temperature, Meissner effect, Destruction of superconductivity by magnetic field, Type I and type II superconductors, Isotope effect, energy gap, London equation, London penetration depth, BCS theory of superconductivity, Coherence length.	15

Study Resources	• Kittel C.. (2005). 8th Ed, Introduction to Solid State Physics, John Wiley &Sons,Inc,. • Dekker A. J. 1st edition, Solid State Physics, Pan McMillan • Ashoroff N. W. & Mermin N. D. (2003). 1steition, Solid State Physics, Cengage. • Singhal R. L. Alvi P. V., (2018). 2018thedition,Solid state Physics, Kedar Nath Ram Nath. • March N.H. and Parrinello M., (1982). 1st edition, Collective Effects in Solids and Liquids, Adam Hilger • Pillai S.O., (2018). 9th Edition, Solid State Physics, New Age International Publishers • Puri R. K., Babbar V.K., (2010). Solid State Physics, S. Chand & CO. Ltd. • Ziman J.M. (1972). 2nd edition, Principles of the Theory of Solids, Cambridge University Press.	

F.Y.M.Sc.
Semester- I
PHY-DSC-513: Classical Mechanics

Total Hours: 60 **Credits: 4**

Course objectives	• To develop familiarity with the physical concepts and the mathematical methods of classical mechanics. • To study difference between Classical and Quantum Mechanics and apply accordingly. • To develop skills in formulating and solving physics problems. • To conquer the need of proper study of macroscopic observations, calculations and solutions.	
Course outcomes	After successful completion of this course, students are expected to: • Understand the physical principles behind the derivation of Lagrange and Hamilton's equations, and the advantages of these formulations, • Master different problem-solving strategies within mechanical physics and assess which of these strategies is most useful for a given problem. • Be familiar with the fundamental principles of central force motion and small oscillation. • Understand the intricacies of Special Theory of Relativity.	
Unit	**Contents**	**Hours**
Unit I	**Newtonian Mechanics and System of Particles** • Frames of Reference, o Newton's Laws of Motion, Inertial and Non-inertial Frames, • Mechanics of a Particle, Motion under a Constant Force, Motion under a Time-dependent Force, Centre of Mass, • Conservation of Linear Momentum, Angular Momentum, Conservation of Angular Momentum, Kinetic Energy for a System of Particles, Energy Conservation of a System of Particles.	15
Unit II	**Lagrangian and Hamiltonian Formulation** • Constraints, Generalized Co-ordinates, Principle of Virtual Work, D'Alembert's Principle, Lagrange's Equations, Kinetic Energy in Generalized Co-ordinates, Generalized Momentum, First Integrals of Motion and Cyclic Co-ordinates, Conservation Laws and Symmetry Properties, Velocity-dependent Potential, Dissipative Force, • Newtonian and Lagrangian Formalisms. • The Hamiltonian of a System, Hamilton's Equations of Motion, Integrals of Hamilton's Equations, Canonical Transformations, Poisson Brackets, Poisson Bracket and Integrals of Motion, The Canonical Invariance of Poisson Bracket, Lagrange Brackets. Poisson Brackets.	15
Unit III	**Variational Principal &Central Force Motion** • Hamilton's Principle, Deduction of Hamilton's Principle, Lagrange's Equation from Hamilton's Principle, Hamilton's Principle for Non-holonomic Systems. • Reduction to One-body Problem, General Properties of Central Force Motion, Inverse Square Law Force, Kepler's Laws, Law of Gravitation from Kepler's Laws, Satellite Parameters, Communication Satellites, Orbital Transfers, Scattering in a Central Force Field.	15
Unit IV	**Motion of Rigid Bodies and Small Oscillation** • Introduction, Angular Momentum, Kinetic Energy, Inertia Tensor, Principal Axes, Euler's Angles, Infinitesimal Rotations, Coriolis Force. • Equilibrium and Potential Energy, • Theory of Small Oscillations, Normal Modes, Two Coupled Pendula.	15

Study Resources	• Arulhas G., (2008). Classical Mechanics, PHI learning Private limited. • Upadhaya : J. C., (1999). 1st edition, Classical Mechanics, Himalaya publishing house. • Chow T.L. (1995). 1st Edition, Classical Mechanics, John Willey & Sons Inc. • Takwale, Puranic 1stEdition, (2007). Classical Mechanics, Tata McGraw Hill Publication. • Goldstein H. (1980). 2ndEdition, Classical Mechanics, Narosa Publishing House. • Rana and Joag, (2001). 1st Edition, Classical Mechanics, Tata McGraw Hill Company Ltd. • Barger and Olsson, (1995). 2ndEdition Classical Mechanics: A Modern Perspective, McGraw Hill Publication.	

Semester- I
PHY-DSE-514A: Material Science

Total Hours: 30 **Credits: 2**

Course objectives	• To study the classification of materials along with their properties & versatile applications • To develop an ability to pin down the proper material property & its application. • To understand importance of advanced development in material science. • To nurture a tendency to study & develop different nanomaterials	
Course outcomes	After successful completion of this course, students are expected to: • Be able to apply knowledge of Material science to real life problems. • work out on scientific temperament. • produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. • Be getting deep Knowledge of this field and will be able to create an employability.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to materials& Chemical Bonding** • **Classification of materials:** o Crystalline & amorphous materials, high Tc superconductors, alloys & composites, semiconductors, solar energy materials, luminescent and optoelectronic materials, Polymer, Liquid crystals and quasi crystals, Ceramics. Crystalline and Non-crystalline Solids, • **Classification of Bonds:** o Ionic Bond or Electrovalent Bond, Covalent Homopolar Bonds, Metallic Bonds, Molecular Bonds, Hydrogen Bond, van der Walls bond (Inter-molecular and Intra-molecular bonds).	08
Unit II	**Properties of Materials** • **Mechanical Properties:** Interpretation of tensile stress – strain curve, Stress, strain (tensile, compressive and shear), strength, elasticity, plasticity, ductility, malleability, hardness, toughness, creep, fatigue, stiffness, Isotropy, Anisotropy, Deformation, Elastic and Plastic deformation, factor affecting the mechanical properties, • **Thermal Properties:** Heat capacity, Thermal expansion, Thermal conductivity, • **Electrical Properties:** Conductivity, resistivity, dielectric strength, piezoelectricity. • **Optical Properties:** Wavelength spectrum of electromagnetic waves. Refraction, Reflection, absorption and Transmission of non-metallic materials, Luminescence and Photoconductivity Luminescence.	07
Unit III	**Diffusion in Materials & Phase Diagram** • **Diffusion:** Introduction, Classification of Diffusion. Diffusion mechanism, Vacancy mechanisms, Interstitial mechanism, Direct interchange mechanism. Diffusivity, Self-diffusion in nickel, Steady state Diffusion (Fick's first law of diffusion) and Non steady state Diffusions (Fick's second law of diffusion), variation of diffusivity with temperature, Activation energy for diffusion, factor affecting the diffusion, • **Phase diagram:** Phase diagrams, Phase rule, Single component system, Binary phase diagram, Microstructure changes during cooling, Lever rule, Phase diagram rules, Applications of phase diagram.	08
Unit IV	**Advanced materials & Carbon based nanmaterials** • **Composites:** Types of Composite & applications of composites in electrical components and nuclear industry. • **Lightweight materials:** Properties and structure alloying elements, manufacture of wrought products, mechanical properties and microstructure correlation $\alpha\beta$ and $\alpha+\beta$ alloys, aerospace and medical applications,	07

	• **Electrets:** properties and applications SMART materials, solar energy materials, surface acoustic wave and sonar transducer materials and applications. • **Geometry of nanoscale carbon:** Introduction, Carbon molecules, nature of the carbon bond, new carbon structures**,** Graphene,Application of Graphene and other carbon nanomaterials-Mechanical, Thermal Electronic and biological.	
Study Resources	• Callister William D., RethwischJr.David G. (2014). 9th Edition, Materials Science & Engineering: An Introduction ,WileyPlus. • Van Vlack Lawrence H., (2002). 6th edition, Elements of Materials Science & Engineering, Pearson. • V Raghavan, (2015). 6th edition, First Course in Materials Science & Engineering, Prentice Hall India Learning Private Limited. • Kakani S. L., KakaniAmit, (2006). Material Science, New Age International Publishers. • Narula G.K, NarulaK.S.andGupta V. K.,(2001). Material Science, Tata McGraw Hill. • Hajra Choudhary S.K., (1978). Material Science and Processes, Indian Book Distributing company. • Anke Krueger, (2010). Carbon Materials and Nanotechnology, Wiley-VCH, • Yury Gogotsi, (2006). Carbon Nanomaterials, Taylor and Francis.	

F.Y.M.Sc.
Semester- I
PHY-DSE-514B: Vacuum Technology

Total Hours: 30 **Credits: 2**

Course objectives	• To develop analytical abilities towards real world problems • To familiarize with current and recent scientific and technological developments • To enrich knowledge through problem-solving, hands-on activities, study visits, projects etc. • To take hands-on-training while doing an experiments.	
Course outcomes	After successful completion of this course, students are expected to: • Understand the vacuum technology, concepts of vacuum, and be able to perform calculations using them. • Understand the concepts of vacuum system components. • study applications of vacuum technology in various fields. • Demonstrate quantitative problem-solving skills in all the topics covered	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Vacuum Technology** • Introduction, production of vacuum, classification, types and range of vacuum pumps, vacuum pump variables, baffle, traps	08
Unit II	**Measurement of Vacuum Parameters** • Classification, types and range of vacuum gauges, measurement of partial pressure, flow measurement, leak testing.	07
Unit III	**Vacuum system components** • Vacuum system engineering, vacuum joints, seals, valves, feed through, view ports, vacuum materials	08
Unit IV	**Application of vacuum technology** • Vacuum system and components for electronics, material synthesis, thin film technology, metallurgy, chemical and nuclear fields, Applications in other fields	07
Study Resources	• Steve Borichevsky, (2017). 2nd edition, Understanding modern vacuum technology,Createspace Independent Pub**.** • O'Hanlon John, (2003.) 3rd edition, A user guide to vacuum tech, Wiley • Redhead P.A, Hobson J.P. Komelsen E. V., (1997). The physical basis of ultrahigh vacuum, Springer. • Chambers Austin, (1998) . 2nd edition, Basic vacuum technology, CRC Press. • Chambers Austin, (2004). 1stedition,Modern Vacuum Physics, CRC Press,Taylor& Francis ltd.	

F.Y.M.Sc.
Semester- I
PHY-DSC-515: Practicals on Mechanics and Condencsed Matter

Total Hours: 30 **Credits: 2**

Course objectives	• To explore microscopic & macroscopic properties of matter practically. • To apply any coordinate system, frame of reference and to study the object for different dimensions.	
Course outcomes	After successful completion of this course, students are expected to: • study electrical and thermal properties of solids and explain their applications. • be able to apply and use space coordinates with different dimensions.	
Sr. No.	**Contents**	**Hours**
1	To determine the Degrees of freedom for given geometrical shapes.	4
2	Comparative study moment of Inertia for Torsional pendulum in air & water.	4
3	Gyroscope and Moment of Inertia of a Wheel	4
4	a) To find the radius of gyration of objects of different geometrical shapes but of the same mass by noting the time period of oscillation, (b) To show that the time period is independent of the mass so long as the shape and size remain the same.	4
5	Study of Focault pendulum	4
6	Simulation of planetary motion.	4
7	Simulation of compound pendulum	4
8	Simulation of compound pendulum	4
9	Study of Hall effect and estimations of Hall coefficient R, carrier density n and carrier mobility of semiconductor material.	4
10	Determination of Curie temp	4
11	Study of variation of magnetic properties with composition of a ferrite specimen using B-H loop in low magnetic fields	4
12	Susceptibility measurement of materials using Guoy's balance method	4
13	Study of Thermal properties of given crystal (specific heat, thermal expansion, thermal conductivity)	4
14	Study of variation of dielectric constant of a ferro electric material with temperature (barium titanate)	4
15	Measurement of Magneto resistance of given semiconductor specimen	4
16	To determine the band gap energy of given semiconductor by studying the variation of reverse saturation current of the diode at different temperatures.	4
Study Resources	• Md. Sahabuddin, Practical Physics ForDegree Student, Hafiz Book Centre. • Annual Reort 2012 • ANNUALREPORT 2012 Solidstatephysicslaboratory (LFKP) Ethzuric	

F.Y.M.Sc.
Semester- I

PHY-DSE-516A: Practical course on Material Science

Total Hours: 30 **Credits: 2**

Course objectives	• To develop the practical knowledge amongst the PG students for material properties. • To contemplate the problem finding ability	
Course outcomes	After successful completion of this course, students are expected to: • Students will able to fulfill the basic need of society by using of earth amterials/raw materials. • Students can easily process any existing materials for further use.	
Sr. No.	**Contents**	**Hours**
1	To study crystal structures with the help of models	4
2	Preparation & Study of Microstructure of Pure Metals – Iron, Copper and Aluminum.	4
3	To prepare and test composite materials	4
4	To study the phase diagram of Pb-Sn &/or other materials.	4
5	Synthesis of semiconductor nanoparticles by chemical method.	4
6	Synthesis of metal nanoparticles.	4
7	Deposition of metallic thin films by vacuum evaporation method.	4
8	Synthesis of porous silicon.	4
9	Conductivity of ionic conductors	4
10	To study the constant load creep behaviour of lead at room temperature. Pattern generation by Photolithography.	4
11	Fabrication and evaluation of dye sensitized solar cell Studies on charge-discharge characteristics of a battery	4
12	To calculate resistivity using four probe method.	4
13	To study optical properties of synthesized material	4
14	Synthesis of nanoparticles using plant extract (Green synthesis method).	4
15	Deposition of thin film by using SILAR method.	4
16	Synthesis of thin film by chemical bath deposition (CBD) method.	4
Study Resources	• Cullity B.D. Elements of X-ray diffraction, Addision-WeselyPublishingCo., USA . • Banwell C.N. Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publ. Delhi. • Elton N. Kaufman. Characterization of Materials, Volume 1, &2, Wiley-Interscience. • Chattopadhyay K.K. and Banerjee A.N. Introduction to Nanoscience and Nanotechnology, PHI Pvt. Ltd., New Delhi- 110001 • Nan Yao, Zhong Lin Wang Kluwer. Handbook of Microscopy for Nanotechnology: Academic Publishers.	

F.Y.M.Sc.
Semester- I
PHY-DSE-516B: Practical course on Vacuum Technology

Total Hours: 30 **Credits: 2**

Course objectives	• To develop the practical knowledge amongst the PG about vacuum and its instrumentation • To learn and operate the vacuum systems	
Course outcomes	After successful completion of this course, students are expected to: • Students will able to understand basic of vacuum and its use. • Students will able to use vacuum system.	
Sr. No.	**Contents**	**Hours**
1	To study the parts of Vauum pump	4
2	To study Working of Vacuum pump	4
3	To maintain different pressure ranges using vacuum pump	4
4	To design rotary pump and test it.	4
5	To calibrate the pump with different pumps.	4
6	To design the vacuum chambers with different capacity	4
7	To obtain viscous pumping using venturi pump and observe momentum transfer	4
8	To obtain viscous pumping using molecular pump and observe diffusion	4
9	To calculate the pressure of turbo pump using shaft speed RPM and time	4
10	To calculate vacuum suction force and fins appropriate suction cup for vacuum system	4
11	To study the effects of conductance of pumping speed of oil diffusion pumping module.	4
12	Demonstration of oil diffusion pump & to evacuate the system & to measure the ultimate vacuum.	4
13	To measure the pumping speed of vacuum system (use of Gaedes equation).	4
14	Deposition of metallic thin film.	4
15	Pumping speed measurements using the constant volume method.	4
16	To investigate the variation of pumping speed of vapour diffusion pumping module with the pressure in vacuum system.	4
Study Resources	• HablanianMarbed H., (2017). 2nd edition, High-Vacuum Technology: A Practical Guide, Routledge. • NagamitsuYoshimura, (2008). Vacuum Technology-Practice for Scientific Instruments, Springer. • Weston G. F., (1985). Ultrahigh Vcuum Practice, Butterworth-Heinemann.	

F.Y.M.Sc.
Semester- I
PHY-RM-517: Research Methodology for Physics

Total Hours: 30 **Credits: 2**

Course objectives	• To understand basic concept of research. • To understand importance of literature survey and problem formulation. • Development of research interest in students. • Study of different nanostructure and their different method of synthesis.	
Course outcomes	After successful completion of this course, students are expected to: • Student able to understand basic of research and different research type. • Students able to do literature survey. • They may understand their research interest and different methodology for research.	
Unit	**Contents**	**Hours**
Unit I	**Research and its types** • Meaning of Research, Objectives of Research, Motivation in Research, • Types of Research, Research Approaches, and Significance of Research, • Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research. **Literature Review and Problem Formation** • Basic Concept of literature review, importance of literature review, types of literature review, review of research, sources and steps in literature review, Essentials of good literature review. • Defining the Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.	15
Unit II	**Research design and Data Collection** • Research Design, Meaning of Research Design, • Need for Research Design, Research Methodology Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, • Collection of Primary Data, Collection of Data through Questionnaires, Collection of Data through Schedules, Some Other Methods of Data Collection, Collection of Secondary Data, Sources, acquisition, and classification of Data, Quantitative and Qualitative Data.	15
Unit III	**Nanostructure and its Formation** • Definitions: Nanoscience, Nanomaterials and Nanotechnology, Quantum confinement, Nanostructures (graphene, fullerene, SWCNT, MWCNT, quantum dots) nano-semiconductor, nano-polymers, nanoceramics. Top-down and bottom-up approach for nanostructure. Mechanical (ball milling, spray coating screen printing), Physical (Thermal evaporation, E beam evaporation, sputtering), Chemical (CBD, SILAR, sol-gel, hydrothermal) and Biological (microorganism and plant extract) methods. **Nanostructure characterization** • Importance of material characterization, Electromagnetic spectrum, properties of electromagnetic spectrum, spectroscopic techniques (UV-Vis spectrophotometer, IR, RAMAN, XPS) Microscopic Techniques (SEM, FESEM, TEM, STM, AFM) diffraction technique (XRD)	**15**
Unit IV	• **Research Ethics and Referencing Method** • Concept and Ethical aspects in science and research, Intellectual honesty, Research integrity, Scientific misconducts (Falsification, Fabrication, Plagiarism), • Redundant publications (Duplicate, overlapping and Salami slicing),Selective reporting and misrepresentation of data, Publication ethics and its significance, Publication misconduct, and Conflict of interest. • Definition of referencing, difference between referencing and bibliography, Different type of referencing style, Sources of references, Element in reference list, Different tools for referencing. • **Intellectual Property Rights (IPR)**	**15**

	• Introduction to IPR, importance of IPR, Trademarks, Purpose and function of trademarks, Types of trademarks, Acquisition of trademarks rights, Type of trademark infringement, Penalties of trademark infringement, Trade Secret, • Law governing to trade secret, Trade secret litigation, Trade secret protection program, Geographical Indications, Copyrights, • Types of Copyright, Need of copyright, Patent, Basic criteria for patentability, Patent search in India, Need of patent, Industrial design, Cyber law, Cyber-crime, Cyber staking,Data security, Information privacy, Internet crime.	
Study Resources	• Kothari C.R., (2004). 2nd edition, Research Methodology: methods and techniques, New Age International Limited, Publisher. • KumarRanjit, (2011). 3rd edition, Research Methodology, SAGE • SinghYogesh Kumar, (2006). 1st edition, Fundamental of Research Methodology and Statistics, New Age International Limited, Publisher. • Guozhong Cao and Ying Wang (2011). 2ndEdition, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, world scientific. • Kulkarni S. K. (2017). 3rd edition, Nanotechnology: Principles and Practice, Capital Publishing Company. • T.Pradip, (2007). 1st edition, Nano: Theessentials-Understanding Nanoscience and Nanotechnology, Tata Mac Graw Hills • Booker and Boysen, (2005). Nanotechnology, For Dummies • B. K. Mishra , Manju Khari , J. M. Chetterjee, A John, (2019). Cybersecurity In Parallel And Distributed Computing, Dac-Nhuong Le , Raghvendra Kumar, Wiley & Sons, Inc., Publication. • Kothari C. R., Garg Gaurav (2019). Research Methodology: methods and techniques, New Age International Limited, Publisher. • Banwell C.N., (2017). 4th edition Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publ. Delhi. • Elton N. Kaufman., (2003). Characterization of Materials, Volume1, & 2, Wiley-Inter science. • Nan Yao, Ahong Lin Wang, Kluwer., (2005). Handbook of Microscopy for Nanotechnology, Academic Publishers. • Mishra J. P. (2012). An Introduction to Intellectual Property Rights, Third Edition, central law publication.	

F.Y.M.Sc.
Semester- II
PHY-DSC-521: Special Theory of Relativity

Total Hours: 60 **Credits: 4**

Course objectives	• Understand the significance of Michelson Morley experiment and failure of the existing theories to explain the null result • Understand the importance of postulates of special relativity, Lorentz transformation equations and how it changed the way we look at space and time, Absolutism and relativity, Common sense versus Einstein concept of Space and time. • Understand the transformation equations for: Space and time, velocity, frequency, mass, momentum, force, Energy, Charge and current density, electric and magnetic fields. • Solve problems based on length contraction, time dilation, velocity addition, Doppler effect, mass energy relation and resolve paradoxes in relativity like twin paradox etc.	
Course outcomes	After successful completion of this course, students are expected to: • Brief introduction of general relativity is helpful to understand cosmology. • This course introduces students to the essence of special relativity which revolutionized the concept of physics • By unifying space and time, mass and energy, electricity and magnetism students Can understand and apply postulate of special theory of relativity in real sense to the frame of reference & inertia. • Students will able to understand universe, dark matter and microconstituents pesent in universe.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Special theory of relativity and Relativistic Kinematics** • **Introduction to Special theory of relativity:** Inertial and Non-inertial frames of reference, Galilean transformations, Newtonian relativity, Electromagnetism and Newtonian relativity. Attempts to locate absolute frame: Michelson- Morley experiment (omit derivation part), Attempts to preserve the concept of a preferred ether frame: Lorentz Fitzgerald contraction and Ether drag hypothesis (conceptual), Stellar aberration, Attempt to modify electrodynamics. • **Relativistic Kinematics - I**: Postulates of the special theory of relativity, Simultaneity, Derivation of Lorentz transformation equations. Some consequences of the Lorentz transformation equations: length contraction, time dilation and meson experiment, The observer in relativity.	15
Unit II	**The Geometric Representation of Space and Time** • **Relativistic Kinematics - II:** The relativistic addition of velocities, acceleration transformation equations, Aberration and Doppler effect in relativity, The common sense of special relativity. • **The Geometric Representation of Space-Time:** Space-Time Diagrams, Simultaneity, Length contraction and Time dilation, The time order and space separation of events, The twin paradox.	15
Unit III	**Relativistic Dynamics:** • Mechanics and Relativity, The need to redefine momentum, Relativistic momentum, Alternative views of mass in relativity, The relativistic force law and the dynamics of a single particle, The equivalence of mass and energy, The transformation properties of momentum, energy and mass.	15
Unit IV	**Relativity and Electromagnetism** • Introduction, The interdependence of Electric and Magnetic fields, The Transformation for E and B, The field of a uniformly moving point charge, Force and fields near a current-carrying wire, Force between moving charges, The invariance of Maxwell's equations. The principle of equivalence and general relativity, Gravitational red shift.	15

Study Resources	• Robert Resnick (2007). Student Edition, Introduction to Special Relativity, Wiley • French A. P., (1968). Special Relativity. The MIT Introductory Physics Series, W.W. Norton & Company, New York. • Sander Bais (2007). Very Special Relativity – An illustrated guide: by-Amsterdam University Press. • Chapter 1: Concepts of Modern Physics by Arthur Beiser. • Chapter 2: Modern Physics by Kenneth Krane. • T.M.Karade, K.S.Adhav and M.S.Bendre: Lectures on Spacial Theory of Relativity ,Sonu Nilu Publication, Nagpur • C.Molar (1952).The Theory of Relativity, Oxford Clarendon Press,. • P.G.Bergman, (1969). Introduction to The Theory of Relativity, Prentice Hall of India, Pvt.Ltd. • J.L.Anderson (1967). Principles of Relativity Physics, Academic Press. • V.A.Ugarov (1979). Special Theory of Relativity, Mir Publishers.	

F.Y.M.Sc.
Semester- II
PHY-DSC-522: Atomic and Molecular Physics-II

Total Hours: 60 **Credits: 4**

Course objectives	• To understand the basic theories of atomic, molecular spectra. • To study & understand different spectroscopies. • To use proper spectroscopic technique to study atomic or molecular structure. • To understand principle working and application of NMR, ESR and LASER.	
Course outcomes	After successful completion of this course, students are expected to: • Understand the basic structure of atom & molecule and their interactions with electromagnetic radiations. • Students will able to study and compare basics of atomic and molecular spectra. • Students will be able to understand single & multi-electron system. • Understand the basic technique and use of Raman spectroscopy.	
Unit	**Contents**	**Hours**
Unit I	**Atomic Spectra:** • Quantum states of an electron in an atom, Electron spin, • Spectrum of hydrogen, Helium and alkali atom., • Relativistic corrections for energy levels of hydrogen atom, Lande interval rule, inverted terms, Hund's rule, • Zeeman effect, Paschen Back effect in complex spectra, Stark effect of hydrogen in weak and strong field, • Hyperfine structure: Introduction, origin of hyperfine structure, hyperfine structure of two or more valence electrons, width of spectral line, LS and JJ coupling.	15
Unit II	**Molecular Spectra** • Classification of molecular spectra, Types of molecules, • Pure rotational pectra, relative intensities of spectral line, rotational spectra of rigid and non-rigid molecule through microwave spectroscopy, • Determination of moment of inertia and bond length from rotational spectra. Harmonic oscillator, Un-harmonic oscillator, rotationalvibrational spectrum, (diatomic vibrating rotator).	15
Unit III	**Electronic Spectra, Raman Spectra** • Electronic Spectra: Electronic spectra of diatomic molecule, Born Oppenheimer approximation, • Vibrational coarse structure of electronic band, Franck- Condon principle, selection rule, dissociation and pre dissociation. • Raman Spectra: Raman effect, experimental arrangement of Raman Spectrometer, Quantum theory of Raman Spectra, Raman spectroscopy in the structure determination of simple molecule.	15
Unit IV	**X-Ray, ESR, NMR** • **X ray spectra:** Production of X-rays, Continuous and characteristic X-ray spectra. X-ray emission from thick and thin targets. Efficiency of X-ray production, emission spectra and mosley law, fine structure of X-ray emission spectra, absorption spectra, structure of x ray absorption, auger effect. • **ESR:** Electron spin resonance, ESR spectrometer and its application. • **NMR:** Nuclear spin magnetic moment, interaction of nuclear magnet with external field, NMR spectrometer, chemical shift and its application.	15

Study Resources	• White, H.E. (1934). Introduction to Atomic Spectra. McGraw-Hill Book Company, Inc., 457. • Bransden, B.H. and Joachain, G.J. (2003). Physics of Atoms and Molecules. Pearson Education, 2nd edition. • Herzberg, Gerhard. (1950). Spectra of Diatomic Molecules. Van Nostrand, Vol. 1, 2nd edition. ISBN 0442033850, 9780442033859. • Banwell, C.B. (1995). Fundamentals of Molecular Spectroscopy. 4th edition, McGraw-Hill. • Jeanne, L. McHale. (1999). Molecular Spectroscopy. Prentice Hall. ISBN 0132290634, 9780132290630. • Bemath, P.F. (2005). Spectra of Atoms and Molecules. 2nd edition, Oxford University Press. ISBN 0195346459, 9780195346459. • Rajkumar, Keadar Nath Ram Nath (1997). Atomic and Molecular Spectra. New Delhi. • Akitt, J.W. (1992). NMR and Chemistry. 3rd edition, Springer Netherlands. ISBN 0412372606, 9780412372605. Demtroder, Wolfgang. (1997). Laser Spectroscopy: Basic Concepts and Instrumentation. Springer Berlin Heidelberg. ISBN 354057171X, 9783540571711.	

F.Y.M.Sc.
Semester- II
PHY-DSC-523: Quantum Mechanics-I

Total Hours: 60 **Credits: 4**

Course objectives	• To understand basic difference and inadequacy in classical & quantum mechanics. • To gain knowledge about the time-dependent and time-independent Schrödinger equation for simple potentials like harmonic oscillator and hydrogen atom. • To apply principles of quantum mechanics to calculate observations on known wave function • To study conservation of angular momentum.	
Course outcomes	After successful completion of this course, students are expected to: • Able to point out differences between classical and quantum mechanics. • Enriched with proper understanding of wave function and uncertainty relations. • Students can develop logic necessary to solve Schrödinger equation for simple potentials. • Students can understand the use of parity, eigen values, eigen functions & operators in spatia inversion of object.	
Unit	**Contents**	**Hours**
Unit I	**The Origin of Quantum Theory and Schrodinger Equation** • Inadequacy of classical Physics, de Broglie hypothesis, wave-particle duality, Born's interpretation of wave function, wave function for particle momentum, wave packets, the Heisenberg's uncertainty principle. • Necessity of wave equation and the conditions imposed on it, time dependent Schrodinger equation, Conservation of probability, Expectation values, Ehrenfest theorem, time independent Schrodinger equation, Eigen functions and Eigen values, Stationary states, orthogonality of eigen functions, parity, continuity and boundary conditions.	15
Unit II	**One Dimensional Energy Eigen Value Problems** • Free particle, infinite square well, potential step, square potential barrier, explanation of alpha decay, square well potential, Linear harmonic oscillator.	15
Unit III	**Formalism of Quantum Mechanics** • Postulates of quantum mechanics, representation of states and dynamical variables, observables, self-adjoint operators, • eigen functions and eigen values, degeneracy, orthogonality, orthonormality, completeness and closure property, physical interpretation of eigen values, eigen functions and expansion coefficients, eigen values and eigen functions of momentum operator, • Dirac's bra and ket notations, linear operators, unit operator, hermitian operator, unity operator, parity operator, eigen values and eigen functions of simple harmonic oscillators by operator method.	15
Unit IV	**Angular Momentum** • Orbital angular momentum, angular momentum algebra, angular momentum as a generator of infinitesimal rotations, Eigen values and functions of L2 and Lz, ladder operators L- and L+, spin angular momentum, Pauli's spin matrices, addition of angular momenta, representation of J in ljm> basis, computation of Clebsch-Gordan coefficients in simple cases (J1=1/2, J2=1/2).	15
Study Resources	• Zettili, Nouredine. (2nd edition, 2009). Quantum Mechanics: Concepts and Applications. Jacksonville State University, Jacksonville, USA. • Bransden, B.H. and Joachain, C.J. (2nd edition, 2004). Quantum Mechanics. Pearson Education Ltd. • Schiff, L.I. (3rd edition, 1998). Quantum Mechanics. MGH Book Company. • Powell, J.D. and Crossman, B. (1st edition, 1998). Quantum Mechanics. Narosa Publishing House. Gasiorowicz, S. (3rd edition, 2003). Quantum Mechanics. Wiley International.	

F.Y.M.Sc.
Semester- II
PHY-DSE-524A: Optical Fiber Communication

Total Hours: 30 **Credits: 2**

Course objectives	• To develop analytical abilities towards real world problems • To familiarize with current and recent scientific and technological developments • To study the measurement of different experimental parameters of optical fibers. • To enrich knowledge through problem-solving, hands-on activities, study visits, projects etc.	
Course outcomes	After successful completion of this course, students are expected to: • Understand concepts of optical fiber communication. • Understand the concepts of communication and able to perform calculations using them. • Understand the concepts of transmission in communication system. • Able to design the optical fiber communication networks. • Demonstrate quantitative problem-solving skills in all the topics covered	
Unit	**Contents**	**Hours**
Unit I	**Optical Fiber Introduction** • Historical development, The general system, total internal reflection,acceptance angle, numerical aperture, skew rays, step index fiber, graded index fiber, single mode fibers, photonic crystal fibers	08
Unit II	**Transmission Characteristics** • Introduction, attenuation, material absorption losses, linear scattering losses, non linear scattering losses, fiber bend losses, infrared transmission, dispersion, chromatic dispersion, overall fiber dispersion	07
Unit III	**Optical Fiber Measurement** • Fiber attenuation measurement, fiber dispersion measurement, fiber refractive index profile measurement, cutoff wavelength measurement, numerical aperture measurement, field measurement.	08
Unit IV	**Optical Networks** • Optical network concept, optical network transmission moded, layers and protocols, wavelength routing network, optical switching network, optical Ethernet, application and uses.	07
Study Resources	• Senior, John. (2009).3rd edition Optical Fiber Communication: Principles and Practice. Pearson Education. • Agarwal Govind P. (2010). 4th edition Fiber Optic Communication System. John Wiley & Sons Pub. • AzadehMohammad.(2009).1st edition, Fiber Optics Engineering. Springer, NewYork, NY. • KeiserGerd (2009) . Optical Fiber Communication. McGraw Hill. • KulkarniPratibha D., Kulkarni Sharvari D., Optical Fiber Communication. Nirali Prakashan.	

Semester- II
PHY-DSC-524B: MATLAB Programming

Total Hours: 30 **Credits: 2**

Course objectives	• To learn features of MATLAB programming tool. • To correlate theory and real-world applications in the field of science and technology • To develop and solve own problems and solve similar problems in the field of electrical systems • To understand and use of MATLAB simulink tool.	
Course outcomes	After successful completion of this course, students are expected to: • The student will understand the basic concept of MATLAB programming. • The student will be able to learn simulation techniques using MATLAB. • The student will be able to use MATLAB to solve computational problems. • Student will be able to simulate electronic theorems using SIMULINK.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to MATLAB** • The MATLAB Environment, Script files, function files, MATLAB Basics– Variables, Numbers, Operators, Expressions, Input and output. Vectors, Matrices	08
Unit II	**MATLAB programming with MATLAB** • Built-in Functions, User defined Functions, command line functions, inline function, Conditional Statements, mathematical operations, Loops, 2D plot, 3D plot	07
Unit III	**Mathematical Computing with MATLAB** • Root finding, Data analysis, Statistical functions, Integration, Integration, differentiation, solution of polynomial, solution of differential equation, Curve fitting, Bode Plot, Pole Zero Plots, Special function in Physics	08
Unit IV	**MATLAB applications and Simulink** • Physics application: Physics of Simple Oscillatory Motion, Motion of a Charged Particle in a Uniform Magnetic Field, Kirchoff's Laws, Fourier Analysis. • Simulink: Introduction, Creating and working with Simulink models, Simulink model for Ohms law, Kirchhoff's law, Network theorems, filters.	07
Study Resources	• Pratap, Rudra. (7th Edition). Getting Started with MATLAB. Oxford University Press, New Delhi. • Gilat, Amos (2008). MATLAB: An Introduction with Applications. Wiley India. • Chapman, Stephen J. (2008). MATLAB Programming for Engineers. Thomas Learning. • Singh, Y. Kirani and Chaudhari, B.B. (2007). MATLAB Programming. PHI. • Karris, Steven T. (2nd edition) (2008). Introduction to Simulink with Engineering Applications. Orchard Publication. • Tyagi, A.K.(2012). MATLAB and Simulink for Engineers. Oxford University Press, New Delhi. • Green, D. (2013). One Hundred Physics Visualizations Using MATLAB. WSPC. ISBN 9789814518468.	

Semester- II

PHY-DSC-525: Practicals on Quantum and Molecular Physics

Total Hours: 30 **Credits: 2**

Course objectives	• To understand the nature of matter at atomic and molecular level. • To understand difference between quantum and atomic & molecular concepts experimentally. • To understand the importance of quntised states of atoms. • To understand the nature of light & its interaction with atoms or molecules.	
Course outcomes	After successful completion of this course, students are expected to: • able to interpret an atomic and molecular nature of matter. • able to elaborate the nature of enerylevele and their values. • able to use different spectroscopies. • Do comparative study of different analysis techniques.	
Sr. No.	**Contents**	**Hours**
1	To estimate efficiency of Gamma/Beta source using Geiger- Müller Counter	4
2	To study transitions in energy levels due to electromagnetic field using Electron Spin Resonance spectroscopy.	4
3	To study Absorption Spectrumand determine energy band gap of given material.	4
4	To study discrete in energy levels using Frank-Hertz Experiment	4
5	To study Diffraction of Light using single slit.	4
6	To find the dispersive power of the material of a given prism using a hydrogen discharge tube.	4
7	Measurement of thickness of thin wire with laser	4
8	Measurement of wave length of He-Ne laser light using ruler.	4
9	To determine the wavelength of sodium light using a plane diffraction grating	4
10	Experimental Investigation of Black Body Radiation Spectrum: Verification of Planck's Law	4
11	Experimental Study of Compton Scattering: Verification of Photon Momentum Conservation	4
12	Experimental Verification of the de Broglie Hypothesis: Investigating the Wave-Particle Duality of Matter through Electron Diffraction	4
13	Double-Slit Experiment: Investigating the Interference Pattern of Light or Particles Passed through Two Slits	4
14	Investigating Heisenberg's Uncertainty Principle: Experimental Study on the Limitations of Simultaneous Measurement in Quantum Systems	4
15	Quantum Spin Measurements: Stern-Gerlach Experiment with Electrons or Ions	4
16	Characterization of Quantum Dots: Electronic and Optical Properties	4
17	Electron Diffraction: Wave-Particle Duality of Electrons	4
18	Young's Double-Slit Experiment with Single Photons	4
Study Resources	• Brehm, A., & Mullins, S. M. (2018). Experimental Techniques in Quantum Mechanics. Oxford University Press. ISBN: 9780198749349. • Gatzke, M., Kuhnert, M., & Kramer, T. (2016). Quantum Mechanics Experiments with Photons. Springer. ISBN: 9783319448852. • Pohl, R. O. (2016). Quantum Mechanics: Concepts and Experiments. Springer. ISBN: 9783319306855. • Mandl, F. (2010). Quantum Mechanics: Concepts and Applications. Wiley-VCH. ISBN: 9783527409915. • Gasiorowicz, S. (2003). Quantum Physics (3rd edition). Wiley. ISBN: 9780471057000.	

Semester- II
PHY-DSC-526A:Practical course on Optical Fibre Communication

Total Hours: 30 **Credits: 2**

Course objectives	• To understand and choose an optically active materials according to their properties. • To study different phenonmenon occurs in travelling of light signal in the medium, & different types of modulation.	
Course outcomes	• Students will able to connect and use optical fibres. • Students will be able to measure loss and maximum gain in signal.	
Sr. No.	**Contents**	**Hours**
1	To establish analog link using Optical Fiber.	4
2	To establish voice link using optical fiber.	4
3	Assignment on eye pattern measurement	4
4	To study splicing &connecterization	4
5	To measure numerical aperture of optical fiber	4
6	To measure bending loss in optical fiber.	4
7	To measure Propagation loss in optical fiber.	4
8	To Transmit and receive Pulse Amplitude Modulated (PAM) signal using OF	4
9	To study and plot the different characteristics of an optocoupler device.	4
10	To observe the effect of noise and dispersion on eye pattern in a communication system	4
11	To generate PWM and PPM signals and demodulate them.	4
12	To measure insertion loss, reflectance, total loss, attenuation coefficient and fiber break location using OTDR.	4
13	To study the characteristics of a multiplexer, FBG, circulator and OADM used in A DWDM system	4
14	To study Manchester encoding and decoding schemes.	4
15	To implement a simple point to point link in OMNeT++ software and analyse its delay performance.	4
16	To generate an intensity modulated signal at the transmitter and demodulate it at the receiver using direct detection scheme in OptSim software.	4
17	To generate a PSK modulated signal at the transmitter and detect it at the receiver using homodyne and heterodyne demodulators in OptSim software.	4
18	To modulate a continuous wave laser using external PRBS generator and analyse the BER, Q-factor and eye diagram obtained at the output.	4
Study Resources	• Luff, Paul. (2018). Practical Guide to Optical Fiber Communications. Wiley-IEEE Press. ISBN: 978-1119382155. • Das, Gautam. (2018). Practical Fiber Optics: From Basic Principles to Deployment. Apress. ISBN: 978-1484237182. • Veljanovski, Ron. (2016). The Essential Guide to RF and Wireless. Wiley. ISBN: 978-1118925392. • Wilson, David B. (2014). Practical Guide to Fiber Optic Connectors. CRC Press. ISBN: 978-1482240556. • Chanda, Jyoti, and Mukherjee, Bishnu P. (2012). Fiber Optic Sensors: Fundamentals and Applications. CRC Press. ISBN: 978-1420093348. • Ramaswami, Rajiv, and Sivarajan, Kumar N. (2010). Optical Networks: A Practical Perspective (3rd Edition). Morgan Kaufmann Publishers. ISBN: 978-0123740927.	

Semester- II
PHY-DSC-526B:Practical course on MATLAB Programming

Total Hours: 30 **Credits: 2**

Course objectives	• To understand MATLAB programming softwares. • To write specific program for mathematical expressions using MATLAB • To run and execute electronic simulations using MATLAB.	
Course outcomes	• Students will be able to use MATLAB for different mathematical expressions. • Students will be able desing and test electronic simulations using MATLAB.	
Sr. No.	**Contents**	**Hours**
1	Develop a MATLAB program to generate prime numbers between 1 to 100.	4
2	Develop a MATLAB program to generate random numbers	4
3	Develop a MATLAB program to illustrate the matrix operations such as determinant, addition, multiplication, inverse.	4
4	Develop a MATLAB program to generate Sine/ Cosine series.	4
5	Develop a MATLAB program to find the root of equation.	4
6	Develop a MATLAB program to solve the polynomial	4
7	Develop a MATLAB program to integration of equation.	4
8	Develop a MATLAB program to solve differential equation.	4
9	Simulate ohms law model using Simulink.	4
10	Develop a MATLAB program to find eigen value.	4
11	Simulate Kirchoff'slaw(KVL/KCL) model using Simulink.	4
12	Develop a MATLAB program to simulate Kirchoff's Laws.	4
13	Develop a MATLAB program to simulate Fourier Analysis of Square Wave	4
14	Develop a MATLAB program to simulate Motion of a Charged Particle in a Uniform Magnetic Field.	4
15	Develop a MATLAB program to simulate Simple Oscillatory Motion.	4
16	Simulate RC filter model using Simulink.	4
Study Resources	• Attaway, Stormy. (2018). MATLAB: A Practical Introduction to Programming and Problem Solving (5th Edition). Elsevier. ISBN: 978-0128154793. • Palm, William J. (2018). Introduction to MATLAB for Engineers (4th Edition). McGraw-Hill Education. ISBN: 978-1260049857. • Higham, Nicholas J., and Higham, Desmond. (2017). MATLAB Guide (3rd Edition). SIAM. ISBN: 978-1611974776. • Chapman, Stephen J. (2018). MATLAB Programming for Engineers (6th Edition). Cengage Learning. ISBN: 978-1337298297. • Hahn, Brian R. (2017). Essential MATLAB for Engineers and Scientists (7th Edition). Academic Press. ISBN: 978-0128052695. • Gilat, Amos. (2019). MATLAB: An Introduction with Applications (6th Edition). Wiley. ISBN: 978-1119496008. • Knight, Andrew. (2019). MATLAB Programming for Engineers: Problem-Solving for Scientists and Engineers (1st Edition). Pearson. ISBN: 978-0134808063. • Pratap, Rudra. (2016). Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers (3rd Edition). Oxford University Press. ISBN: 978-0199655742.	

F.Y.M.Sc.
Semester- II
PHY-OJT-527: Internship/On Job Training

Hours: 120 **Credits: 4**

Course Objectives	• To provide the students with actual work experience • To make aware prescribe standards and guidelines at work • To develop the employability of participating student • To avail an opportunities to eventually acquire job experiences
Course outcomes	After successful completion of this course, students are expected to: • Get actual work experience with office and virtual exposure to various management styles, technical, industrial, and procedural systems • Acquaintthe knowledge related to working hours, work protocols and guidelines • Understand the roles and responsibilities of employee as well as team work • Justify job experiences that match theirpotentials, skills, and competencies
	On the job training On the job training is a form of training provided at the workplace. During the training, employees are familiarized with the working environment they will become part of. Employees also get a hands-on experience using machinery, equipment, tools, materials, etc.