Program Structure

Program: MSc (Physics)

Program Code: SBR0201

Batch: 2020-22

Department of Physics

School of Basic Sciences and Research

1. Standard Structure of the Program at University Level

1.1 Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship

Mission of the University

1. **Transformative educational experience**
2. **Enrichment by educational initiatives that encourage global outlook**
3. **Develop research, support disruptive innovations and accelerate entrepreneurship**
4. **Seeking beyond boundaries**

Core Values

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

School of Basic Sciences and Research

Vision of the School

Achieving excellence in the realm of basic and applied sciences to address the global challenges of evolving society

Mission of the School

1. **To equip the students with knowledge and skills in basic and applied sciences**
2. **Capacity building through advanced training and academic flexibility.**
3. **To establish center of excellence for ecologically and socially innovative research.**
4. **To strengthen inter institutional and industrial collaboration for skill development and global employability.**

1.3.1 Programme Educational Objectives (PEO) for MSc (Physics) program

PEO1: To prepare students to attain successful professional careers by applying critical thinking and skills based on Physics in their professions or higher education to meet the challenges in industry, academia or the pursuit of other fields.

PEO2: To engage Students in lifelong learning, adapt to evolving technologies, and work in interdisciplinary research to design innovative products and solutions to become successful professionals, entrepreneurs or researchers.

PEO3: To provide an opportunity to the students to explore research and development, in collaboration with other institutions, in the areas of Material Sciences, Nuclear Sciences and Renewable Energy.

PEO4: To impart values in students to practice professional ethics, communicate effectively, emerge as leaders in chosen fields and be socially responsible.

1.3.2 Program Outcomes (PO's)

PO1: Proficiency - Students should demonstrate proficiency in Nuclear and Particle Physics, Advanced Quantum Mechanics, Spectroscopy, Statistical Mechanics, Electronics, Characterization & Synthesis of Materials, Solid State Physics and Renewable Energy and should be able to apply these functions, principles and concepts for solving professional or research problems.

PO2: Skills - Students should understand the need and acquire skills to design and conduct physics experiments, as well as to analyze and interpret data. He should also learned analytical skills on an advanced level, needed in industry, consultancy, education, research, or public administration.

PO3: Communication - Students should understand and capable of writing scientific publication and present their research works in conferences and seminars.

PO4: Research - Students shall have ability to Identify, formulate, research literature, and analyses substantiated conclusions to take up higher education or work on interdisciplinary research problems or take up physics as a teaching profession.

PO5: Responsibility - Students shall have a clear understanding of professional and ethical responsibility.

PO6: Life-long learning - Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of research and technology.

1.3.3 Program Specific Outcomes (PSO's)

PSO1: Materials Science - An idea about all types of crystal defects and dislocations, information about Phase diagrams and general diffusion theory in detail, A fair idea of plastic deformation and fracture of material from an engineering point of view, A comprehensive awareness of the most important engineering material of the century namely polymers and state of the art facts and techniques of the synthesis and characterization of materials.

PSO2: Nano Science - Studying nano science will contribute to the development of technology and devices such as single photon sources, solar cells, nano electronics and nanomaterial's. Highly relevant to the recruitment needs of industrial employers, particularly in the semiconductor, telecommunications and imaging sectors and for further research.

Program Structure Template
School of Basic Sciences & Research
MSc. Physics
Batch: 2020-2022
TERM: I

S. No.	Subject Code	Subjects	Teaching Load L	T	P	Credits	Pre-Requisite/ Co Requisite	Type of Course: 1. CC 2. AECC 3. SEC 4. DSE
THEORY SUBJECTS								
1.	MPH112	Solid state physics	4	0	0	4	Pre-Requisite	CC
2.	MPH119	Mathematical Physics	4	0	0	4	Pre-Requisite	CC
3.	MPH120	Quantum mechanics	4	0	0	4	Pre-Requisite	CC
4.	MPH111	Classical mechanics	4	0	0	4	Pre-Requisite	CC
5.	MMT129	Introduction to MATLAB and its Applications	2	0	2	3	Pre-Requisite	GE1
Practical								
6.	MPH155	Physics Lab-1	0	0	6	3	Pre-Requisite	CC
7.	MPH156	Physics Lab-2	0	0	6	3	Pre-Requisite	CC
TOTAL CREDITS						**25**		

SHARDA UNIVERSITY
Beyond Boundaries

Program Structure Template
School of Basic Sciences & Research
MSc. (Physics)
Batch: 2020-2022
TERM: II

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective	Type of Course: 1. CC 2. AECC 3. SEC 4. DSE
			L	T	P			
THEORY SUBJECTS								
1.	MPH115	Renewable energy sources	4	0	0	4	Core	GE 2
2.	MPH113	Electronics	4	0	0	4	Core	CC
3.	MPH117	Statistical Mechanics	4	0	0	4	Core	CC
4.	MPH123	Atomic, molecular physics and spectroscopic techniques	4	0	0	4	Core	CC
5.	MPH122	Advanced quantum mechanics	4	0	0	4	Core	CC
6.	CCU 401	Community Connect	-	-	-	2	Elective	SEEC-1
Practical								
7.	MPH157	Physics Lab-3	0	0	6	3	Core	CC
8.	MPH158	Physics Lab-4	0	0	6	3	Core	CC
TOTAL CREDITS						**28**		

Program Structure Template
School of Basic Sciences & Research
MSc. Physics
Batch: 2020-2022
TERM: III

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective	Type of Course: 5. CC 6. AECC 7. SEC 8. DSE
			L	T	P			
THEORY SUBJECTS								
1.	MPH204	Electromagnetics	4	0	0	4	Core	CC
2.	MPH205	Materials Physics	4	0	0	4	Core	DSE-1
3.	MPH208	Synthesis of Materials	4	0	0	4	Core	DSE-2
4.	MPH217	Nuclear and particle physics	4	0	0	4	Core	CC
5.	MPH256	Dissertation – 1	0	0	0	4	Core	DSE-3
Practical								
6.	MPH257	Specialized Physics lab	0	0	6	3	Core	CC
TOTAL CREDITS						**23**		

Program Structure Template
School of Basic Sciences & Research
MSc. Physics
Batch: 2020-2022
TERM: IV

S. No.	Course Code	Course	Teaching Load L	Teaching Load T	Teaching Load P	Credits	Core/Elective	Type of Course: 9. CC 10. AECC 11. SEC 12. DSE
THEORY SUBJECTS								
1.	OPExxx	Open Elective	2	0	0	2	Elective	SEEC 2
2.	MPH209	Characterization of Materials	4	0	0	4	Core	DSE 4
3.	MPH210	Properties of Materials	4	0	0	4	Core	DSE 5
4.	MPH258	Dissertation – 2	0	0	0	6	Core	DSE 6
TOTAL CREDITS						**16**		

Total Credits= (25+28+23+16=92)

C. Course Templates

School: SBSR		**Batch : 2020-2022**
Program: M.Sc.		**Current Academic Year: 2020-2021**
Branch: Physics		**Semester: I**
1	Course Code	MPH-112
2	Course Title	Solid State Physics
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	This course provides an opportunity to develop knowledge and understanding of the key principles and applications of physics of solids.
6	Course Outcomes	CO1: Knowledge of real space, reciprocal space (k-space), Electrons in a Periodic Potential and Free electron theory. CO2: Knowledge and understanding the theory of defects and diffusion in Solids. CO3: Knowledge and understanding the theory of lattice vibrations (phonons) and use that to determine thermal properties of solids. CO4: Knowledge and understanding of dielectric and Ferro-electric Properties of Materials. CO5: Knowledge and understanding of magnetic and superconducting properties of solids. CO6: Apply the knowledge gained to solve problems in solid state physics using relevant mathematical calculations.
7	Course Description	This course provides students a full exposure to the basic principles and essential concepts of Solid State Physics including theoretical description of crystal structure, lattice dynamics, thermal, electrical and magnetic properties of solids.
8	Outline syllabus	
	Unit 1	**Electronic Energy Bands**
	A	Wigner Seitz cell, Brillouin Zone, Bragg planes
	B	Band structure, Bloch Theorem, Electrons in a Periodic Potential
	C	Kronig-Penney Model, Classical and quantum Free electron theory
	Unit 2	**Defects and Diffusion in Solids**
	A	Point defects, line defects and dislocations
	B	Fick's law, diffusion constant
	C	self-diffusion, color centres and excitons.
	Unit 3	**Lattice Vibration and Thermal Properties of Solids**
	A	Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains
	B	Acoustical and Optical Phonons. Qualitative description of the Lattice heat capacity
	C	Classical theory of specific heat, Einstein's and Debye's theory of

		specific heat of solids.
	Unit 4	**Dielectric and Ferro-electric Properties of Materials**
	A	Local Field and Clausius-Mossotti Equation, Polarization mechanism: Ionic Polarization, Orientational Polarization, Interfacial Polarization, Total Polarization
	B	Piezoelectricity, Ferroelectricity, Pyroelectricity effect, Ferroelectric effect,
	C	Curie-Weiss Law, Ferroelectric domains, Structural phase transition.
	Unit 5	**Magnetism and Superconductivity**
	A	Ferromagnetic Domains – Anisotropy energy, origin of domains, transition region between domains, Bloch wall, Coercive force, Temperature dependence of spontaneous magnetisation,
	B	Saturation Magnetization, Antiferromagnetism, Ferrimagnetism, Anisotropic and Giant Magnetoresistance, London equation;
	C	Elementary BCS theory, coherence Length, Quantization of magnetic flux, Josephson effect.
	Mode of examination	Class test (10) ,Assignments (10) and presentation (10)
	Weightage Distribution	CA: 30% · MTE: 20% · ETE: 50%
	Text book/s*	1. Introduction to solid state physics: C. Kittel
	Other References	2. Solid State Physics: S.O. Pillai 3. Solid State Physics: A. J. Dekker 4. Physics of Materials: Richar Jerome Weiss 5. Introduction to solids: L.V. Azaroff

School: SBSR		**Batch : 2020-22**
Program: M.Sc.		**Current Academic Year: 2020-21**
Branch: Physics		**Semester: I**
1	Course Code	MPH 119
2	Course Title	**MATHEMATICAL PHYSICS**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. The objective of this course is to familiarize the students with various techniques of solving ordinary and partial differential equations. 2. To understand the concepts of Laplace and Fourier transformations, basic statistical and numerical methods and their applications.
6	Course Outcomes	CO1: Explain the methods of solving differential equations of various types. CO2: Explains the methods of solving Heat, Wave and Laplace's Equations CO3: Know that any periodic function can be expressed as a Fourier series and fundamental mathematical properties of the Fourier and Laplace transform. CO4: Know the condition(s) for a complex variable function to be analytic and/or harmonic, able to determine the points of singularities of a function and understand the concept of sequences and series with respect to the complex numbers. CO5: Describe various probability distributions and their applications. CO6: Describe and use the concepts of different numerical methods.
7	Course Description	This course is an introduction to the fundamentals of Ordinary and partial differential equations, Integral transformations, complex variables, statistics and numerical analysis. The main objective of the course is to develop the basic understanding of differential equations, Fourier and Laplace Transforms, complex variables and numerical methods.
8	Outline syllabus	Mathematical Physics
	Unit 1	**Ordinary Differential Equations**
	A	Linear ordinary differential equations of first & second order.
	B	Series solution of differential equation, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Green's function
	C	Partial differential equations (Laplace, wave and heat equations in two and three dimensions)
	Unit 2	**Fourier series, Fourier and Laplace transforms**
	A	Fourier series, Fourier series in change of interval, Half range sine and cosine series. Transform.
	B	Fourier Transforms, Fourier Cosine and sine Transform, properties of Fourier
	C	Laplace transform of some standard functions and its properties, Inverse Laplace transform and Convolution theorem

	Unit 3	**Complex Analysis**		
	A	Elements of complex analysis, analytic functions.		
	B	Taylor & Laurent series.		
	C	Poles, residues and evaluation of integrals.		
	Unit 4	**Probability and Statistics**		
	A	Elementary probability theory, random variables.		
	B	Binomial, Poisson and normal distributions		
	C	Central limit theorem.		
	Unit 5	**Numerical Techniques**		
	A	Elements of computational techniques: root of functions, interpolation, extrapolation.		
	B	Integration by trapezoidal and Simpson's rule.		
	C	Solution of first order differential equation using Runge-Kutta method and Finite difference method		
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		30%	20%	50%
	Text book/s*	1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons Inc. 2. Jain, M.K., and Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa Publications		
	Other References	**1.** S.L. Ross, " Differential Equations" , John Willey & Sons Inc. **2.** S. C. Gupta and V. K. Kapoor: Fundamentals of Mathematical Statistics: Sultan Chand and Sons.		

School: SBSR		**Batch : 2020-2022**
Program: MSc (Physics)		**Current Academic Year: 2020-21**
Branch:		**Semester: I**
1	Course Code	MPH 120
2	Course Title	Quantum Mechanics
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. pinpoint the historical aspects of development of quantum mechanics, understand the uncertainty, dirac notations 2. relations understand and explain the differences between classical and quantum mechanics, understand the idea of wave function 3. solve Schrodinger equation for simple potentials 4. spot, identify and relate the eigenvalue problems for energy, momentum, angular momentum and central potentials.
6	Course Outcomes	After the completion of this course, the student will be able to CO1 understanding and relating the events which led toward the development of quantum mechanics CO2 understanding the basic principles of wave mechanics CO3 relating the knowledge of mathematics to the formalism of quantum mechanics CO4 ability to solve simple problems exactly CO5 adapting the gained knowledge to be implement. CO6 Understanding the concept of Quantum Mechanics and its application for real problems
7	Course Description	The course is a one semester course on Quantum Mechanics at the M.Sc. Level. It will start with an introduction to Dirac notations, uncertainty principle, postulates of Quantum Mechanics, Matrix representation of State Vectors, operators, derivation of Schrodinger equation, its application to simple potentials, hydrogen atom, Bohr radius, Schrodinger and Heisenberg pictures in quantum mechanics and their applications to Harmonic Oscillator
8	Outline syllabus	
	Unit 1	
	A	Introduction to the course and Prerequisite required, Linear vector space – State space, Dirac notation and Representation of State Spaces, Concept of Kets, Bras and Operators
	B	Expectation Values, Superposition Principle, Orthogonality, Completeness, Expansion of State Vector, Non commutating Observables
	C	Commutation and Compatibility, Change of basis, Unitary operators. Generalized Uncertainty Relations, Ehrenfest theorem
	Unit 2	

	A	Postulates of Quantum mechanics, State function and its interpretation
	B	Wave-function in coordinate and momentum representations, Expansion of a State Function.... and Superposition of states
	C	Matrix representation of State Vectors and operators, Continuous Basis, Relation between a State Vector and its wave function
	Unit 3	
	A	Schrödinger equation and its applications- In one dimensional consideration: Schrödinger equation (time-dependent and time-independent).
	B	Eigenvalue problems: Particle in one-dimensional potential well (finite and infinite depth) and its energy states
	C	Solutions of different one-dimensional barriers (finite and infinite width) and penetration problems.
	Unit 4	
	A	Schrödinger equation and its applications in three dimensional consideration: Free particle wave function
	B	Motion of a charged particle in a spherically symmetric field
	C	Energy states associated wave functions of Hydrogen atom; Expression of Bohr radius
	Unit 5	
	A	Schrödinger interaction Pictures in quantum mechanics
	B	Heisenberg interaction Pictures in quantum mechanics
	C	Linear harmonic oscillator: solution of the Linear Harmonic Oscillator with Operator Method, Coherent States
	Mode of examination	Theory

	Weightage Distribution	CA	MTE	ETE
		30%	20%	50%

	Text Book/s	1. Nouredine Zettili, Quantum Mechanics: concepts and applications, John Wiley & Sons (2001) 2. L. Schiff, Quantum Mechanics, Mcgraw-Hill (1968).
	Other References	1. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Pearson Education 2nd Ed. (2004) 2. R. L. Liboff, Introductory Quantum Mechanics, Pearson Education, 4th Ed. (2003). 3. J. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002). 4. K. Gottfried and T-M Yan, Quantum Mechanics: Fundamentals,2nd Ed., Springer (2003). 5. D. J. Griffiths, Introduction to Quantum Mechanics, Pearson Education (2005). 6. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill(1995). 7. F. Schwabl, Quantum Mechanics, Narosa (1998).

School: SBSR		**Batch: 2020-22**
Program: M.Sc.		**Current Academic Year: 2020-21**
Branch: Physics		**Semester: I**
1	Course Code	MPH111
2	Course Title	Classical Mechanics
3	Credits	4
4	Contact Hours(L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. To make the students familiar with the concepts Constraints and generalized coordinates, d' Alembert's principle and virtual work. 2. To understand the concept of Hamilton's principle, Hamilton's canonical equations of motion, cyclic coordinates, Central Forces, Lagrangian and Hamiltonian, em forces, coupled oscillators. 3. To know the concept of Canonical Transformations, Hamilton Jacobi theory, action and angle variables, Small oscillations, principal axis transformation, Degrees of freedom for a rigid body, Euler angles. 4. To understand the concept of Two body central force problem, reduction to the equivalent one body problem, equation of motion and first integral, Virial theorem.
6	Course Outcomes	CO1: Learn the basic concepts of Constraints and generalized coordinates, d' Alembert's principle and virtual work, Euler-Lagrange equations of motion. CO2: Understand the Hamilton's principle, Hamilton's canonical equations of motion, cyclic coordinates, Central Forces – Lagrangian and Hamiltonian, em forces, coupled oscillators. Canonical variables, Poisson's bracket. CO3: Able to explain the Canonical Transformations, Hamilton Jacobi theory, action and angle variables, centre of mass and laboratory systems. CO4: Figure out the Small oscillations, principal axis transformation, normal coordinates and its applications to linear molecules. Degrees of freedom for a rigid body, Foucault's pendulum. CO5: State the concepts of Two body central force problem, reduction to the equivalent one body problem, equation of motion and first integral, Virial theorem. CO6: Analyse the concepts of Lagrangian Formulation, Hamiltonian Formulations, Canonical Transformations, Thoery of Small Oscillations, Two Body Problem.
7	Course Description	This course is about describing the concepts of Lagrangian Formulation, Hamiltonian Formulations, Canonical Transformations, Thoery of Small Oscillations, Two Body Problem.
8	Outline Syllabus	
	Unit 1	**Lagrangian Formulation**
	A	Constraints and generalized coordinates

	B	d' Alembert's principle and virtual work		
	C	Euler-Lagrange equations of motion, variational calculus.		
	Unit 2	**Hamiltonian Formulations**		
	A	Hamilton's principle, Hamilton's canonical equations of motion, cyclic coordinates, Central Forces		
	B	Lagrangian and Hamiltonian, em forces, coupled oscillators		
	C	Canonical variables, Poisson's bracket, Jacobi identity.		
	Unit 3	**Canonical Transformations**		
	A	Canonical Transformations, generators of infinitesimal canonical transformations, symmetry principles and conservation laws		
	B	Hamilton Jacobi theory, action and angle variables		
	C	centre of mass and laboratory systems.		
	Unit 4	**Thoery of Small Oscillations**		
	A	Small oscillations, principal axis transformation, normal coordinates and its applications to linear molecules		
	B	Degrees of freedom for a rigid body, Euler angles, Rotating frame, Coriolis force, Foucault's pendulum		
	C	Eularian coordinates and equations of motion for a rigid body, motion of a symmetrical top.		
	Unit 5	**Two Body Problem**		
	A	Two body central force problem, reduction to the equivalent one body problem		
	B	equation of motion and first integral, Virial theorem		
	C	differential equation of orbit, Kepler problem, precessing orbits.		
	Mode of Examination	Theory		
	Weightage Distribution	CA 30%	MTE 20%	ETE 50%
	Text Book/s	1. Classical Mechanics by H.Goldstein, Narosa Publishing Home, New Delhi. 2. Classical Mechanics by N.C.Rana and P.S.Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.		
	Other References	3. Introduction to Classical Mechanics by R.G.Takawale and P.S.Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi. 4. Classical Mechanics by J.C.Upadhyaya, Himalaya Publishing House.		

School: SBSR		**Batch : 2020- 2022**
Program: M.Sc.		**Current Academic Year: 2020-21**
Branch: Mathematics, Physics, Chemistry		**Semester: I**
1	Course Code	MMT-129
2	**Course Title**	**Introduction to MATLAB and its applications**
3	Credits	3
4	Contact Hours (L-T-P)	2-0-2
	Course Status	Compulsory
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts for MATLAB and cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. Once the foundations of the language have been established students will explore different types of scientific programming problems including curve fitting, ODE solving etc.
6	Course Outcomes	CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K2, K3) CO2: Demonstrate with strings and matrices and their uses. (K2, K3) CO3: Illustrate basic flow controls (if-else, for, while). (K3) CO4: Create plots and export this for use in reports and presentations. (K3, K5) CO5: Develop program scripts and functions using the MATLAB development environment. (K4, K5) CO6: Write the program for evaluates linear system of equations, ordinary differential equations in MATLAB. (K5,K6)
7	Course Description	The course will give the fundamental knowledge and practical abilities in MATLAB required to effectively utilize this tool in technical numerical computations and visualisation in other courses. Syntax and interactive computations, programming in MATLAB using scripts and functions, rudimentary algebra and analysis. One- and two-dimensional graphical presentations. Examples on engineering applications.
8	Outline syllabus	**Introduction to MATLAB and its applications**
	Unit 1	**Introduction**
	A	Vector and matrix generation, Subscripting and the colon notation.
	B	Matrix and array operations and their manipulations,
	C	Introduction to some inbuilt functions.
	Unit 2	**Relational and Logical Operators**
	A	Flow control using various statement and loops including If-End statement, If-Else –End statement
	B	Nested If-Else-End Statement,
	C	For – End and While-End loops with break commands.
	Unit 3	**m-files**

	A	Scripts and functions		
	B	concept of local and global variable		
	C	few examples of in-built functions, editing, saving m-files.		
	Unit 4	**Two dimensional Graphics**		
	A	Basic Plots, Change in axes and annotation in a figure		
	B	multiple plots in a figure		
	C	saving and printing figures		
	Unit 5	**Applications of MATLAB**		
	A	Solving a linear system of equations,		
	B	Curve fitting with polynomials using inbuilt function such as polyfit, solving equations in one variable,		
	C	Solving ordinary differential equations using inbuilt functions		
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		30%	20%	50%
	Text book	An introduction to MATLAB : Amos Gilat		
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill. 2. Getting started with Matlab: RudraPratap		

School: SBSR		Batch: 2020-2022
Program: MSc (Physics)		**Current Academic Year: 2020-21**
Branch:		**Semester: I**
1	Course Code	MPH 155
2	Course Title	**Solid state physics lab**
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
	Course Status	Compulsory
5	Course Objective	1. To Understand the significance and value of solid state physics, both scientifically and practically. 2. To understand laboratory experiments to Interpreting results, error analysis, writing reports and analyzing data. 3. To learn the fundamental properties of semiconductors. 4. Apply key analysis techniques to understand the 5. To understand laboratory experiments to
6	Course Outcomes	CO1: Student will be able to determine the Planck's constant and excitation potential of mercury. CO2: Student will be able conclude the value of the ratio of charge to mass (e/m) of an electron using a cathode-ray tube. CO3: Student will be able to understand the concept of and susceptibility of paramagnetic solution by Quinck`s Tube Method and Energy Band Gap of Semiconductor materials. CO4: Student will be able to understand the Hysteresis loss of Magnetic materials and the dielectric constant of some materials CO5: Student will be able to understand the concept of Hall effect Carrier density and mobility of a semiconductor material. CO6: Student will be able to know the python programming language.
7	Course Description	This course integrates exposure of the theory of Solid State Physics with experimental demonstrations in the Physics Lab. The course will provide a valuable overview of the fundamental applications of the physics of solids.
8	Outline syllabus	
	Unit 1	**Practical related to**
		1. To determine the Planck's constant by measuring radiation in a fixed spectral range. 2. To measure the excitation potential of mercury using the Franck-Hertz method.

	Unit 2	**Practical related to**		
		3. To determine the value of the ratio of charge to mass (e/m) of an electron by Thomson's method using a cathode-ray tube. 4. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method).		
	Unit 3	**Practical related to**		
		5. Understanding basics of GM Counter. 6. Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope.		
	Unit 4	**Practical related to**		
		7. To measure the dielectric constant of some materials. 8. To understand Hall effect and determine Hall co-efficient, Carrier density and mobility of a semiconductor material.		
	Unit 5	**Practical related to**		
		9. Experiment related to python programming language-(1). 10. Experiment related to python programming language-(2).		
	Mode of examination	Practical and Viva		
	Weightage Distribution	CA	MTE	ETE
		60%	0%	40%
	Text book/s*	-		
	Other References			

School: SBSR		**Batch: 2020-2022**
Program: M.Sc.		**Current Academic Year: 2020-2021**
Branch: Physics		**Semester: 1st**
1	Course Code	MPH156
2	Course Title	**Quantum physics lab using scilab software**
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
	Course Status	Compulsory
5	Course Objective	• To Understand Scilab basics • To learn inbuild functions of scilab and will learn to define new function • To verify various physics laws • To solve quantum mechanics problems
6	Course Outcomes	CO1: Learn the Basics of Sci lab, Inbuild functions and plotting CO2: Learn to preserve data, Complex and Character data, string function, Multidimensional arrays CO3: Able to write the program for Hookes law, spring constant and Classical equation of motion: harmonic oscillator (low, moderate & high damping case) CO4: Able to solve Schrodinger equation for the ground and excited state of an atom and to find their energies and to plot corresponding wavefunctions in scilab CO5: Able to solve the Schrodinger equation for hydrogen atom in sci lab CO6: Learn physics concepts via writing scilab programs.
7	Course Description	This course is about to understand Scilab basics, to learn inbuild functions of scilab and will learn to define new function, to verify various physics laws and to solve quantum mechanics problems.
8	Outline syllabus: This course is about to understand Scilab basics, to learn inbuild functions of scilab and will learn to define new function, to verify various physics laws and to solve quantum mechanics problems.	
	Unit 1	**Practical based on Basics of Sci lab, Inbuild functions and plotting**
		Sub unit – a: Introduction to Scilab, Command window, Figure window, Edit window, Variables and arrays, Initializing variables in Scilab
		Sub Unit b:Multidimensional arrays, Sub-array, Special values, Displaying output data, data file, Scalar and array operations, Hierararchy of operations, Built in Scilab functions,
		Sub Unit c: Introduction to plotting, 2D and 3D plotting, Branching Statements and program design, Relational and logical operators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization. User defined functions
	Unit 2	**Practical related to lean to preserve data, Complex and Character data, string function, Multidimensional arrays**
		Sub unit - a, Introduction to Scilab functions, Variable passing in Scilab,

		optional arguements, preserving data between calls to a function,
		Sub Unit b: Complex and Character data, string function, Multidimensional arrays an introduction to Scilab file processing, file opening and closing,
		Sub Unit c: Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program
	Unit 3	**Practical related to write the program for Hookes law, spring constant and Classical equation of motion: harmonic oscillator (low, moderate & high damping case**
		Sub unit - a, Sci-lab program of following physical relations: Hookes law, Calculate spring constant, Classical equations of motion,
		Sub Unit b: Harmonic oscillator (no friction) Damped Harmonic oscillator (i) Overdamped (ii) Critical damped (iii) Oscillatory
		Sub Unit c: Forced Harmonic oscillator (i) Transient and (ii) Steady state solution
	Unit 4	**Practical related to solve Schrodinger equation for the ground and excited state of an atom and to find their energies and to plot corresponding wavefunctions**
		Sub unit – a Solve the s wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511×10^6 eV/c^2
		Sub Unit b & c: Solve the s-wave radial Schrodinger equation for an atom. Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential. Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511×10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases
	Unit 5	**Practical related to solve Schrodinger equation for hydrogen atom**
		Sub unit – a: Solve the s-wave radial Schrodinger equation for a particle of mass m. For the anharmonic oscillator potential for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases
		Sub Unit b & c: Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule. Where μ is the reduced mass of the two-atom system for the Morse potential. Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: m = 940x106 eV/C^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

	Mode of examination	Practical		
	Weightage Distribution	CA	MTE	ETE
		60%	0%	40%
	Text book/s*	• Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.		
	Other References	• A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press • Getting started with Matlab, Rudra Pratap, 2010, Oxford University Press		

School: SBSR		**Batch : 2020-2022**
Program: M.Sc		**Current Academic Year: 2020-2021**
Branch: Physics		**Semester: II**
1	Course Code	MPH115
2	Course Title	Renewable Energy Sources
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. To know the importance of Physics and Materials Science. 2. To utilize the various synthesis procedure to develop materials. 3. To explain the practical application of materials in various area
6	Course Outcomes	CO1: Learn the basics of Materials/Technology CO2: Understand the correlation between Applied science and Technology CO3: Apply the concept of materials and technology at certain levels. CO4: Develop devices using materials. CO5: Create the path to handle materials. CO6: Expertise in various tools will make a bridge between industry and students and find out the platform for employment in high tech industries
7	Course Description	This course is based on renewable energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy often provides energy in four important areas: electricity generation, air and water heating/cooling, transportation, and rural (off-grid) energy services
8	Outline syllabus	
	Unit 1	**Natural and Renewable Energy Resources**
	A	Natural resources and associated problems, Forest, Water, Mineral, Food, Energy and Land resources
	B	Use and over-exploitation, Concept of an ecosystem, Environmental Pollution, Nuclear hazards
	C	Renewable Energy sources: Definition and types of renewable sources, Wind, Ocean, Geothermal, Biomass, Hydro as renewable energy resources
	Unit 2	**Solar Energy: Fundamental and Material Aspects**
	A	Fundamentals of photovoltaic Energy Conversion Physics and Material Properties, Types of solar energy conversion
	B	solar thermal: basics and design of water heaters, solar ponds, Basic to Photovoltaic Energy Conversion: Optical properties of Solids
	C	Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carriers.
	Unit 3	**Solar Energy: Different Types of Solar Cells**
	A	Types of Solar Cells, p-n junction solar cell, Transport Equation, Current Density, Open circuit voltage and short circuit current

	B	Brief description of single crystal silicon and organic and Polymer Solar Cells, Elementary Ideas of Advanced Solar Cells e.g. Tandem Solar cells, Solid Liquid Junction Solar Cells
	C	Nature of Semiconductor, Principles of Photo-electrochemical Solar Cells.
	Unit 4	**Hydrogen Energy: Fundamentals, Production and Storage**
	A	Hydrogen as a source of energy, Solar Hydrogen through Photoelectrolysis, Physics of material characteristics for production of Solar Hydrogen
	B	Brief discussion of various storage processes, special features of solid hydrogen storage materials
	C	Structural and electronic characteristics of storage material, New Storage Modes.
	Unit 5	**Hydrogen Energy: Safety and Utilization**
	A	Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation
	B	Fuel Cells, Various type of Fuel Cells, Applications of Fuel Cell
	C	Elementary concepts of other Hydrogen- Based devices such as Hydride Batteries
	Mode of examination	Theory
	Weightage Distribution	CA: 30%, MTE: 20%, ETE: 50%
	Text book/s*	1.Fundamentals of Solar Cells Photovoltaic Solar Energy :Fahrenbruch&Bube
	Other References	1.Solar Cell Devices-Physics :Fonash 2. Phoptoelectrochemical Solar Cells: Chandra 3. Hydrogen as an Energy Carrier Technologies Systems Economy : Winter &Nitch (Eds.) 4. Hydrogen as a Future EngeryCarrier : Andreas Zuttel, Andreas Borgschulte and Louis Schlapbach

School: SBSR		**Batch: 2020-2022**
Program: M.Sc.		**Current Academic Year: 2020-21**
Branch: Physics		**Semester: II**
1	Course Code	MPH113
2	Course Title	Electronics
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1.To make students aware of Physics of semiconductors. 2. To impart the in depth knowledge of electronic devices like amplifiers, op-amp, oscillators etc. 3. To give the idea of digital electronics.
6	Course Outcomes	After the completion of this course, the student will be able to CO1: understand the physics and underlying phenomena in semiconductors. CO2: know the working of transistor and use it as amplifier CO3: use operational amplifier as mathematical operator. CO4: appreciate the working of oscillators and its applications. CO5: understand the components of digital electronics like flipflops, counters, converters, decoders etc. CO6: appreciate the physics of semiconductors and will be able to apply the concept on various devices.
7	Course description	This course teaches the students about the physics of the semiconductor materials and then how to apply this knowledge in understanding the working of various devices like transistors, op-amps, oscillators and digital electronics.
8	Outline Syllabus	
	Unit 1	**Review of Semiconductors**
	A	Energy bands, Intrinsic and extrinsic semiconductors, direct and indirect band gap semiconductors, concept of density of states and Fermi-level
	B	carrier concentrations at equilibrium, Temperature dependence of carrier concentrations and mobility, carrier generation and recombination
	C	Continuity equation, p-n junction : qualitative description of current flow, Small signal of model of p-n junction
	Unit 2	**Transistor as Amplifier**
	A	Transistor action, Charge transport and amplification, Minority carrier distributions and terminal currents
	B	Base width modulation, Ebers – Moll Model, Hybrid pi model, RC coupled transistor amplifier
	C	Multi-stage transistor amplifier, Frequency response, negative feedback
	Unit 3	**Operational Amplifier**
	A	Review of Op-amps, current mirror, input impedance of OP-AMP
	B	OP-AMP parameters and their frequency response, Differential amplifier, transfer characteristics of a differential amplifier
	C	Comparators (Schmitt trigger) and F to V and V to F Converters

	Unit 4	**Oscillators**
	A	Positive feedback, conditions for oscillation
	B	Phase shift oscillator, Multivibrators: types of multi-vibrators
	C	timer 555: block diagram and operations, applications
	Unit 5	**Digital Electronics**
	A	Review of Flipflops, Asynchronous and synchronous Counter
	B	Mod counters, Ring counters, Shift Registers (SISO, SIPO, PISO, PIPO), A to D and D to A converter
	C	Multiplexer, Demultiplexer, Decoder, Encoder
	Mode of Examination	Theory
	Weightage Distribution	CA 30% / MTE 20% / ETE 50%
	Text Book/s	1. Solid State Electronic Devices- Streetman and Banerjee, Pearson Education. 2. Integrated Electronics- Millman - Halkias, Tata Mc Graw Hill.
	Other References	1. Electronic Devices and Circuit Theory- Robert Boylestad and Louis Nashelsky, Prentice Hall. 2. Digital Electronics, Malvino and Leech Prentice Hall of INdia 3. Op-amp and Linear Integrated Circuits by – R.A.Gayakwad 4. Op-amp and Circuits by – Coughlin and Driscoll 5. Digital electronics by Floyd.

School: SBSR		Batch: 2020-2022
Program: MSc		**Current Academic Year: 2020-2021**
Branch: Physics		**Semester: 1I**
1	**Course Code**	**MPH 117**
2	**Course Title**	**Statistical Mechanics**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	Course Status	**Compulsory**
5	**Course Objective**	This course aims: 1. To establish a foundation in Statistical mechanics. 2. To impart the concept of phase space ensembles, the distinction between distinguishable and indistinguishable particles. 3. To provide detailed understanding of Bose Einstein statistics and Fermi-Dirac statistics. 4. Introduction to random walk, diffusion, Landau theory of phase transitions and Ising model.
6	**Course Outcomes**	**Upon successful completion of this course, the student will be able to:** CO1: acquire knowledge of phase space, ensembles, Liouville's theorem and phase space Introduction to random walk, diffusion, Landau theory of phase transitions and Ising model. volume. CO2: understand the concepts of Boltzmann entropy, Boltzmann statistics, equipartition of energy and apply them to equilibrium properties of ideal systems. CO3: learn fundamentals of Bose-Einstein statistics and its properties apply it in solving the problems. CO4: learn the concept of Fermi Dirac Statistics and its properties. CO5: develop an understanding of diffusion, random walk, and second order phase transitions. CO6: understand, analyze and apply the concept of statistical mechanics to various problems which help to explain the behavior of large systems.
7	**Course Description**	This course introduces the various concepts, methods and terminologies of statistical mechanics that are further used to develop the statistics for Bose-Einstein, Fermi-Dirac etc. Statistical Mechanics can be used to explain the thermodynamic behavior of large system.
8	Outline syllabus	
	Unit 1	**Review of Classical Statistics**
	A	Review of the ideas of phase space, phase points; Micro canonical, canonical and grand canonical Ensembles.
	B	Density of phase points, Partition function formulation (for Distinguishable and Indistinguishable particles.
	C	Liouville's equation and Liouville's theorem.
	Unit 2	**Basic Concepts of Classical Statistics**

	A	Law of equi-partition of energy and its application to specific heat and its limitations
	B	Equilibrium properties of ideal systems: ideal gas, Harmonic oscillators
	C	Rigid rotators, Para magnetism. Chemical potential.
	Unit 3	**Bose Einstein Statistics**
	A	B-E distribution function, properties of ideal Bose gas, Photon Gas, Bose Einstein Condensation
	B	Properties of liquid He (qualitative treatment), Transition in liquid He^4, Superfluidity in He^4.
	C	Radiation as photon gas and thermodynamic functions of photon gas, Bose derivation of Planck's Law.
	Unit 4	**Fermi Dirac Statistics**
	A	F-D distribution function, properties of ideal Fermi gas, Completely and Strongly degenerate Fermi gas.
	B	Fermi energy, Fermi level, Equivalence of Fermi level and the electrochemical potential, Chemical potential of the fermion.
	C	Specific heat of metals, White dwarf stars, Chandrashekhar mass limit for white dwarf stars.
	Unit 5	**Diffusion, Random walk and Phase Transitions**
	A	Diffusion equation, Random walk
	B	First and second order phase transitions, Landau theory
	C	1-D Ising model, Graphical explanation of Ising model of ferromagnetism.
	Mode of examination	Theory/Jury/Practical/Viva
	Weightage Distribution	CA: 30% · MTE: 20% · ETE: 50%
	Text book/s*	• Statistical Physics by F Reif (Tata McGraw-Hill Company Ltd, 2008) • Statistical Mechanics, R.K. Patharia, Pergamin press, Oxford. • Statistical Mechanics by K. Huang, Wiley and sons. • Statistical Mechanics and dynamics by Henry J. Eyring, Wiley and sons. • Fundamentals of classical and statistical thermodynamics, Bimalendu N. Roy, Wiley
	Other References	• Thermal Physics, S. C. Garg, R. M. Bansal, C. K. Ghosh, Tata McGraw-Hill • Thermodynamics and Statistical Mechanics, Greiner, Springer • Statistical and Thermal Physics: an introduction by S.Lokanathan and R.S.Gambhir.

School: SBSR		**Batch : 2020-22**
Program:MSc (Physics)		**Current Academic Year: 2020-21**
Branch:		**Semester: II**
1	Course Code	MPH 123
2	Course Title	Atomic, molecular physics and spectroscopic techniques
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course Status	Compulsory
5	Course Objective	1. To know concept of atomic physics of one electron atom 2. To understand concept of atomic physics of many electron atom 3. To understand effect of magnetic and electric field on an atom. 4. To understand the concept of molecular Physics. 5. To understand the working principle of spectroscopic techniques.
6	Course Outcomes	After the completion of this course, the student will be able to CO123.1: know about different atom model and will be able to differentiate different atomic systems, different coupling schemes, Discuss the relativistic corrections for the energy levels of the hydrogen atom and their effect on optical spectra CO123.2: Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields CO123.3: Discuss the importance of spin orbit interactions. CO123.4: State and justify the selection rules for various optical spectroscopies in terms of the symmetries of molecular vibrations CO123.5: Identify the basic components of spectroscopic instrumentation. Demonstrate a working knowledge of IR, NMR, ESR and Mossbauer spectroscopy. CO123.6: Understanding spectroscopy the way other common tools of measurement like the watch or the ruler are understood and also understanding basic concepts of instrumentation, data acquisition and data processing.
7	Course Description	This course addresses various aspects of spectroscopic analysis relevant to both research and industry. Students will learn the relative merits of the techniques, the operating principles, and develop problem solving skills generally useful in chemical analysis. The objectives of this subject are to provide students with an increased knowledge of advanced principles, with emphasis on: - understanding how light interacts with matter and how it can be used to quantitatively understand samples. - understanding spectroscopy the way other common tools of measurement like the watch or the ruler are understood

		- seeing that spectroscopy is a set of tools that can put be together in different ways to understand systems and solve problems - understanding basic concepts of instrumentation, data acquisition and data processing.
8	Outline syllabus	
	Unit 1	**Fine and Hyperfine Structure**
	A	General discussion in Hydrogen spectra, Hydrogen-like systems, Spectra of monovalent atoms
	B	Introduction to electron spin, spin-orbit interaction and fine structure, relativistic correction to spectra of hydrogen atom, Selection rules; Lamb shift.
	C	Effect of external magnetic field - Strong, moderate and weak field. Hyperfine interaction and isotope shift; Hyperfine splitting of spectral lines; Broadening of spectral lines.
	Unit 2	**Many Electron Atom**
	A	Independent particle model; He atom as an example of central field approximation; Central field approximation for many electron atom;
	B	Slater determinant; L-S and j-j coupling; Equivalent and nonequivalent electrons
	C	Energy levels and spectra; Spectroscopic terms; Hunds rule; Lande interval rule; Alkali spectra.
	Unit 3	**Rotational and Vibrational Spectra**
	A	Concept of molecular potential, Born-Oppenheimer approximation and separation of electronic and nuclear motions in molecules
	B	Band structures of molecular spectra. Molecular rotation: Energy levels of diatomic molecules under rigid rotator and non-rigid rotator models, Selection rules, Spectral structure, Structure determination
	C	Isotope effect, Centrifugal distortion, Symmetric top molecules, Molecular vibrations: Harmonic oscillator and the anharmonic oscillator approximation, Morse potential. Vibration-rotation spectra: Pure vibrational transitions, Pure rotational transitions, Vibration-rotation transitions.
	Unit 4	**Electronic and Raman Spectra**
	A	Electronic transitions: Franck-Condon principle, Rotational structure of electronic transitions
	B	Dissociation energy of molecules, Continuous spectra
	C	Raman transitions and Raman spectra, Characteristics of Raman Lines, Stoke’s and Anti-Stoke’s Lines, Complimentary Character of Raman and infrared Spectra.
	Unit 5	**Basic Aspects of Photo Physical Processes**
	A	Radiative and non-radiative transitions; fluorescence and phosphorescence
	B	Nuclear Magnetic resonance spectroscopy. Electron spin resonance spectroscopy
	C	Mossbauer spectroscopy.
	Mode of examination	Theory

	Weightage Distribution	CA	MTE	ETE
		30%	20%	50%
	Text Book/s	1. Introduction of atomic spectroscopy: White 2. C. L. Banwell and E. M. McCash. 'Fundamentals of Molecular Spectroscopy' Tata- McGraw-Hill.		
	Other References	8. G. Herzberg. 'Molecular Spectroscopy (Diatomic Molecules)' Van-Nostrand. 9. G. M. Barrow. 'Molecular Spectroscopy'. McGraw-Hill. 10. J.Michael Hollas. ' Modern spectroscopy'. John-Wiley & sons. 11. G.Aruldhas 'Molecular Spectroscopy'. 12. Bransden and Joachin. 'Atoms and Molecules'		

School: School of Basic Sciences and Research		**Batch:2020-2022**
Program: M. Sc		**Current Academic Year: 2020-2021**
Branch: Physics		**Semester: II**
1	Course Code	MPH 122
2	Course Title	Advance Quantum Mechanics
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. The course should give the in depth knowledge about the foundations of quantum mechanics and skills in problem solving in quantum mechanics. 2. Various approximation methods for not exactly solvable systems. 3. To know the concept of angular momentum and scattering. 4. The course treats non-relativistic quantum mechanics, in detail and gives an introduction to relativistic quantum mechanics.
6	Course Outcomes	After the completion of this course students will be able to: CO 1: Explain orbital and spin momentum operator formalism. CO 2: Demonstrate the time independent perturbation theory. CO 3: Explain the variational and WKB methods. CO 4: Apply the scattering theory to various problems. CO 5: Explain the relativistic quantum mechanics. CO 6: Comprehend quantum mechanical applications at the research level
7	Course description	"Advanced Quantum Mechanics" is a core continuation course in quantum mechanics including angular momentum, approximate methods, scattering theory and relativistic quantum mechanics that aim at the applications of quantum mechanics. The course should give you deeper knowledge about the foundations of quantum mechanics and skills in problem solving in quantum mechanics.
8	Outline Syllabus	
	Unit 1	**Angular Momentum**
	A	Generalized angular momentum, Infinitesimal rotation, Generator of rotation, Commutation rules, Matrix representation of angular momentum operators
	B	Spin, Pauli spin matrices, Rotation of spin states
	C	Coupling of two angular momentum operators, Clebsch Gordon coefficients, Applications
	Unit 2	**Approximate methods: Time Independent Perturbation Theory**
	A	Approximation methods: Time-independent perturbation theory for non-degenerate states,
	B	Approximation methods: Time-independent perturbation theory for degenerate states,
	C	Time independent perturbation theory Applications: anharmonic oscillator,

		Helium atom, Stark effect in hydrogen atom.
	Unit 3	**Approximation Methods: Time dependent perturbation, variational and WKB methods**
	A	Time-dependent perturbation theory; Harmonic perturbation; Fermi's golden rule. Sudden approximation.
	B	Variational method and its applications (1-D harmonic oscillator, ground state energy of Hydrogen atom),
	C	WKB approximation and application to 1-D harmonic oscillator, WKB method; Connection formula,
	Unit 4	**Scattering Theory**
	A	Scattering theory- Scattering of a particle by a fixed centre of force, scattering amplitude differential and total cross sections,
	B	Method of partial waves, Phase shifts, Optical theorem, Scattering by a hard sphere and potential well
	C	Integral equation for potential scattering, Green's function, Born approximation, Yukawa and Coulomb potential.
	Unit 5	**Relativistic quantum mechanics**
	A	Introduction to Relativistic quantum mechanics
	B	Klein-Gordon and Dirac equations,
	C	Semi-classical theory of radiation.
	Mode of Examination	Theory
	Weightage Distribution	CA: 30%; MTE: 20%; ETE: 50%
	Text books	1. Quantum Mechanics by L.I. Schiff 2. Quantum mechanics – concepts and applications by N. Zettili.
	Other References	1. Modern quantum mechanics by J.J. Sakurai and San Fu Tuan 2. Introductory Quantum Mechanics, R. L. Liboff, Addison-Wesley. 3. Principles of Quantum Mechanics, R. Shankar.

SCHOOL: SBSR		**Batch :2020-2022**
Program: M. Sc		**Current Academic Year: 2020-21**
Branch: Physics		**Semester: II**
1	**Course Number**	**Course Code: CCU 401/ Course ID: 30804**
2	**Course Title**	**Community Connect**
3	**Credits**	**2**
4	**(L-T-P)**	**(0-0-2)**
5	**Learning Hours**	Contact Hours: 30 Project/Field Work: 20 Assessment: 00 Guided Study: 10 Total hours: 60
6	**Course Objectives**	1. **Contribute to the holistic development of students** by making them more aware of socially and economically disadvantaged communities and their specific issues 2. **Provide more richer context to classrooms**, so as to make them more effective laboratories of learning by aligning them to social realities beyond textbooks 3. **Provide scope to faculty members to align their teaching and research goals** by giving them ample opportunity to carry out community -oriented projects 4. **Ensure that the community connect programs provides benefits to communities** in tangible ways so that they may feel perceptibly better off post the interaction and involvement of the Sharda academic community 5. **Provide ample opportunity for Sharda University academic community to contribute** effectively to society and nation building
7	**Course Outcomes**	After completion of this course students will be able to: **CO1:** Students learn to be sensitive to the living challenges of disadvantaged communities. **CO2:** Students learn to appreciate societal realities beyond textbooks and classrooms **CO3:** Students learn to apply their knowledge via research, and training for community benefit

		CO4: Students learn to work on socio-economic projects with teamwork and timely delivery **CO5:** Students learn to engage with communities for meaningful contribution to society
8	**Theme**	**Major themes for research:** 1. ***Survey and self-learning***: In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc. 2. ***Survey and solution providing***: In this mode, students will identify the common problems and will provide solution/ educate rural population. E.g. air and water pollution, need of after treatment, use of renewable (mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture etc. 3. ***Survey and reporting***: In this mode students will educate villagers and survey the ground level status of various government schemes meant for rural development. The analyzed results will be reported to concerned agencies which will help them for taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana, Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri FasalBima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Program,BetiBachao, BetiPadhao Yojana, DeenDayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL Discom Assurance Yojana, PAHAL,Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima Yojana, UDAN scheme, DeenDayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri SurakshitMatritva Abhiyan, Pradhan Mantri RojgarProtsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri Matritva Vandana Yojana, and Ayushman Bharat Yojana.

<table>
<tr><td>9.1</td><td><u>Guidelines for Faculty Members</u></td><td>It will be a group assignment.
There should be not more than 10 students in each group.
The faculty guide will guide the students and approve the project title and help the student in preparing the questionnaire and final report.
The questionnaire should be well design and it should carry at least 20 questions (Including demographic questions).
The faculty will guide the student to prepare the PPT.
The topic of the research should be related to social, economical or environmental issues concerning the common man.
The report should contain 2,500 to 3,000 words and relevant charts, tables and photographs.
Plagiarism check of the report must.
ETE will conduct out of 100, divided in three parts (i) 30 Marks for report (ii) 30 Marks for presentation (iii) 40 Marks for knowledge.
The student should submit the report to CCC-Coordinator signed by the faculty guide by …………………
The students have to send the hard copy of the report and PPT, and then only they will be allowed for ETE.</td></tr>
<tr><td>9.2</td><td>Role of CCC-Coordinator</td><td>The CCC Coordinator will supervise the whole process and assign students to faculty members.
1. PG- M.Sc.-Semester II - the students will be allocated to faculty member (mentors/faculty member) in odd term.</td></tr>
<tr><td>9.3</td><td>Layout of the Report</td><td>Abstract (250 words)
a. Introduction
b. Literature review(optional)
c. Objective of the research
d. Research Methodology
e. Finding and discussion
f. Conclusion and recommendation
g. References

Note: Research report should base on primary data.</td></tr>
<tr><td>9.4</td><td>Guideline for Report Writing</td><td>Title Page: The following elements must be included:
• Title of the article;
• Name(s) and initial(s) of author(s), preferably with first names spelled out;
• Affiliation(s) of author(s);
• Name of the faculty guide and Co-guide
Abstract: Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper.
Text:Manuscripts should be submitted in Word.</td></tr>
</table>

		• Use a normal, plain font (e.g., 12-point Times Roman) for text. • Use italics for emphasis. • *Use the automatic page numbering function to number the pages.* • *Save your file in docx format* (Word 2007 or higher) or doc format (older Word versions) **Reference list:** The list of references should only include works that are cited in the text and that have been published or accepted for publication. The entries in the list should be in alphabetical order. Journal article Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995) Article by DOI Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z Book Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992) Book chapter Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002) Online document Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007 Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see www.issn.org/2-22661-LTWA-online.php For authors using EndNote, Springer provides an output style that supports the formatting of in-text citations and reference list. EndNote style (zip, 2 kB) **Tables:All tables are to be numbered using Arabic numerals.** **Figure Numbering: All figures are to be numbered using Arabic numerals**.
9.5	**Format:**	**The report should be Spiral/ hardbound** The Design of the Cover page to report will be given by the Coordinator-CCC Cover page Acknowledgement Content Project report Appendices
9.6	**Important**	Students should prepare questionnaire and get it approved by concern

	Dates:	faculty member and submit the final questionnaire within ……………….to CCC- Coordinator. Students will complete their survey work within ………….. and submit the same to concern faculty member. (Each group should complete 50 questionnaires) The student should show the 1st draft of the report to concern faculty member within …………….. and submit the same to concern faculty member. Faculty members should give required inputs, so that students can improve their project work and make the final report submission on ……………….. The students should submit the hard copy and soft copy of the report to CCC-Coordinator signed by the faculty guide within ………………. **The students should submit the soft copy of the PPT to CCC-Coordinator signed by the faculty guide within** …………………. **The final presentation will be organized on ………………...**
9.7	**ETE**	**The students will be evaluated by panel of faculty members on the basis of their presentation on …………………**

10	**Course Evaluation**	
10.01	**Continuous Assessment**	**60%**
	Questionnaire design	**20 Marks**
	Report Writing	**40 Marks**
10.02	**ETE (PPT presentation)**	**40%**

School: School of Basic Sciences and Research		**Batch: 2020-2022**
Program: MSc		**Current Academic Year: 2020-2021**
Branch: Physics		**Semester: II**
1	Course Code	MPH 157
2	Course Title	Physics Lab 3 (Electronics Lab)
3	Credits	2
4	Contact Hours (L-T-P)	0-0-6
	Course Status	Compulsory
5	Course Objective	1.To gain practical knowledge of electronics experiments 2.To study basic electronic components 3.To observe the characteristics of the OpAmp, different types of FETs and Flipflops. 4. To study amplitude modulation demodulation.
6	Course Outcomes	After successful completion of this course the students will/will be able to: **CO1:** Acquire knowledge of Operational amplifier and will be able to construct various circuits using ICs and different components. **CO2:** Analyze the characteristics and various operations of the OpAmp. **CO3:** Determine the parameters of JFET. **CO4:** Determine characteristics of MOSFET, UJT. **CO5:** Build various Flip-Flops, shift registers etc. **CO6:** Use equations/theoretical concept to verify the experimental results with ability to conduct, analyze and interpret experiments
7	Course Description	This course is designed to provide students with lab experience in designing various electronic circuits, study their characteristics and analyze the results.
8	Outline syllabus	
	Unit 1	
	A	1. To calculate the Operational Amplifier parameter common mode rejection ratio (CMRR) 2. To study the Operational Amplifier as a negative feedback amplifier
	B	
	C	
	Unit 2	
	A	3. To study the Operational Amplifier as Adder and Subtractor 4. To study Amplitude Modulation and Demodulation
	B	
	C	
	Unit 3	
	A	5. To draw the static characteristics of a junction field effect transistor (JFET) and hence to determine its parameters. 6. To study the characteristics of a MOSFET.
	B	
	C	

	Unit 4			
	A	**7.** To study the characteristics of a Uni-junction Transistor (UJT). 8. To build JK Master-slave flip-flop using Flip-Flop ICs		
	B			
	C			
	Unit 5			
	A	**9.** To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram. **10.** To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.		
	B			
	C			
	Mode of examination	Practical/Viva		
	Weightage Distribution	CA	MTE	ETE
		60%	0%	40%
	Text book/s*	1. Basic electronics and linear circuits – N N Bhargava, D C Kulshreshtha, S C Gupta, Tata McGraw-Hill publishing company Ltd. 2. Linear Integrated Circuits- D Choudhary Roy		
	Other References	1. Practical Physics- C L Arora, S. Chand Publishing 2. Lab Manual		

School: SBSR		**Batch: 2020-2022**
Program: MSc (Physics)		**Current Academic Year: 2020-21**
Branch:		**Semester: II**
1	Course Code	MPH 158
2	Course Title	Physics Lab 4 **(Nuclear lab)**
3	Credits	2
4	Contact Hours (L-T-P)	0-0-6
	Course Status	Compulsory
5	Course Objective	• To understand laboratory experiments to Interpreting results, error analysis, writing reports and analyzing data. • To develop a sense of understanding of statistical mechanics • To develop working knowledge of Nuclear physics • To have understanding of software scilab
6	Course Outcomes	CO1: Students will be able to understand the particle nature of light. CO2: Students will be able to use scilab for understanding the basic important laws of statistical and nuclear physics CO3: Students learn to plot Planck's law of Black body radiation, Rayliegh Jeans law, Specific Heats of Solids etc. CO4: Students will learn plotting different functions (a) Maxwell-Boltzmann distribution b) Fermi-Dirac distribution c) Bose-Einstein distribution with energy. CO5: Students will be able to understand the statistics of the nuclear counting and show that the mean, variance, and standard deviation follow Poisson distribution and the mean value (N) is equal to the variance (σ^2) CO6: Students will learn how to use GM counter and its applications in determination of its operating voltage, plateau length / slope, Verification of Inverse Square Law for γ rays, estimate the efficiency of the GM counter, determine the range and maximum energy of beta particle using half thickness method. And backscattering of beta particles.
7	Course Description	This course integrates exposure of the theory of Statistical and Nuclear Physics with experimental demonstrations in the Physics Lab. The course will provide a valuable understanding of software scilab and its use to understand the basic concepts of Statistical Mechanics.
8	Outline syllabus	
	Unit 1	**Practical based on semi-conductors**
		1. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature. 2. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein

		distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.
	Unit 2	**Practical related to --**
		3.Plot the following functions with energy at different temperatures a) Maxwell-Boltzmann distribution b) Fermi-Dirac distribution c) Bose-Einstein distribution 4.To study the statistics of the nuclear counting and show that the mean, variance, and standard deviation follow Poisson distribution and the mean value (N) is equal to the variance (σ^2).
	Unit 3	**Practical related to---**
		Understanding the basics of GM counter and its Applications. 5. Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope.
	Unit 4	**Practical related to---**
		6. Verification of Inverse Square Law for γ rays. 7. To estimate the efficiency of the GM counter.
	Unit 5	**Practical related to---**
		8. To determine the range and maximum energy of beta particle using half thickness method. 9. To study backscattering of beta particles.
	Mode of examination	Practical/Viva

	Weightage Distribution	CA	MTE	ETE
		60%	0%	40%
	Text book/s*	-		

School: SBSR		**Batch : 2020-22**
Program:MSc (Physics)		**Current Academic Year: 2021-22**
Branch:		**Semester: III**
1	Course Code	MPH 204
2	Course Title	Electromagnetics
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. To know concept of electrostatics, magnetostatics and electromagnetism. 2. To understand the propagation of electromagnetic waves. 3. To utilize the laws of electromagnetism on various problems. 4. To explain the practical application of electromagnetism and electromagnetic waves.
6	Course Outcomes	After the completion of this course, the student will be able to CO1: Learn the concepts of electromagnetism. CO2: Learn the .basic concepts of electromagnetic waves CO3: Understand the reflection and transmission of e. m waves CO4: Apply the concept of electromagnetism at certain levels. CO5: Apply the concept of relativistic electrodynamics at certain levels. CO6: Understand the application of electromagnetics on real problems.
7	Course Description	The course is a one semester advanced course on Electrodynamics at the M.Sc. Level. It will start by revising the behaviour of electric and magnetic fields, in vacuum as well as matter, and casting it in the language of scalar and vector potentials. Writing Maxwell equations in the same language will lead to the analysis of electromagnetic waves, their propagation, scattering and radiation. Special relativity will be introduced, which will allow the covariant formulation of Maxwell's equations and the Lagrangian formulation of electrodynamics. Relativistic motion of charges in electromagnetic fields, and the motion of electromagnetic fields through matter will be covered, with plenty of examples.
8	Outline syllabus	
	Unit 1	**Electrostatics and Magnetostatics**
	A	Introduction to the course and Prerequisite required, Maxwell’s Equations in differential and integral form and their Physical Meaning, Displacement current, Modified Ampere’s Law and explanation of Modified Ampere’s Law.

	B	Scalar and Vector Potential, Poisson and Laplace Equation, Laplace equation in Cartesian, Cylindrical and Spherical co-ordinate system. Brief introduction to all the three Co-ordinate system (Cartesian, Cylindrical and Spherical) and how to relate with each other. Boundary conditions and Boundary Value Problems, Methods of Images
	C	Green Function formalism, Magnetic field, Magnetic flux and Magnetic Induction for a circular carrying loop, Boundary Value problems, Magnetic shielding and Magnetic field in conductors.
	Unit 2	**Electromagnetic waves**
	A	Derive electromagnetic wave equation in free space, dielectric medium and in conducting medium.
	B	Solution of electromagnetic wave equation in free space, dielectric medium and conducting medium, skin depth.
	C	Reflection and refraction of em waves through different medium for normal incidence and oblique incidence, Total internal reflection, Brewster's Law, Complex Refractive index
	Unit 3	**Wave Guides**
	A	Electromagnetic waves between parallel conductors
	B	TE and TM waves
	C	Rectangular and Cylindrical wave Guide, Resonant Cavities
	Unit 4	**Potentials and Fields**
	A	Gauge Transformation, Coulomb and Lorentz Gauges
	B	Retarded Potential, L W Potential
	C	Field of an accelerating point charge and localized oscillating source, Electric and Magnetic dipole fields and radiation
	Unit 5	**Relativistic Electrodynamics**
	A	Covariant formalism of Maxwell's equations
	B	Transformation Laws and its applications
	C	Relativistic Generation of Larmor;s Frequency, Relativistic formulation of radiation by single moving charge.
	Mode of examination	Theory

	Weightage Distribution	CA	MTE	ETE
		30%	20%	50%

	Text Book/s	1. D. J Griffths, " Introduction to Electrodynamics", 2. W. H Hayt & J. A. Buck, "Enginerring Electromagnetics", TMH
	Other References	13. R. Reitz, F. J. Milford and R. W. Chirsty, "Foundations of Electromagnetic Theory" Narosa. 14. J. D. Jackson, "Classical Electrodynamics", Wiley.

School: SBSR		**Batch : 2020-2022**
Program: M.Sc.		**Current Academic Year: 2021-22**
Branch: Physics		**Semester: III**
1	Course Code	MPH205
2	Course Title	MATERIALS PHYSICS
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. To know the importance of Physics and Materials Science. 2. To utilize the various synthesis procedure to develop materials. 3. To explain the practical application of materials in various area.
6	Course Outcomes	CO1: Learn the basics of Materials. CO2: Understand the correlation between Materials & Physics behind CO3: Apply the concept of materials and technology at certain levels. CO4: Develop devices using materials and understand science. CO5: Create the path to handle materials. CO6: Expertise in various tools will make a bridge between industry and students. Find out the platform for employment in high tech industries
7	Course Description	Material physics is the use of physics to describe the physical properties of materials. It is a synthesis of physical sciences such as chemistry, solid mechanics, solid state physics, and materials science.
8	Outline syllabus	
	Unit 1	**Materials: Basic Concepts**
	A	Concept of amorphous
	B	single and polycrystalline structures and their effect on properties of materials
	C	Crystal growth
	Unit 2	**Imperfections in Solids**
	A	Defects, Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects
	B	Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank-Read sources
	C	Planar Defects: grain boundaries and twin interfaces; Dislocation Theory – experimental observation of dislocation, dislocations in FCC, HCP and BCC lattice.
	Unit 3	**Semiconductors**
	A	Metals and Semiconductors: Conduction in metals, Mobility, Semiconductors: Intrinsic, Extrinsic
	B	Band structures of semiconductors, Quantum well structures, Intrinsic carrier concentration, Defect levels in semiconductors

	C	Type – III- V and II-VI group semiconductors, PN junctions, Hall Effect
	Unit 4	**Ceramics and Glass**
	A	Properties, processing and applications of traditional and advanced ceramics, Silica, glass transition temperature, commercial ceramics, mechanical properties
	B	high temperature properties
	C	Glass formation – glassformers, Random network model, heat flow and precipitation from glasses, photosensitive and photochromic glasses
	Unit 5	**Polymers and Composites**
	A	Polymers, types and classification, Insulating, conducting and ion conducting polymers, resins
	B	Composites: Reinforcement-Matrix Interface, Metal matrix composite, Ceramics matrix composite, Carbon fiber composite
	C	Properties and applications of various composites
	Mode of examination	Theory
	Weightage Distribution	CA: 30% MTE: 20% ETE: 50%
	Text book/s*	William F Smith, "Foundations of Materials Science and Engineering", McGraw Hill Book Co., 2000. Michel W Barsoum, "Fundamentals of Ceramics", McGraw Hill Book Co., 1997
	Other References	• Krishnan K Chawla, "Composite Materials Science and Engineering", Springer, 2001. • Derek Hull, "Introduction to Composite Materials", Cambridge University Press, 1988. • George Odian "Principles of Polymerization", John Wiley and sons, Inc, 2002.

School: SBSR		**Batch :2020-2022**
Program: M.Sc.		**Current Academic Year: 2021-22**
Branch: Physics		**Semester: III**
1	Course Code	MPH 208
2	Course Title	Synthesis of Materials
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. To know the importance of Physics and Materials Science. 2. To utilize the various synthesis procedure to develop materials. 3. To explain the practical application of materials in various area.
6	Course Outcomes	CO1: Learn the basics of Materials/Technology CO2: Understand the correlation between Applied science and Technology CO3: Apply the concept of materials and technology at certain levels. CO4: Develop devices using materials. CO5: Create the path to handle materials. CO6: Expertise in various tools will make a bridge between industry and students. Find out the platform for employment in high tech industries
7	Course Description	Chemistry has many aspects; but there are three general regions: the study of structures of materials, the study of reactions of materials, and the synthesis of materials. Previously, it was generally thought that synthesis, compared with structure and reactions, was more empirical and devoid of rigid theory. As our understanding of structures and reactions has advanced, however, synthesis has also gradually become theoretically grounded and systematized.
8	Outline syllabus	
	Unit 1	**Chemical Techniques**
	A	Chemical precipitation and co-precipitation, Wet chemical methods, Metal crystals by reduction, Sol-gel synthesis.
	B	Microemulsions or reverse micelles, Hydrothermal & Solvothermal synthesis, Thermolysis routes
	C	Microwave heating synthesis, Electrochemical synthesis.
	Unit 2	**Synthesis of Nano Particles**
	A	Preparation of materials by Ball milling, Attrition and Vibration milling
	B	Cluster compounds, Preparation of nano particles
	C	Preparation of nanostructured polymers/Conducting polymers, composites.
	Unit 3	**Vacuum Systems**
	A	Characteristics of vacuum: Mean free path
	B	Measurement of Vacuum: Pressure gauges – Pirani and Penning Gauge; Mechanical pumps
	C	Rotary Vane Pumps, Diffusion & Molecular pump, pumping speed, Liquid Nitrogen trap

	Unit 4	**Physical Vapour Deposition**		
	A	Physical Vapor Deposition - Hertz Knudsen equation; mass evaporation rate; evaporators, e-beam		
	B	pulsed laser and ion beam evaporation, Hybrid and Modified PVD- Ion plating, reactive evaporation		
	C	ion beam assisted deposition, Sputtering techniques		
	Unit 5	**Chemical Vapour Deposition**		
	A	Chemical Vapor Deposition - reaction chemistry and thermodynamics of CVD		
	B	Thermal CVD		
	C	laser & plasma enhanced CVD, Pyrolytic synthesis		
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		30%	20%	50%
	Text book/s*	Carbon Nanotubes: Synthesis, Characterization and Applications by Kamal K Kar, Research Publishing, Singapore, 2011 Principles of Nanoscience and Nanotechnology – M. A. Shah, Tokeer Ahmad (Narosa Publishing House, New Delhi, 2011)		
	Other References	• Pradeep T., "NANO The Essential, understanding Nanoscience and Nanotechnology". Tata McGraw-Hill Publishing Company Limited, 2007. • • Charles P.Poole Jr. "Introduction to Nanotechnology", John Willey & Sons, 2003. • • Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama Nanoparticle Technology Handbook, Elsevier Publishers (2007) • • Synthesis, properties and applications by CNR Rao et.al.2002 • Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge, UK,,2005		

School: SBSR		**Batch: 2020-2022**
Program: MSc		**Current Academic Year: 2021-2022**
Branch: Physics		**Semester: III**
1	**Course Code**	**MPH 217**
2	**Course Title**	**Nuclear and Particle Physics**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	Course Status	**Compulsory**
5	**Course Objective**	This course aims: 1.To introduce students to the fundamental principles and concepts of nuclear and particle physics 2. To make students acquire profound working knowledge of advanced topics in nuclear and particle physics and their applications to real life problems.
6	**Course Outcomes**	**Upon successful completion of this course, the student would be able to:** **CO1:** Understand and differentiate the types of nuclear forces, their properties; and explain the nuclear forces using Meson theory and Yukawa potential. **CO2:** Remember the conservation laws and analyze different types of nuclear reactions and their energetics. **CO3:** Compare different types of nuclear models to obtain the angular momenta of nuclear states. **CO4:** Recognize and discriminate types of nuclear decays and the governing theories. **CO5:** Classify the elementary particles and understand their standard model. **CO6:** Acquire relevant knowledge about the nuclear and particle physics to apply it to the real-life problems.
7	**Course Description**	This course illustrates in depth various nuclear interactions, nuclear forces, different models depicting the nucleus, nuclear decay, types of nuclear reactions and introduces particle physics while classifying the elementary particles.
8	Outline syllabus	
	Unit 1	**Nuclear Interaction and Nuclear Forces**
	A	**Nuclear forces:** Nuclear forces - properties of nuclear forces, exchange forces, nuclear force has tensor component, charge independence, spin dependence of nuclear forces
	B	**Two body problem:** Two body problem- ground state of deutron, magnetic moment, quadrupole moment, nucleon nucleon interaction
	C	**Meson Theory of Nuclear Forces**: Meson theory-Yukawa potential, nucleon nucleon scattering, charge symmetry, isospin.
	Unit 2	**Nuclear Reactions**
	A	**Nuclear Reactions:** Types of reactions and conservation laws, Energetics of

		nuclear reactions, Dynamics of Nuclear reactions, Q value equations.
	B	**Scattering and Reaction Cross sections:** Scattering cross section, reaction cross section, compound nucleus reactions and direct reactions.
	C	**Resonance Scattering:** Breit-Wigner one level formula (Qualitative analysis)
	Unit 3	**Nuclear Models**
	A	**Liquid drop model:** Liquid drop model, Bohr Wheeler theory of fission.
	B	**Shell Model:** Experimental evidence for shell effects, shell model, spin orbit coupling, magic numbers, angular momenta and parities of nuclear ground state.
	C	**Schimdt lines:** Estimate of transition rates, Magnetic moments and Schmidt lines.
	Unit 4	**Nuclear Decay**
	A	**Beta Decay:** Fermi theory of beta decay, shape of the beta spectrum, Mass of the neutrino, angular momenta and parity selection rule, allowed and forbidden decays
	B	**Comparative half-lives**, neutrino physics, non-conservation of parity.
	C	**Gamma decay** Multipole transition in nuclei, angular momenta and parity selection rules, Internal conversion, nuclear isomerism
	Unit 5	**Particle Physics**
	A	**Classification of Elementary Particles** Basic forces, classification of elementary particles, spin and parity, determination of isospin, strangeness, lepton and baryon no., conservation laws
	B	**Gellmann-Nishijima Scheme** Meson and baryon octet, elementary ideas of SU (3), symmetry quark model
	C	**High Energy Physics:** Types of interaction, typical strength and time scale, conservation laws, parity and time reversal, CPT theorem
	Mode of examination	Theory/Jury/Practical/Viva
	Weightage Distribution	CA: 30% / MTE: 20% / ETE: 50%
	Text book/s*	• Bernard L Cohen, "Concept of Nuclear Physics" Mc Graw Hill. • S N Ghoshal, "Nuclear Physics" • M K Pal, "Theory of Nuclear Structure" East West Press Pvt Ltd, Delhi. • S P Kuila, "Concept of Nuclear Physics" New Central Book Agency Ltd • Kakani and Kakani, "Nuclear and Particle Physics" Viva Books
	Other References	• M L Pandya and R P S Yadav, "Elements of Nuclear Physics" Kedar Nath Ram Nath • R R Roy and B P Nigam, "Nuclear Physics" New Age International Ltd • D C Tayal, "Nuclear Physics" Himalaya Publication Home • D Griffiths, "Introduction to Elementary Particle Physics" Harper and Row • NP-TEL (National Program on Technology Enhanced Learning) https://www.youtube.com/playlist?list=PLbMVogVj5nJRvq-w3zway7k3GzmUDte3a

School: SBSR		Batch :2020-2022		
Program: M.Sc		**Current Academic Year: 2021-22**		
Branch: Physics		**Semester: III**		
1	Course Code	MPH 256		
2	Course Title	Dissertation 1		
3	Credits	4		
4	Contact Hours (L-T-P)	0-0-0		
	Course Status	Compulsory		
5	Course Objective	• To synthesize carbon nano materials • To develop solvent free polymer electrolyte • To study the electrical, optical and thermal studies of a systems		
6	Course Outcomes	CO1: In depth knowledge of carbon nano materials and their functionalization. CO2: In depth knowledge of different types of electrolytes. CO3: Familiar with the basic principle and working in systems like CH-Impedance, Kethley-24, POM and many more in laboratory. CO4: Fabrication of Third generation solar cells. CO5: Fabrication of Super capacitors. CO6: Seminars/workshops are in regular intervals and students present their own work.		
7	Course Description	Synthesis of carbon nano materials and their application in energy storage devices like DSSC, Super capacitors… etc. Additionally, synthesis of solvent free polymer electrolyte, application of ionic liquids in energy devices.		
8	Outline syllabus			
	Unit 1	**Introduction**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 2	**Case study**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 3	**Conceptual**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 4	**Development**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 5	**Finalisation**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Mode of examination	Jury/Practical/Viva		
	Weightage Distribution	CA	MTE	ETE
		60%	0%	40%
	Text book/s*	Handbook of Photovoltaic Science and Engineering Antonio Luque, Steven Hegedus; Copyright © 2003 John Wiley & Sons, Ltd; DOI:10.1002/0470014008		
	Other References	1. Zakaria NA, Isa MIN, Mohamed NS, et al. Characterization of		

		polyvinyl chloride/polyethyl methacrylate polymer blend for use as polymer host in polymer electrolytes. J Appl Polym Sci 2012; 126: E419–E424. 2. Khatijah S, Subban RHY and Mohamed NS. Ionic conductivity of PVC-NH4I-EC proton conducting polymer electrolytes. Adv Mater Res 2012; 545: 312–316. 3. Chaurasia SK, Saroj AL, Shalu, et al. Studies on structural, thermal and AC conductivity scaling of PEO-LiPF6 polymer electrolyte with added ionic liquid [BMIMPF6]. AIP Adv 2015; 5: 077178.

School: SBSR		Batch: 2020-2022
Program: MSc (Physics)		**Current Academic Year: 2021-22**
Branch:		**Semester: III**
1	Course Code	MPH 257
2	Course Title	Specialized Physics lab
3	Credits	2
4	Contact Hours (L-T-P)	0-0-6
	Course Status	Compulsory
5	Course Objective	1. To gain knowledge on the synthesis procedures of various nanomaterials. 2. To understand laboratory experiments to investigate the properties of materials. 3. To learn the operation of the advanced characterization instruments. 4. To understand the structural, electrical, mechanical and optic properties of materials
6	Course Outcomes	CO1: Student will be able to use UTM machine and calculate stress, strain (mechanical properties) of materials CO2: Student will be able to know about young modulus and how to find out the value of young modules of a wire. CO3: Student will be able to synthesis nano materials by different methods CO4: Student will be able to operate different characterization tools. CO5: Student will be able to analysis the output of different characterization techniques CO6: Student will be able to find out the structural, electrical, optical and mechanical properties of nano materials and how to tune them by chemical substitution method.
7	Course Description	In this course of MSc (Physics), students will synthesis nano materials and nano composite by different chemical methods. How to use different characterization tools to understand the structural, electrical, optical and mechanical properties of nano materials.
8	Outline syllabus	
	Unit 1	**Practical based on mechanical properties**
		1. To determine tensile strength by Universal Testing Machine. 2. To determine Young's Modulus of Steal wire by applying Load.
	Unit 2	**Practical related to --**
		3. To synthesis Zinc Oxide nanoparticle by chemical method. 4. To synthesis Titanium Oxide nanoparticle by chemical method.
	Unit 3	**Practical related to---**
		5. To synthesis Composite by chemical method.
	Unit 4	**Practical related to---**
		6. Growth of nanoparticles by solid state method.
	Unit 5	**Practical related to---**

		7. To analyze XRD data for the determination crystallite size and structure of the sample. 8. To determine dielectric properties of Zinc Oxide/TiO_2 nano particles. 9. Analysis of uv/vis absorption spectrum of nanomaterials.
	Mode of examination	Jury/Practical/Viva
	Weightage Distribution	CA: 60% / MTE: 0% / ETE: 40%
	Text book/s*	-
	Other References	

School: School of Basic Sciences and Research		**Batch: 2020-2022**
Program: M. Sc		**Current Academic Year: 2021-2022**
Branch: Physics		**Semester: IV**
1	Course Code	MPH 209
2	Course Title	CHARACTERIZATION OF MATERIALS
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. The course will focus on the structure-property correlations and how these could be unravelled by the use of simple characterization methods such as optical and scanning electron microscopy, x-ray diffraction and Raman spectroscopy. 2. To understand the characterization methods used for state-of-the-art materials. 3. To appreciate the results from characterization methods and their reliability. 4. To appreciate the multiscale and multidisciplinary nature of materials
6	Course Outcomes	After the completion of this course students will be able to: **CO 1:** Explain know the basics of optical and Atomic Force Microscope. **CO 2:** Explain the properties of electrons and the effect of accelerating potential and basic operational modes of a SPM, SEM and TEM. **CO 3:** Understand the Electronic, Vibrational, Structural, Compositional properties of materials via different spectroscopy and diffraction techniques. **CO 4:** Demonstrate dc conductivity and ac impedance spectroscopy. **CO 5:** Explain the phase transitions in materials by thermal characterization. **CO 6:** Apply materials characterization methods based on microscopy, chemical, physical and structure analysis, and thermal analysis techniques to various research problems.
7	Course description	Determination of the structural character and chemical composition of a material is an essential activity of material science. After completion of the course the student should have obtained knowledge of characterization of materials by introducing the basic principles and performing experiences of a large range of techniques used to characterize different types of materials.
8	Outline Syllabus	
	Unit 1	**Microscopic Techniques**
	A	Basics of Microscope and its resolving power; Construction,
	B	working principle and applications of optical polarizing microscope,
	C	Magnetic force microscope, Atomic force microscope (AFM); Electron Tomography.
	Unit 2	**SPM Techniques**
	A	**S**canning probe microscopic (SPM) Techniques: Scanning tunneling

		microscopy (STM),
	B	Scanning Electron Microscopy (SEM)
	C	Transmission Electron Microscopy (TEM), and EDX (energy dispersion X-ray analysis)
	Unit 3	**Spectroscopic Techniques**
	A	UV-visible, FT-IR, Raman and Atomic absorption spectroscopy
	B	X-ray diffraction, Glancing angle and wide angle, Debye-Scherer formula, Dislocation density, Micro strain
	C	AUGER Spectroscopy and X-ray photoelectron spectroscopy (XPS)
	Unit 4	**Solid state Techniques**
	A	Conductivity measurement: Four probe techniques
	B	Dielectric and Impedance measurement
	C	Dielectric measurement of materials: Frequency dependence measurement and temperature dependent measurements.
	Unit 5	**Thermal techniques**
	A	Thermogravimetry, Differential Thromogravimetry,
	B	Differential Scanning Calorimetry,
	C	Differential Thermal Analysis.
	Mode of Examination	Theory
	Weightage Distribution	CA: 30%; MTE: 20%; ETE: 50%
	Text books	1. Characterization of materials (Vol. 1 and 2) by E.N. Kaufmann, John Wiley and Sons. 2. Introduction to Nanotechnology - Charles P. Poole Jr. and Franks. J. Qwens (Wiley Interscience, 2003)
	Other References	1. Processing & properties of structural nano materials by Leon L. Shaw (Warrendale, 2003) 2. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao (Taylor & Francis 2008)

MPH210 Properties of Materials

School: SBSR		**Batch: 2020-22**
Program: M.Sc.		**Current Academic Year: 2021-22**
Branch: Physics		**Semester: IV**
1	Course Code	MPH210
2	Course Title	Properties of Materials
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	5. To make the students familiar with the **S**tress Strain diagram for different engineering materials, Engineering and true stress strain diagram, Ductile and brittle material, Fatigue, Creep. 6. To understand the concept of Classification of magnetic materials, Diamagnetism, Paramagnetism, Langevin theory of dia and paramagnetism, Weiss theory, Structure of Ferrite. 7. To know the concept of Dielectric Materials: Basic concepts: complex permittivity, dielectric loss factor, polarization, mechanism of polarization, Optical Properties: Refractive index and dispersion, Transmission. 8. To understand the concept of The Gibbs Phase Rule and Phase Diagrams, Phase diagram of one component system, Methods for the Study of Phase Diagrams of Condensed (solid – liquid) Systems, Binary phase diagrams, Lever rule intermediate phases.
6	Course Outcomes	CO1: Learn the basic concepts of Engineering and true stress strain diagram, Ductile and brittle material, Tensile strength, Hardness, Impact strength, Fracture (Types and Ductile to brittle transition), Fatigue, Creep. CO2: Understand the Diamagnetism, Paramagnetism, Langevin theory of dia and paramagnetism, Weiss theory, Susceptibility measurement, Ferromagnetism, Curie-Weiss law. CO3: Able to explain the Dielectric Materials: Basic concepts : complex permittivity, dielectric loss factor, polarization, mechanism of polarization, Clausius-Mossotti Relation, Ferroelectricity. CO4: Figure out the Optical Properties: Refractive index and dispersion, Transmission, Reflection and absorption of light, Optical material for UV and IR, Optical anisotropic, Non-linear optical crystals, Photoluminescene. CO5: State the concepts of The Gibbs Phase Rule and Phase Diagrams, Phase diagram of one component system, Methods for the Study of Phase Diagrams of Condensed (solid – liquid) Systems, Binary phase diagrams, Lever rule intermediate phases, Eutectics, peritectic and eutectoids iron-iron carbide phase diagram, Microstructure, Nucleation and Growth

		CO6: Analyse the concepts of Mechanical Properties, Magnetic properties of materials, Dielectric properties, Optical properties of solids, Phase Diagrams.
7	Course Description	This course is about describing the concepts of Mechanical Properties, Magnetic properties of materials, Dielectric properties, Optical properties of solids, Phase Diagrams.
8	Outline Syllabus	
	Unit 1	**Mechanical Properties**
	A	**S**tress Strain diagram for different engineering materials, Engineering and true stress strain diagram, Ductile and brittle material, Tensile strength, Hardness
	B	Impact strength, Fracture (Types and Ductile to brittle transition), Fatigue, Creep
	C	Factors affecting mechanical properties.
	Unit 2	**Magnetic properties of materials**
	A	Classification of magnetic materials, Diamagnetism, Paramagnetism, Langevin theory of dia and paramagnetism, Weiss theory
	B	Susceptibility measurement, Ferromagnetism, Curie-Weiss law, Antiferromagnetism
	C	Ferrimagnetism, Structure of Ferrite.
	Unit 3	**Dielectric properties**
	A	Dielectric Materials: Basic concepts : complex permittivity, dielectric loss factor, polarization, mechanism of polarization, classification of dielectrics-frequency dependence of dielectric constant; Langevin's Theory of Polarization
	B	Clausius-Mossotti Relation, Ferroelectricity, Piezoelectricity, pyro-electric states, transition temperature
	C	polarization catastrophe, Landau theory of first and second-order phase transitions, antiferroelectricity, ferro electric domains.
	Unit 4	**Optical properties of solids**
	A	Optical Properties: Refractive index and dispersion, Transmission, Reflection and absorption of light
	B	Optical material for UV and IR
	C	Optical anisotropic, Non-linear optical crystals, Photoluminescene.
	Unit 5	**Phase Diagrams**
	A	The Gibbs Phase Rule and Phase Diagrams, Phase diagram of one component system, Methods for the Study of Phase Diagrams of Condensed (solid – liquid) Systems
	B	Binary phase diagrams, Lever rule intermediate phases
	C	Eutectics, peritectic and eutectoids iron-iron carbide phase diagram, Microstructure, Nucleation and Growth
	Mode of Examination	Theory

	Weightage Distribution	CA 30%	MTE 20%	ETE 50%
	Text Book/s	1. Mechanical Metallurgy', 3rd Edition, McGraw Hill,by G. E. Dieter, 1988 *2.* Testing of Metallic Materials', Prentice Hall India,by Suryanarayana, *1979.* 3. Structure and Properties of Materials', Volume III,by R. M., Rose Shepard L. A., Wulff J.,4th Edition, John Wiley, 1984		
	Other References	4. Introduction to Magnetic Materials, Addison-Wesley Publications, California, London, by B. D. Cullity, 1972 5. Magnetism and Magnetic Materials, Institute of Materials, London, by J. P. Jakubovics 1994 6. Introduction to Magnetism and Magnetic Materials, Chapman & Hall,by D. Jiles 1991		

School: SBSR		Batch :2020-2022
Program: M.Sc		**Current Academic Year: 2021-22**
Branch:Physics		**Semester: IV**
1	Course Code	MPH 258
2	Course Title	Dissertation 2
3	Credits	6
4	Contact Hours (L-T-P)	0-0-0
	Course Status	Compulsory
5	Course Objective	• To synthesize carbon nano materials • To develop solvent free polymer electrolyte • To study the electrical, optical and thermal studies of a systems
6	Course Outcomes	CO1: In depth knowledge of carbon nano materials and their functionalization. CO2: In depth knowledge of different types of electrolytes. CO3: Familiar with the basic principle and working in systems like CH-Impedance, Kethley-24, POM and many more in laboratory. CO4: Fabrication of Third generation solar cells. CO5: Fabrication of Super capacitors. CO6: Seminars/workshops are in regular intervals and students present their own work.
7	Course Description	Synthesis of carbon nano materials and their application in energy storage devices like DSSC, Super capacitors… etc. Additionally, synthesis of solvent free polymer electrolyte, application of ionic liquids in energy devices.
8	Outline syllabus	

	Unit 1	**Introduction**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 2	**Case study**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 3	**Conceptual**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 4	**Development**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Unit 5	**Finalisation**		
		Sub unit - a, b and c detailed in Instructional Plan		
	Mode of examination	Jury/Practical/Viva		
	Weightage Distribution	CA	MTE	ETE
		60%	0%	40%
	Text book/s*	Handbook of Photovoltaic Science and Engineering Antonio Luque, Steven Hegedus; Copyright © 2003 John Wiley & Sons,		

		Ltd; DOI:10.1002/0470014008
	Other References	1. Zakaria NA, Isa MIN, Mohamed NS, et al. Characterization of polyvinyl chloride/polyethyl methacrylate polymer blend for use as polymer host in polymer electrolytes. J Appl Polym Sci 2012; 126: E419–E424. 2. Khatijah S, Subban RHY and Mohamed NS. Ionic conductivity of PVC-NH4I-EC proton conducting polymer electrolytes. Adv Mater Res 2012; 545: 312–316. 3. Chaurasia SK, Saroj AL, Shalu, et al. Studies on structural, thermal and AC conductivity scaling of PEO-LiPF6 polymer electrolyte with added ionic liquid [BMIMPF6]. AIP Adv 2015; 5: 077178.