VANITA VISHRAM WOMEN'S UNIVERSITY

SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF PHYSICS

MASTER OF SCIENCE (M.Sc.) PHYSICS PROGRAMME

SEMESTERS-2

Core Courses (CC), General Elective Courses (GEC)

Syllabus applicable to the students seeking admission in

M.Sc. Physics

w.e.f. the Academic Year 2021-2022

1. Preamble – VVWU

Vanita Vishram Women's University (VVWU) is the First-ever Women's University of Gujarat approved by the Government of Gujarat under the provisions of the Gujarat Private Universities Act, 2009. It is a University committed to achieve Women's Empowerment through Quality Education, Skill Development, and by providing employment opportunities to its girl students through its model curriculum, integration of technology in pedagogy and best-in-class infrastructure. The focus is on prioritizing practical component and experiential learning supported through academia-industry linkages, functional MoUs, skill development training, internships etc. It aims at providing opportunities to the girl students for holistic development and self-reliance.

VISION

Empowerment of women through quality education and skill development, so as to make them strong pillars of stability in the society.

MISSION

To provide Education & Professional Training to all women for their all-round development, so as to enable them to become economically independent and socially empowered citizens.

2. Introduction of the Programme

Physics is essentially one of the most fundamental scientific disciplines, and its main goal is to understand how the universe behaves. It seeks to understand natural phenomena in a quantitative manner, and to answer some of the oldest and deepest questions ever asked by human beings. Master of Science (M.Sc.) in Physics is one of the most preferred academic degree courses after graduating with Physics as a major subject.

Vanita Vishram Women's University (VVWU) is the First-ever Women's University of Gujarat proposed under Public-Private-Partnership with the Government of Gujarat under the Gujarat Private Universities Act, 2009. VVWU is committed to provide quality education and employment opportunities to its girl students through its revamped curriculum and pedagogy. Various courses at undergraduate and postgraduate level have been started under VVWU. We have state-of-the-art laboratories for conducting the various laboratory classes. We also have ICT-enabled classroom facilities to provide the students with the best learning experience.

3. Programme Specific Objectives (PSOs)

- ☞ The students are expected to understand the fundamentals, principles, physical concepts and recent developments in the subject area.
- ☞ The student can understand the role of Physics in society and has a background to consider ethical problems.
- ☞ To create an ample amount of prospects for the students in various fields like academics, industry, research organization, consultancy, defense and entrepreneurial pursuit at national and international level.
- ☞ To prepare students to take up challenges as a researcher in diverse areas of theoretical and experimental physics.
- ☞ Create the environment to perform the high-end research through Dissertation work.
- ☞ To develop the scientific research approach among students, in defining problems, execution through analytical methods, and systematic presentation of results keeping in line with the research ethics through dissertations.

4. Programme Specific Outcomes (PSOs):

After the completion of the course student will:

PSO-1. Have proficiency in various mathematical concepts for the proper understanding of application in all physical systems especially in Nuclear physics, Statistical Mechanics, Spectroscopy, Electronics, Electromagnetism, Materials Science, Classical and Quantum Mechanics.

PSO-2. Have fundamental and advanced level knowledge in various subjects of physics such as advanced mathematical physics, classical mechanics, quantum mechanics, statistical mechanics, nuclear and particle physics, solid state physics, materials science and electronics.

PSO-3. Learn the laboratory skills, enabling measurements in a Physics Laboratory and analysis of the measurements to draw valid conclusions.

PSO-4. Have fundamental and advanced level knowledge in physics so as to handle the computational tools and scientific software.

PSO-5. Get opportunities to acquire or develop skills and expertise, a comprehensive understanding of techniques, and a thorough knowledge of the literature, applicable to their own research.

PSO-6. Have cross cultural competency exhibited by working as a member or in teams.

5. Structure of the Programme:

Sem-1	Sem-2	Sem-3	Sem-4
Core Course-I	Core Course-VII	Core Course-XII	Core Course -XVII
Core Course-II	Core Course-VIII	Core Course-XIII	Core Course -XVIII
Core Course-III	Core Course-IX	Core Course-XIV	Core Course-XIX
Core Course-IV	General Elective-I	Departmental Elective-I Or Departmental Elective-I	Departmental Elective-V Or Departmental Elective-VI Or Departmental Elective-VII
Core Course -V Practical	Core Course -X Practical	Departmental Elective-III Or Departmental Elective-IV	Core Course -XX Practical
Core Course -VI Practical	Core Course -XI Practical	Core Course-XV Practical	Core Course -XXI Dissertation
		Core Course-XVI Project Work	

6. Structure of the Course:

Sem-1	Sem-2	Sem-3	Sem-4
Mathematical Methods of Physics (4+1)	Quantum Mechanics-I (4+1)	Quantum Mechanics-II (4+1)	Nuclear & Particle Physics (4+1)
Classical Mechanics (4+1)	Statistical Mechanics (4+1)	Condensed Matter Physics (4+1)	Modern Optics (4+1)

Computational Physics (4+1)	Electrodynamics and Plasma Physics (4+1)	Atomic and Molecular Physics (4+1)	Molecular Spectroscopy OR Experimental Techniques for Material Characterization OR Solar Photovoltaics (3+1)
Electronics (4+1)	Introduction to Nanoscience and Nanotechnology	Material Science OR Advanced Electronics (3+1)	Physics Experiments Lab-VI (4+1)
Physics Experiments Lab-I (4)	Physics Experiments Lab-III (4)	Atomic and Laser Spectroscopy OR Thin Film Physics & Vacuum Technology (3+1)	Dissertation (12)
Physics Experiments Lab-II (4)	Physics Experiments Lab-IV (4)	Physics Experiments Lab-V (4)	-
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7. Course Objectives – Course Outcomes – Course Contents

SEMESTER-2

CC7 QUANTUM MECHANICS-I
(PH21070)

Credits: 4 (Theory) + 1 (Learning Outside the Class)
Contact hours per week: 4

Course Objectives:

- To formulate Quantum Mechanics using abstract mathematical structure of linear vector spaces.
- Describe the postulates of Quantum Mechanics and discuss the concepts of state, observables and time evolution in Quantum Mechanics
- To understand the concepts of Angular momentum and mathematics involved with it.
- Discuss various 3-dimensional time independent problems in quantum mechanics

Outline of the Course:

No.	Unit	Minimum No. of Contact Hours	Weightage in %
1.	**Linear Vector Spaces**	18	30
2.	**Postulates of Quantum Mechanics**	16	26
3.	**Angular Momentum**	13	22
4.	**Three Dimensional Problems**	13	22
	Total	**60**	**100**

Course outcome:

CO-1. Students will understand the concepts of linear vector spaces and its usefulness as a mathematical tool to the basic Quantum Mechanics

CO-2. Comprehensive understanding of postulates of Quantum Mechanics and bridging of Classical & Quantum Mechanics

CO-3. The student will learn to solve various 3-dimensional time independent problems in Quantum Mechanics

CO-4. To imbibe the concepts of angular momentum and related mathematics

M.Sc. Physics Semester-2	
Subject	**Hours**
CC7 QUANTUM MECHANICS-I	**4 Hours /week**
Topic	**Hours**
Unit – I	
Linear Vector Spaces: The Linear Vector Space, The Hilbert Space, Dimension and Basis of a Vector Space, Wave Functions; Operators: Hermitian Adjoint, Projection Operators, Commutator Algebra, Inverse and Unitary Operators, Eigenvalues and Eigenvectors of an Operator; Representation in Discrete Bases: Matrix Representation of Kets, Bras, and Operators, Change of Bases and Unitary Transformations, Matrix Representation of the Eigenvalue Problem; Representation in Continuous Bases: Position Representation, Momentum Representation; Matrix Mechanics, Wave Mechanics.	**18**
Unit – II	
Postulates of Quantum Mechanics: Postulates of Quantum Mechanics: State of a System, Probability Density, Superposition Principle, Observables as Operators, Position and Momentum operators, Position and Momentum representation of state vector, Connecting the position and momentum representations, Measurement in quantum mechanics, Expectation values, Time evolution of the state: Time-independent potentials and Stationary States, Time evolution operator, infinitesimal and finite Unitary Transformations; Poisson's brackets and commutators	**16**
Unit – III	
Angular Momentum: Orbital Angular Momentum, General Formalism of Angular Momentum, Matrix Representation of Angular Momentum, Geometrical Representation of Angular Momentum, Spin Angular Momentum: Experimental Evidence of the Spin, General Theory of Spin, Spin ½ and the Pauli Matrices; Eigenfunctions of Orbital Angular Momentum: Eigenfunctions and Eigenvalues of $\hat{L}_z$, Eigenfunctions of $\hat{L}^2$, Properties of the Spherical Harmonics.	**13**
Unit – IV	
Three Dimensional Problems: The Free Particle, The Box Potential, The Harmonic Oscillator, Central Potential in Spherical Coordinates; Scattering Theory: Laboratory and centre of mass frames, Differential and Total Scattering Cross-Sections, Scattering Amplitude, Scattering by spherically symmetric potentials, Partial wave analysis and phase shifts; Ramsauer-Townsend effect; Relation between sign of phase shift and attractive or repulsive nature of the potential; Scattering by a rigid sphere and square well; Coulomb scattering; Formal theory of scattering, Green's function in scattering theory; Born approximation.	**13**

Note: In addition to above content, numerical solved/unsolved problems to be discussed from each unit.

Reference books:

1. Quantum Mechanics Concepts and Applications By Nourdine Zettili, 2nd edition, Wiley (2009)
2. Quantum Mechanics By L.I. Schiff, 4^{th} Ed., McGraw Hill Education (2017).
3. Modern Quantum Mechanics By J.J. Sakurai, 2^{nd} Ed., Cambridge University Press (2017).
4. A Text Book of Quantum Mechanics By P.M. Mathews and K. Venkatesan,
5. Introduction to Quantum Mechanics By D J Griffiths and D F Schroeter, Cambridge University Press (2019).
6. Quantum Mechanics By B. H. Bransden and C. J. Joachain, 2^{nd} Ed., Pearson Education (2004).
7. Quantum Mechanics: 500 Problems with solutions By G Aruldhas, Prentice Hall India (2010).
8. Relativistic Quantum Mechanics By W. Greiner, 3^{rd} Ed., Springer (2000).
9. Lectures on Quantum Mechanics By Paul Dirac, Snowball Publishing (2012).

SEMESTER-2

CC8 STATISTICAL MECHANICS
(PH21080)

Credits: 4 (Theory) + 1 (Learning Outside the Class)
Contact hours per week: 4

Course Objectives:

- This course introduces students to the Quantum Mechanical Picture of the statistical physics.
- The focus is on developing a formalisms applicable to the various systems like Ideal Fermi Gases, Bose Gases and to develop the approximations to implicate these formalisms to Real Gas Systems.
- To introduce the formalism which underpins all of material science and other branches where one is interested in the collective behavior of a system.

Outline of the Course:

No.	Unit	Minimum No. of Contact Hours	Weightage in %
1.	**Quantum Statistical Mechanics**	13	22
2.	**Canonical and Grand Canonical Ensembles**	16	26
3.	**Ideal Fermi Gas and Ideal Bose Gas**	18	30
4.	**Phase Transition and Critical Phenomena and The Ising Model**	13	22
	Total	**60**	**100**

Course outcome:

CO-1. Demonstrate an understanding of the terminology, concepts and principles of describing equilibrium properties of physical systems.
CO-2. For a given ideal system, derive various macroscopic quantities - either using a classical or a quantum setting using the principles learned.
CO-3. Derive the macroscopic properties of ideal quantum gases.
CO-4. Develop a basic understanding of various aspects of the statistical physics of systems by virtue of interaction between its constituent components.

M.Sc. Physics Semester-2	
Subject	**Hours**
CC8 STATISTICAL MECHANICS	**4 Hours /week**
Topic	**Hours**
Unit – I	
Quantum Statistical Mechanics: Microcanonical Ensemble, Quantization of phase space, Basic Postulates, Classical Limit, Symmetry of Wave Functions, Effect of Symmetry on counting: Maxwell-Boltzmann statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics, Distributions of an Ideal Gases using Microcanonical Ensemble	**13**
Unit – II	
Canonical and Grand Canonical Ensembles: Canonical Ensembles, Entropy of a system in contact with a heat reservoir, Ideal Gas in Canonical Ensemble, Maxwell Velocity Distribution, Equipartition of Energy, Grand Canonical Ensembles, Ideal Gas in Grand Canonical Ensemble, Comparison of various Ensembles, Equation of state for Ideal Quantum Gases. Canonical and Grand Canonical Partition Functions	**16**
Unit – III	
Ideal Fermi Gas: The Fermi-Dirac Distribution, The Degenerate Electron Gas, Spin Paramagnetism, Landau Diamagnetism, The Equation of State at High Density, White Dwarf Stars, Neutron Stars, Neutron Stars **Ideal Bose Gas:** The Bose-Einstein Distribution, Degenerate Bose Gas, Blackbody Radiation	**18**
Unit – IV	
Phase Transition and Critical Phenomena: Phase Transition, Landau Theory of Second Order Phase Transition, Critical Exponents **The Ising Model:** Cooperative Phenomena, Formulation of Ising Model, Bragg Williamson Approximation, One Dimensional Ising Model.	**13**

Note: In addition to above content, numerical solved/unsolved problems to be discussed from each unit.

Reference books:

1. Statistical Mechanics By B K Agarwal and Melvin Eisner, 3rd Ed., New Age International (2020)
2. Statistical Mechanics By R.K. Srivastava and J Ashok, Prentice Hall India (2005)
3. Statistical Mechanics By K. Huang, Wiley India (2008).
4. Statistical Physics, Berkeley Physics Course, Volume 3 By F. Reif, Tata- McGraw-Hill (2008).
5. Statistical Physics By Satya Prakash, 1st Ed., Kedar Nath Ram Nath, Meerut (2019).
6. Problems in Statistical Mechanics By D A R Dalvit, 1st Edition, CRC Press (1999).

SEMESTER-2

CC9 ELECTRODYNAMICS AND PLASMA PHYSICS (PH21090)

Credits: 4 (Theory) + 1 (Leaning Outside the Class)
Contact hours per week: 4

Course Objectives:

- The aim of course is to familiarize the students with the advanced topics of electrodynamics and plasma physics.

Outline of the Course:

No.	Unit	Minimum No. of Contact Hours	Weightage in %
1.	Transmission lines and Wave guides	15	25
2.	Potential, Fields and Radiation	15	25
3.	Relativistic Electrodynamics	15	25
4.	Waves in Plasma, Diffusion and Resistivity	15	25
	Total	60	100

Course Outcomes:

On completion of the course the student shall be able to,

CO-1. Understand the concept of need of transmission lines and analyze transmission of electromagnetic waves through different structure of waveguides.
CO-2. Develop skills on solving analytical problems in electrodynamics.
CO-3. Evaluate vector potentials for point charge and radiation emitted by moving charges.
CO-4. Understand the electrodynamics of radiating and relativistic system.
CO-5. Describe the propagation of waves in plasmas, and understand plasma resistivity and diffusion in plasma based on the charged particle motion.

M.Sc. Physics Semester-2	
Subject	**Hours**
CC9 ELECTRODYNAMICS AND PLASMA PHYSICS	**4 Hours /week**
Topic	
Unit – I	
Transmission lines and Wave guides: Transverse Electromagnetic Wave along a Parallel-Plate Transmission Line, General Transmission-Line Equations, Wave Characteristics on an Infinite Transmission Line, General Wave Behaviours along Uniform Guiding Structures, Rectangular Waveguides, TM Waves in Rectangular Waveguides, TE Waves in Rectangular Waveguides, Attenuation in Rectangular Waveguides.	**15**
Unit – II	
Potential, Fields and Radiation: Scalar and Vector Potentials, Gauge Transformations, Coulomb Gauge and Lorenz Gauge, Retarded Potentials, Liénard-Wiechert Potentials, Radiation from electrical dipole and magnetic dipole, Potentials for a charge in uniform motion, Radiation from an accelerated charged particles, power radiated by a point charge.	**15**
Unit – III	
Relativistic Electrodynamics: Lorentz transformation, Some consequences of Lorentz transformation, charges and fields observed in different frames, covariant formulation of Electrodynamics, Transformation of the field, Electromagnetic field tensor, langrangian formulation of the motion of charged particles in electromagnetic field, radiation from relativistic particles.	**15**
Unit – IV	
Waves in Plasma: Plasma oscillations, electron plasma waves, sound waves, ion waves, comparison of ion and electron waves. **Diffusion and Resistivity:** Diffusion and mobility in weakly ionized gases, decay of plasma by diffusion, steady state solutions, recombination, diffusion across magnetic field, collision in fully ionized plasma, single fluid MHD equations.	**15**

Reference books:

1. Field and Waves Electromagnetics by David K. Cheng, 2nd Edition, Pearson Education India Learning Private Limited (2014)
2. Introduction to Electrodynamics by David J. Griffith, 4th Edition, Pearson Education India Learning Private Limited (2015)

3. Electromagnetics by B. B. Laud, 3rd Edition, New Age International Private Limited (2011)
4. Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.
5. Introduction to Plasma Physics and Controlled Fusion by Francis F. Chen, 3rd Edition, 2015
6. Classical Electrodynamics by John David Jackson, 3rd Edition, Wiley (2007).

SEMESTER-2

CC10 GENERAL PHYSICS LAB-II
(PH21100)

Credits: 4 (Practical)
Contact hours per week: 8

Sr. No.	Name of the Experiment
1	Solution of transcendental or polynomial equations by the Newton Raphson method.
2	Numerical Integration using Simpson's ⅓ Method
3	Matrix Inversion and solution of simultaneous equation
4	To study the diffraction of laser light due to a double slit, grating, and circular aperture. Hence determine (a) the wavelength of the laser light, (b) the ruling density of the grating, and (c) the diameter of the circular aperture.
5	Faraday Effect: Polarisation under the effect of External Field
6	Michelson's Interferometer a. Alignment of Michelson's Interferometer using He-Ne laser to observe concentric circular fringes b. Measurement of the wavelength of He-Ne Laser and Na lamp using circular fringes c. Study of fringes of equal inclination and equal thickness using Na lamp
7	KERR EFFECT: a. To demonstrate the kerr effect in nitrobenzene solution b. To observe the light intensity as a function of voltage across the kerr cell using photo detector.
8	To find the thickness of a thin sheet of paper (air wedge experiment) using Newton's Ring Experiment Setup.
9	Multiple beam interference using Fabry-Parot
10	Ultrasonic Interferometer for Ultrasonic velocity and compressibility of liquids
11	Nanofluid Interferometer: a. To measure the velocity of Ultrasonic Waves in Nano-Fluid (Ag, Au, Cu). b. To study the effect of temperature on velocity in nanofluids of different concentrations.
12	Synthesis of gold nanoparticles by chemical route and its characterisation
13	Synthesis of CdS Nanoparticles by chemical route and its characterisation
14	Synthesis of Silver Nanoparticles by chemical route and its characterisation
15	Synthesis of ZnO Nanoparticles by chemical route and its characterisation
16	Determination of e/m of electron by normal Zeeman effect using Febry Perot Etalon
17	Electron Diffraction Experiment
18	Determination of Energy Eigenvalue of a Particle in a Square Well Potential

19	To measure the impedance of a coaxial cable and a rectangular waveguide using a microwave bench.
20	Experimental Determination of Avogrado Number
21	Study of thermoluminescence
22	Calculate the difference in wavelength between atomic transition lines and Zeeman lines using Zeeman effect set-up

SEMESTER-2

CC11 ELECTRONICS LAB-II
(PH21110)

Credits: 4 (Practical)
Contact hours per week: 8

Sr. No.	Name of the Experiment
1	To design and construct a (Wein bridge/phase shift) oscillator for a given cut-off frequency.
2	To design an astable multivibrator of given specifications using 555 Timer
3	To design a monostable multivibrator of given specifications using 555 Timer
4	Design of a Common Emitter Transistor Amplifier
5	DAC (digial to Analogue convertor) using R-2R and binary ladder
6	Study of multiplexer and demultiplexer
7	Study of Hybrid parameters of transistor
8	Study of modulation and demodulation
9	Use of laser in optical fiber communications
10	To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates
11	To prepare a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs
12	Solar Cell: a. To investigate the effects of tilting angle on a solar panel on an I-V characteristic. b. To investigate the effect of incidence of different wavelengths c. To Investigate the effect of series and parallel combination of Solar Cells and respective Power Characteristics.
13	To study the characteristics and frequency response of a push- pull amplifier
14	To design built and test high pass filter (2nd order) using Op-Amp.
15	To design and setup an integrator and differentiator circuit using Op-Amp
16	To design, built and test four-bit binary counter with up/down control
17	Study of IC 723 as Voltage and Current Regulator
18	To design, built and Test a band pass filter using Op-Amp
19	To design, built and Test Schmitt Trigger Circuit

8. Teaching Methodology:

- Direct Instructions
    - Chalk and Talk
    - ICT based teaching
- Flipped Classroom
- Competency based learning
- Kinesthetic Learning
- Differentiated Instruction
- Personalised learning
- Inquiry-based Learning
- Expeditionary Learning
- Flipped Classroom
- Cooperative Learning
- Spaced Learning
- Use of maximum demonstration to explain theoretical concepts.

9. Glossary:

CC – Core Course
GEC – General Elective Course
DEC – Department Elective Course
(P) – Practical
PW – Project Work
DW - Dissertation

VANITA VISHRAM WOMEN'S UNIVERSITY

SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF PHYSICS

GENERIC ELECTIVE (GE) PHYSICS SYLLABUS

under

Learning Outcomes-based Curriculum Framework (LOCF)
for Under Graduate (UG) Education

SEMESTERS 2

Syllabus applicable to the students seeking admission in the under graduate program of any discipline

Under LOCF

w.e.f. the Academic Year 2021-2022

SEMESTER-2

WAVES & OSCILLATIONS AND OPTICS
(PH13030)

Credits: 4 (Theory) + 2 (Practical)
Contact hours per week: 4 (Theory) + 4 (Practical)

Objective of the Course:

- This course reviews the concepts of waves and optics learnt at 10+2 level from a more advanced perspective and goes on to build new concepts.
- The course begins with explaining ideas of harmonic motion and superposition of harmonic oscillations extending to physics of wave motion and standing waves.
- To analyze some of the fundamental laws and principles of light which is used in many important optical instruments.
- The course gives information about the behavior of light due to its wave nature and it also provides an in depth understanding of different phenomena due to the interaction of light with light and matter.

Outline of the Course:

No.	Unit	Minimum No. of Contact Hours	Weightage in %
1.	Simple Harmonic Motion and Superposition of Simple Harmonic Oscillations	15	25
2.	Wave Motion and Standing Waves	15	25
3.	Interference	15	25
4.	Diffraction and Resolving Power	15	25
	Total	**60**	**100**

Course Outcome:

CO-1. After the completion of this course, the students will have the skill and knowledge to:
CO-2. Understand simple harmonic motion, linearity and superposition principle of simple harmonic oscillations.
CO-3. Understand concept of waves motions and associated phenomena.
CO-4. Understand concept of Fermat's and Huygens principle, Interference as superposition of waves from coherent sources.

CO-5. Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from Aperture/obstacle, understand Fraunhofer and Fresnel Diffraction.

Semester-2 For courses of all the disciplines	
Subject	**Hours**
WAVES & OSCILLATIONS AND OPTICS (Theory)	**4 Hours /week**
Topic	
Unit – I	
Simple Harmonic Motion (SHM): Description of SHM, Characteristics of SHM, representation of SHM by a complex exponential, Equation of the simple harmonic wave and its solution, Kinetic energy, potential energy, total energy and their time-average values, Damped oscillation. **Superposition of Harmonic Oscillations:** Linearity and Superposition Principle, Superposition of two collinear harmonic oscillations having equal frequencies and different frequencies (beats), Superposition of two perpendicular oscillations, Lissajous figures with equal and unequal frequencies and their uses.	15
Unit – II	
Wave Motion: Differential equation and solution of wave motion, wave front, plane and spherical waves, longitudinal and transverse waves, Plane Progressive (Travelling) Waves Equation, Particle and Wave Velocities. Energy transported by of plane progressive wave, Intensity of Wave, Velocity of Transverse Vibrations of Stretched Strings, Velocity of Longitudinal Waves in a Fluid in a Pipe. **Standing Waves:** Standing (Stationary) Waves in a String, Phase velocity and group velocity, Energy of Vibrating String, Energy in each normal mode of a vibrating string, Melde's experiment (longitudinal and transverse mode of vibrations)	15
Unit – III	
Interference: Fermat's principle, laws of reflection and refraction from Fermat's principle, Huygens principle, Interference of light waves, methods for obtaining interference (Division of amplitude and wavefront), Condition for Interference, Young's double slit experiment, Interference pattern and Intensity distribution of Interference pattern, Lloyd's Mirror and Fresnel's Biprism, Interference in Thin Films, plane parallel thin films, wedge-shaped films. Newton's Rings, Measurement of wavelength and refractive index using Newton's Rings	15
Unit – IV	
Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones, Theory of zone plate, multiple Foci of a Zone Plate, Fresnel diffraction pattern due to a straight edge, narrow slit and narrow wire, fraunhofer diffraction due to single slit, theory of plane transmission grating.	15

Resolving Power: Resolving power, Rayleigh's criteria, limit of resolution, Resolving power of telescope, Resolving power of prism, Resolving power of grating	

Note: In addition to above content, numerical solved/unsolved problems will be discussed from each unit.

Textbooks:

1. Optics by Ajoy Ghatak, 7th Edition-2020 (McGraw Hill)
2. Waves and Oscillations by N. Subrahmaniyam & Brij lal, 2nd Edition-2018 (Vikas Publishing House Pvt Ltd)
3. A Text Book of Optics by N. Subrahmaniyam & Brij lal, 25th Edition-2012 (S.Chand Publishing)
4. Oscillations and Waves by Suresh Garg, C K Ghosh, Sanjay Gupta, 1st Edition-2009 (PHI Learning)

Reference books:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
5. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
6. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

SEMESTER-2

WAVES & OSCILLATIONS AND OPTICS (Practical) (PH13040)

Credits: 2 (Practical) **Contact hours per week: 4 (Practical)**

Objectives of the course:

- Students will get an experience of using various light source used to demonstrate optics related experience.
- Students will learn the calibration of the spectrometer in order to determine accurate measurement.
- Students will understand the concepts of wave theory of light by performing various experiments.

Course Outcome:

CO-1: In the laboratory course, student will gain hands-on experience of handling various equipments used to demonstrate different experiment associated with waves and optics. Study of Lissajous figures and behaviour of transverse, longitudinal waves can be learnt in this laboratory course.

CO-2: Various properties such as refractive index, dispersive power and resolving power of prism will be studied. In addition to this, wave length of light using Newton Rings experiment, Fresnel Biprism and plane transmission grating can be learnt.

Practical Code	Fundamentals of Physics-II Lab (Practical) (WAVES & OSCILLATIONS AND OPTICS LAB)
WO-1.	To determine the frequency of tuning fork by Melde's experiment
WO-2.	To determine the frequency of A.C mains using a sonometer and an electromagnet.
WO-3.	To study Lissajous Figures
WO-4.	Study of Simple Harmonic/ Damped Oscillations
WO-5.	Study of Resonator: Relation between oscillating frequency and volume of the resonating column.
WO-6.	To determine the force constant using Spring-Mass Oscillation System
WO-7.	Familiarization with: Schuster`s focusing; determination of angle of prism.
WO-8.	To determine the Refractive Index of the Material of a Prism using Sodium light.
WO-9.	To determine the dispersive power of the material of a prism using mercury light
WO-10.	To determine the value of Cauchy Constants.
WO-11.	To determine wavelength of sodium light using Fresnel Biprism.
WO-12.	To determine wavelength of sodium light using Newton's Rings.

WO-13.	To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
WO-14.	To determine the wavelength of Laser light using Diffraction of Single Slit.
WO-15.	To determine the diameter of a thin wire by studying the diffraction pattern produced by it.
WO-16.	To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
WO-17.	To determine the Resolving Power of a Plane Diffraction Grating
WO-18.	To determine the Resolving Power of a Prism.

Note: To be performed any 12 Experiments.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted, 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
4. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

VANITA VISHRAM WOMEN'S UNIVERSITY

SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF PHYSICS

SEMESTERS-2

General Elective Course (GEC)

GEC1-INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

(PH23010)

w.e.f. the Academic Year 2021-2022

SEMESTER-2

GEC1-INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY
(PH23010)

Credits: 3 (Theory) + 1 (Outside the classroom)
Contact hours per week: 3

Course Objectives:

- The aim of this course is to introduce an emerging area of science which involves the study of materials on an ultra-small scale and the novel properties that these materials possess.

Outline of the Course:

No.	Unit	Minimum No. of Contact Hours	Weightage in %
1.	Background of Nanoscience & Nanotechnology, Quantum Mechanics of Low Dimensional Systems and its Application to Nanoscience	15	33.33
2.	Synthesis Techniques of Nanomaterials (Physical Methods and Chemical methods)	15	33.33
3.	Properties of Nanomaterials, Recent Advances in Nanotechnology and Applications of Nanotechnology in Various Fields	15	33.33
	Total	**45**	**100**

Course Outcome:

At the end of this course, students will be able to

CO-1. Know the history and necessity of the field of nanoscience and nanotechnology.
CO-2. Understand the role of quantum mechanics in nanoscience and nanotechnology.
CO-3. Develop the skill of various synthesis methods of nanomaterials.
CO-4. Gain the knowledge about the properties of nanomaterials, advanced in nanotechnology.
CO-5. Understand the applications of nanomaterial.

General Elective Physics Semester-2	
Subject	**Hours**
GEC1-INTRODUCTION TO NANO SCIENCE AND NANOTECHNOLOGY	**3 Hours /week**
Topic	
Unit – I	
Background of Nanoscience & Nanotechnology: History of Nanoscience, Definition of Nanometer, Nanomaterial, and Nanotechnology, Ancient Nanotechnology, Early Nanotechnologists. **Quantum Mechanics of Low Dimensional Systems and its Application to Nanoscience:** Introduction Energy Considerations: Bound States and Density of States, Quantum Confinement, Superlattices, Band Offsets, Quantum Transport in Nano clusters /Quantum Dots	**15**
Unit – II	
Synthesis Techniques for Nanomaterials: **Physical Methods:** Ball Milling, Thermal and Electron beam evaporation, DC Sputtering, Chemical Vapour Deposition (CVD), Molecular Beam Epitaxy **Chemical Methods:** Nucleation and Growth of Nanoparticles, Synthesis of Metal Nanoparticles by Colloidal Route, Sol-Gel Method, Chemical bath Deposition, Hydrothermal Synthesis	**15**
Unit – III	
Properties of Nanomaterials: Mechanical properties, structural properties, Electrical properties, optical properties, magnetic properties. **Recent Advances in Nanotechnology:** Introduction, Designing Molecules for Nano-electronics, Advances of Nanotechnology in Materials Science **Applications of Nanotechnology in Various Fields:** Applications in Material Science, Applications in Biology and Medicine, Applications in Surface Science, Applications of Quantum Dots, Applications of Magnetic Nanoparticles	**15**

Textbooks:

1. Nanotechnology: Principles and Practices, Sulabha K. Kulkarni, 3rd Edition, 2014 (Springer Nature)
2. Nanoscience and Nanotechnology: Fundamentals of Frontiers, Shubra Singh M.S. Ramachandra Rao,1st Edition, 2013 (Wiley).
3. Basics Principles of Nanotechnology by Wesley C. Sander
4. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
5. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited)