SANDIP UNIVERSITY

Courses of Study

2019-20

Msc Physics

IILP

SANDIP UNIVERSITY

School of Science

M.Sc (Part Time) 2018-19

Semester	Course I				Course II				Course III				Course IV				Course V				Course VI				Course VII				Course VIII				L	T	P	C	Contact Hours
I																					Code				Code				Code								
	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	16	0	12	22	28
	4	0	0	**4**	4	0	0	**4**	4	0	0	**4**	4	0	0	**4**	0	0	4	**2**	0	0	4	**2**	0	0	4	**2**	0	0	0	**0**					
	PC				PC				PC				PC				PC				PC				UC												
	MMP				**CLM**				**SSP**				**ED**				**LAB I**				**LAB II**				**Seminar I**												
II																									Code				Code								
	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C	L	T	P	C					16	0	12	22	28
	4	0	0	**4**	4	0	0	**4**	4	0	0	**4**	4	0	0	**4**	0	0	4	**2**	0	0	4	**2**	0	0	4	**2**									
	PC				PC				PC				PCE1				PC				PC				UC												
	QM				**ELE-I**				**NM**				**DE1**				**LAB III**				**LAB IV**				**Seminar II**												

SANDIP UNIVERSITY

School of Science

M.Sc (Part Time) 2018-19

Semester	Course	Code	Course Name	Category	L	T	P	C
III	Course I		NP	PC	4	0	0	**4**
III	Course II		NSNT	PC	4	0	0	**4**
III	Course III		DE 2	PCE2	4	0	0	**4**
III	Course IV		LAB V	PC	0	0	4	**2**
III	Course V		Project Stage I	UC	0	0	8	**4**
III	Course VI	Code	Internship I	UC	0	0	0	**2**
III	Course VII	Code			0	0	0	**0**
III	Course VIII	Code			0	0	0	**0**
IV	Course I		Project Stage II & Viva Voce	UC	0	0	32	**16**
IV	Course II				0	0	0	**0**
IV	Course III				0	0	0	**0**
IV	Course IV				0	0	0	**0**
IV	Course V				0	0	0	**0**
IV	Course VI				0	0	0	**0**
IV	Course VII	Code			0	0	0	
IV	Course VIII	Code			0	0	0	**0**

Semester	L	T	P	C	Contact Hours
III	12	0	12	20	24
IV	0	0	32	16	32
TOTAL	44	0	68	80	112

Department Elective I					
Transportation Engineering					
Course Code	**Course**	**L**	**T**	**P**	**C**
1					3
2					3
3					3

Department Elective II					
Water Resources and Environmental Engineering					
Course Code	**Course**	**L**	**T**	**P**	**C**
1					3
2					3
3					3
4					
5					

SANDIP UNIVERSITY

School of Science

FirstYear M.Sc Physics (Part Time)

Year: First Year **Semester: I**

Course: Mathematical Physics **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) -3Hrs.											

Prerequisite	1. Introduction and basic concepts of derivative and integration of functions. 2. Basic concepts andmethods to solve simultaneous equations, quadratic equations.

Objectives	
1	To study complex mathematical analysis in order to use integral theorems, obtain the residues of a complex function and to use the residue theorem to evaluate definite integrals.
2	To identify and study vector spaces.
3	Study of matrices, properties and their application in various streams of physics.
4	Identify special functions and apply them in physics related problems
5	Apply integral transforms (Fourier and Laplace) to solve mathematical problems of interest in physics.

Unit Number	Details	Hours
1	**Complex Analysis :** Analytical functions, Cauchy-Riemann conditions, Line integrals, Cauchy theorem, Cauchy integral formula, Derivatives of analytical functions, Power Series, Taylor's theorem, Laurent's theorem, Calculus of residues, revaluation of real definite integrals.	**12**
2	**Vector Spaces:** Vector spaces and subspaces, Linear dependence and independence, Basis and Dimensions, linear operators, Inverses.	**12**
3	**Determinants and Matrices:** Determinants, properties, Laplacian development by minors, solution of a set of homogeneous and inhomogeneous equation, matrices, basic operations, matrix inversion, orthogonal matrices, successive rotations, Euler angles, oblique coordinates, Hermitian matrices, Unitary matrices, diagonalization of matrices, eigenvalues and eigenvectors.	**12**
4	**Special Function :** Partical differential equations of physics, Legendre Hermite, Laguerre function – equation, polynomials, Generating function, Recurrence relations and their differential equations Orthogonality properties,	**12**

	Bessels's function of first kind , Spherical Bessel function, Associated Legendre function, Spherical harmonics, Application in physics.	
5	**Fourier Series and Integral transforms :** Fourier Series : Definition, Dirichlet's condition, Convergence, Development of Fourier Integral, Fourier transform & properties, Convolution theorem, Parseral's identity, Applications to the solution of differential equations, Laplace transform, properties, Applications to the solution of differential equations, Fourier transform & Laplace transform of Dirac Delta function.	**12**
	Total	**60 Hrs**

Course Outcome	
Students should able to	
CO1	Student will able to use complex mathematical analysis in order to use integral theorems
CO2	Student will able to identify and study vector spaces
CO3	Student will able to Study of matrices, properties and their application in various streams of physics.
CO4	Student will able to Identify special functions and apply them in physics related problems
CO5	Student will able to Apply integral transforms (Fourier and Laplace) to solve mathematical problems of interest in physics.

Resources	
Recommended Books	1. Complex Variables and Applications – J.W.Brown, R.V.Churchill – (7th Edition)- Mc-Graw Hill. 2. Complex Variables – Seymour Lipschutz 3. Mathematical methods for Physicists – Arfken & Weber – 6th Edition- Academic Press- N.Y. 4. Mathematical Methods of Physics – Mathews & Walker – 2nd Edition- Pearson Edition 6. Fourier Series - Seymour Lipschutz, Schaum Outlines Series 7. Laplace Transform - Seymour Lipschutz, Schaum Outlines Series 8. Mathematical Methods in Classical and Quantum Physics – Tulsi Das, S.K.Sharma- University Press India. 9. Matrices and Tensors in Physics, A. W. Joshi, 3rd Edition, New Age International.
Reference Books	**1.**Stroud, B. (2003). *Advanced Engineering Mathematics*. Fourth Edition. Published by Macmillan, New York, N.Y. **2.**Mathematics of Classical and Quantum Physics – Byron, Fuller Dover (1992) **3.**Mathematics for Physical Sciences – Mary Boas, John Wiley & Sons **4.**Advanced Engineering Mathematics, E. Kreyszig, 7th Edition, New Age International

School of Science
First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**
Course: Classical Mechanics **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3		Lab	Theory	Lab	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) - 3Hrs.											

Prerequisite	3. Introduction and basic concepts of physics like Force, displacement, velocity, acceleration, speed impulse, momentum, work, Newton's laws of motion, energy etc. 4. Basic concept and equations of mathematics like simultaneous equations, quadratic equations.

Objectives	
1	Formulate and solve classical mechanics problems using Lagrangian and Hamiltonian methods.
2	To apply the familiar techniques to systems in a variety of coordinate systems and references frames.
3	Use calculus of variation to characterize the function that extremizes a function
4	Set up & solve for equation of motion to rigid bodies and central force problems
5	Understand special theory of relativity and its effect

Unit Number	Details	Hours
1	**Lagrangian formulation:** Survey of elementary principles of mechanics of a particle & system of particles, constraints & their classifications, D'Alemberts Principle, Variational Principle, Lagrange's equation, Applications of Lagrange equation, cyclic-coordinates, integrals of motion, Jacobi integrals and energy conservation.	**12**
2	**Hamiltonian formulation: P**hase space**,** Conservation theorems and symmetry properties, Hamiltonian formalism, Hamilton equations, Applications of Hamilton equation, Routh's procedure for cyclic coordinates, Canonical transformations, Poisson brackets and Poisson theorems.	**12**
	Rigid body: Angular momentum and kinetic energy of a rigid body, number	

3	of degree of freedom, Euler's angles and Euler's theorem, infinitesimal rotation, rate of change of vector, Coriolis force, inertia tensor and moment of inertia, principle axes transformation, Euler's equation of motion.	**12**
4	**Central force:** Central force motion, reduction to one body problem, General properties of central force motion, effective potential, classification of orbits for inverse square central forces, Lagrangian analysis of motion in central force field.	**12**
5	**Special Theory of Relativity:** Introduction, Inertial and non-inertial frame of references, Galilean transformation, postulates of special theory of relativity, Lorentz transformation, length contraction, time dilation, simultaneity, Velocity addition, Total relativistic energy.	**12**
	Total	**60**

Course Outcome	
Students should able to	
CO1	Student will be able to formulate and solve classical mechanics problems using Lagrangian and Hamiltonian methods.
CO2	Student will be able to apply the familiar techniques to systems in a variety of coordinate systems and references frames.
CO3	Student will be able to use calculus of variation to characterize the function that extremizes a function
CO4	Student will be able to set up & solve for equation of motion to rigid bodies and central force problems
CO5	Student will be able to understand special theory of relativity and its effect

Resources	
Recommended Books	1. H. Goldstein, C. Poole & J. Safko, "Classical Mechanics", 3rd ed, Addison-Wesley 2. Takwale & puranik Classical Mechanics, tata McGraw Hill 3.K.C. Gupta," Classical Mechanics of Particles and Rigid Bodies", Wiley.
Reference Books	**1.**L.D. Landau & E.M. Lifschitz, "Mechanics"Pergamon, **2.**T. L. Chow, "Classical Mechanics", John Wiley **3.**. V.I. Arnold , "Mathematical Methods of Classical Mechanics " , 2nd ed. , Springer

School of Science
First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**
Course: Solid state physics **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) - 3Hrs.											

Prerequisite	5. Introduction and basic concepts of surveying and its principles. 6. Basic concept and equations of mathematics like area and angle calculations on field.

Objectives	
1	Understand foundation principles of solid state physics & applicability in predicting the properties of solids
2	Provide valuable theoretical introduction and overview of fundamental applications of solids
3	Formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials
4	Develop an understanding of relation between band structure and the electrical/optical properties of a material

Unit Number	Details	Hours
1	**Crystal Physics:** External symmetry elements of crystals, Concept of point group, stereograms for 32 point groups, Space groups, kinds of liquid crystalline order. Quasi crystals, Reciprocal lattices, Vector development of reciprocal lattice, Properties of the reciprocal lattice, Reciprocal Lattice to SC, BCC, FCC.	**12**
2	**Crystal Diffraction:** Laue, Rotating Crystal, Powder Method. Scattered wave amplitude, Fourier analysis of the basis; Structure Factor of lattices (SC, BCC, FCC); Atomic Form Factor;Elastic scattering from Surfaces; Elastic scattering from amorphous solids.	**12**
3	**Lattice Vibrations:** Vibrations of Monoatomic Lattice, normal mode frequencies, dispersion relation. Lattice with two atoms per unit cell,Quantization of lattice vibrations, phonon momentumInelastic scattering of neutrons by phonons, Surface vibrations, Inelastic Neutron scattering.	**12**

	Anharmonic Crystal Interaction. Thermal conductivity – Lattice Thermal Resistivity, Umklapp Process, Imperfections	
4	**Semiconductor Physics:** Tight binding approximation and Empty lattice approximation, Shallow impurities, Deep impurities, Density functional theory, Many-body theory of impurities, Quantized Hall effect, Metastability.	**12**
5	**Magnetism:** Classification and general properties of magnetic materials, Langevin theory of Paramagnetism, Quantum theory of Paramagnetism, Paramagnetic susceptibility of conduction electron, Wiess theory of ferromagnetism, Curie point, Curie-Weiss law for susceptibility, Exchange integral, saturation magnetizationand its temperature dependence, Saturation magnetization at absolute zero.	**12**
	Total	**60**

Course Outcome	
Students should able to	
CO1	Student will be able to understand foundation principles of solid state physics & applicability in predicting the properties of solids
CO2	Student will be able to provide valuable theoretical introduction and overview of fundamental applications of solids
CO3	Student will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials
CO4	Student will be able to develop an understanding of relation between band structure and the electrical/optical properties of a material

Resources	
Recommended Books	1. Introduction to solid states Physics - Charles, Kittle 7th Edition 2. Solid States Physics - S.O. Pillai 3. Elementary Solid States Physics- M. Ali Omar 4. Solid States Physics – A.J. Dekkar
Reference Books	1. Elements of Solid State Physics, J. P. Srivastava, Prentice-Hall of India 2. Solid state physics Mckelvy, Harper books 3. Solid state physics, Blakemore, McGraw Hill 4. B.S. Saxena, R.C. Gupta, P.N.Saxena, Fundamentals of solid state physics, Pragati Prakashan, 7th edition (1999).

School of Science
First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**
Course: Electrodynamics **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) - 3Hrs.											

Prerequisite	1. Introduction and basic concepts of integrations and derivations. 2. Basic concept and equations of mathematics like area and angle calculations on field.

Objectives	
1	To understand principles of electrodynamics and ability of applying them to physical systems in order to explain and predict the behavior of such systems
2	Understand and use skill of solving problems using concepts of electrostatics and magneto-statics
3	Formulate potential problems within electrostatics, magneto-statics using separation of variables and the method of images
4	To interpret Poynting theorem
5	To develop mathematical techniques useful for solving problems in E&M as well as other areas of physics
6	Describe and make calculations of plane electromagnetic waves
7	Knowledge of theory of electromagnetic wave propagation

Unit Number	Details	Hours
1	**Electrostatics:** Coulomb's law, Electric field, Charge distribution, Dirac delta function, Field lines, Gauss's law and applications, Differential form of Gauss's law, Electric potential, Poisson and Laplace's equations, Electrostatic potential energy.	**12**
2	**Electrostatics:** Boundary value problems, Uniqueness theorems, Green's theorem, Method of images, Method of separation of variables (Cartesian Coordinates, Spherical and Cylindrical Coordinates), Multipole expansion.	**12**
3	**Magneto statics:** Biot-Savart law, Ampere's law, Differential form of Ampere's law, Vector potential, magnetic field of localized current	**12**

	distribution, magnetic moment, Magneto-statics boundary conditions, Magnetic Shielding.	
4	**Time varying fields:** Faraday's law, Maxwell's displacement current, Maxwell's equations, Maxwell's equations in matter, Scalar and vector potentials, Gauge Transformation, Poynting theorem, Conservation laws.	**12**
5	**Electromagnetic Waves:** Waves in one dimension, Wave equation, Boundary conditions reflection and transmission, Electromagnetic waves in vacuum, Electromagnetic waves in linear media. Reflection, refraction and polarization of electromagnetic waves, Wave guide, waves in rectangular wave guide	**12**
	Total	**60**

Beyond the Syllabus
Case studies of various rocks and minerals.

Course Outcome	
Students should able to	
CO1	Student will be able to understand principles of electrodynamics and ability of applying them to physical systems in order to explain and predict the behavior of such systems
CO2	Student will be able to understand and use skill of solving problems using concepts of electrostatics and magneto-statics
CO3	Student will be able to formulate potential problems within electrostatics, magneto-statics using separation of variables and the method of images
CO4	Student will be able to interpret Poynting theorem
CO5	Student will be able to develop mathematical techniques useful for solving problems in E&M as well as other areas of physics

Resources	
Recommended Books	1. Introduction to Electrodynamics, David J. Griffith, Prentice Hall of India Private Limited. 2. Classical Electrodynamics, John D. Jackson, Wiley Eastern Limited. 3. Electromagnetic waves and radiating systems :Jordan and Balman (Prentice Hall India)
Reference Books	1. Classical Electrodynamics, Tung Tsang, World Scientific Publishing Private Limited. 2. E. M Purcell, D. J. Morin: Electricity and Magnetism. 3rd edition, Cambridge University Press. 3. Feynman Lectures, Vol.-II. Narosa Publications.

School of Science

First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**

Course: **Laboratory I** **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
0	0	4	2	-	-	-		50	-	50	100
Max. Time, End Semester Exam (Theory) - 2Hrs.											

Practical Objective	
1	To study the crystal structures using VESTA.
2	To study magnetic properties of materials.
3	To study the electrical properties of semiconductor materials.

Sr. No.	Description
1	To study basics of VESTA
2	Structure determination on the basis of XRD data using VESTA
3	To study different models of crystals
4	To determine radius ratio of ions present in various types of bravais lattice
5	To determine atomic radius and atomic packing factor of different cubic lattice.
6	To determine miller indices
7	To determine the resistivity of the given sample using Four Probe method.
8	To study B-H curve.
9	Measurement of magnetic field strength and its variation using a solenoid. (Determine dB/dX).
10	Measurement of Hall coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrier concentration.

Term Work:	
Term Work assessment shall be conducted for the Project, Tutorials and Seminar. Term work is continuous assessment based on attendance, good laboratory practice (GPL), timely completion, journal/record book, oral/viva, respectively. It should be assessed by course teacher of the institute. At the end of the semester, the final grade for a Term Work shall be assigned based on the performance of the student and is to be submitted to the University.	
Notes	
1	The regular attendance of the students during semester for practical course will be monitored and marks will be given accordingly (10 Marks).
2	Good Laboratory Practices (10 Marks)
3	Timely Completion (10 Marks)
4	Journal / Record Book (10 Marks)
5	Oral / Viva (10 Marks)

Practical/Oral/Presentation:
Practical/Oral/Presentation shall be conducted and assessed jointly by at least a pair of examiners appointed as internal and external examiners by the University. The examiners will prepare the mark/grade sheet in the format as specified by the University, authenticate and seal it. Sealed envelope shall be submitted to the head of the department or authorized person.

Notes	
1	One experiment from the regular practical syllabus will be conducted (40 Marks).
2	Oral/Viva-voce (10 Marks).

School of Science

First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**

Course: **Laboratory II** **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
0	0	4	2	-	-	-		50	-	50	100
Max. Time, End Semester Exam (Theory) - 2Hrs.											

Practical Objective	
1	To study the behavior various non-linear circuits.
2	To study SciLab for various operations in mathematical physics.
3	To study the use of the instruments operated on the basis of Electrodynamics Principles.

Sr. No.	Description
1	To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2	To study the RC Circuit: Capacitive reactance and RC time constant.
3	To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
4	To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
5	To study basics of SciLab
6	To analyze Taylor's series approximation using SciLab
7	To find the Fourier Transform of the given signal using SciLab
8	To study the rotational matrices using SciLab
9	To determine a Low Resistance by Carey Foster's Bridge.
10	Ballistic Galvanometer: (i) Measurement of charge and current sensitivity (ii) Measurement of CDR (iii) Determine a high resistance by Leakage Method (iv) To determine Self Inductance of a Coil by Rayleigh's Method.

Term Work:
Term Work assessment shall be conducted for the Project, Tutorials and Seminar. Term work is continuous assessment based on attendance, good laboratory practice (GPL), timely completion, journal/record book, oral/viva, respectively. It should be assessed by course teacher of the institute. At the end of the semester, the final grade for a Term Work shall be assigned based on the performance of the student and is to be submitted to the University.

Notes	
1	The regular attendance of the students during semester for practical course will be monitored and marks will be given accordingly (10 Marks).
2	Good Laboratory Practices (10 Marks)
3	Timely Completion (10 Marks)
4	Journal / Record Book (10 Marks)
5	Oral / Viva (10 Marks)

Practical/Oral/Presentation:
Practical/Oral/Presentation shall be conducted and assessed jointly by at least a pair of examiners appointed as internal and external examiners by the University. The examiners will prepare the mark/grade sheet in the format as specified by the University, authenticate and seal it. Sealed envelope shall be submitted to the head of the department or authorized person.

Notes	
1	One experiment from the regular practical syllabus will be conducted (40 Marks).
2	Oral/Viva-voce (10 Marks).

School of Science

FirstYear M.Sc Physics (Part Time)

Year: First Year **Semester: II**

Course: Quantum Mechanics **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3		Lab	Theory	Lab	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) -3Hrs.											

Prerequisite	7. Introduction and basic concepts of derivative and integration of functions. 8. Basic concepts andmethods to solve simultaneous equations, quadratic equations.

Objectives	
1	Understand the concepts and properties of Vector Spaces, Wave function, Operators and to learn and apply these with the help of postulates and other principles of Quantum Mechanics to study systems in quantum mechanics
2	Use discrete Eigen Value problem to analyze systems (SHO) using Dirac Notation
3	Find out the angular momentum of a system as a result of various Magnetic interactions using Lee Algebra
4	Obtain approximate solutions (Perturbation Theory, Variational Principle, WKB approximation) for wave functions of complex systems which closely resemble to a known system for which solution is available.
5	Understand scattering of subatomic particles in Quantum Mechanical Domain

Unit Number	Details	Hours
I	**General formalism:** Postulates of quantum mechanics - Wave function and its Physical Interpretation, Schrödinger equation- Time-independent Schrödinger equation- Dynamical variables and operators- Commutation relations of operators- Hermitian operators- Expansion in Eigen functions- Heisenberg Uncertainty relation- Time evolution operator-Schrödinger and Heisenberg pictures of time evolution- Time variation of expectation values.Schrödinger equation in three dimensions - Spherical polar coordinate form, Schrodinger, Heisenberg and Interaction matrix representations.	12

II	**Discrete eigenvalue problems:** Dirac's Bra and Ket notations for vectors and their properties, Ket vector as a column matrix and bra vector as a row matrix, Operators as matrices, Matrix form of wave function, Unitary transformation, Eigen value problem. Harmonic oscillator in one dimension, Defining equations for the operators a and a+, , Eigen values & Eigen functions of 1-D harmonic oscillator using ladder operators a and a+, Computation of values of a a+, a+a, [a, a+], [a, H], [a+, H], Matrices for the operators: a, a+, x, p, H, Derivation of Schrodinger's equation from a and a+.	**12**
III	**Angular Momentum:** Orbital angular momentum L operator as generator of rotation, Total angular momentum operator J. Ladder Operators J_+ and J_- , Commutation relations of J2 and Jz with J+ and J- , Commutation between J_+ and J_-, Eigen values and Eigen functions of J2 and Jz , Angular momentum Matrices, Electronic states in a central field, Addition of angular momenta, Computation of Clebesch- Gordan coefficients for (j_1 = ½ & j_2 = ½) and for (j_1 = 1 & j_2 = ½) .	**12**
IV	**Approximation methods:** Time independent perturbation theory for discrete levels: Non-degenerate cases and degenerate cases and applications to fine structure splitting, Zeeman effect: Normal and anomalous, Stark effect, and other simple cases - Removal of degeneracy- Spin-Orbit coupling- Fine Structure of Hydrogen-Time-independent Perturbation theory : non-degenerate and degenerate and applications to variational method and applications to helium atom and simple cases; WKB approximation and applications to simple cases. Time dependent Perturbation theory, Fermi's Golden rule, Semi-classical theory of interaction of atoms with radiation.	**12**
V	**Scattering theory:** Mutual scattering of two particles - Schrödinger equation in laboratory and center of mass frames Two electron atoms - Exchange interactions- Spin half particles in a box - Fermi gas- Band structure- Quantum Scattering theory - Differential and total cross sections- Scattering amplitude- Formal expression for scattering amplitude - Green's functions- Born approximation - Application to spherically symmetric potentials.	**12**
	Total	**60**

Course Outcome	
Students should able to	
CO1	Student will be able to understand the concepts and properties of Vector Spaces, Wave function, Operators and to learn and apply these with the help of postulates and other principles of Quantum Mechanics to study systems in quantum mechanics
CO2	Student will be able to use discrete Eigen Value problem to analyze systems (SHO) using Dirac Notation
CO3	Student will be able to find out the angular momentum of a system as a result of various Magnetic interactions using Lee Algebra
CO4	Student will be able to obtain approximate solutions (Perturbation Theory, Variational Principle, WKB approximation) for wave functions of complex systems which closely resemble to a known system for which solution is available.
CO5	Student will be able to understand scattering of subatomic particles in Quantum Mechanical Domain

	Resources
Recommended Books	1. David J. Griffiths, Introduction to Quantum Mechanics, 2nd Edition, Pearson, 2009. 2. Mathews P.M. and Venkatesan K., Quantum Mechanics, 2nd Edition, McGraw Hill, 2010. 3. Quantum mechanics: E. Merzbacher - Wiley and sons 4.Quantum mechanics : Ghatak and Loknathan 5. Quantum mechanics: B.Craseman and J.D.Powell - B I Publications
Reference Books	1. Leonard I Schiff, Quantum mechanics, 3rd Edition, McGraw Hill Book Company, 1968. 2. Schaum Series Outline of Quantum Mechanics 3. Quantum Mechanics Satya Prakash, Revised Edition, Pragathi Prakashan publishing Limited, 2008. 4. Modern quantum mechanics: J.J.Sakurai, McGraw Hill Book Company. 5. Quantum Theory D. Bohm, (Asia Publishing House)
Web References	1. SUN Server Link: http://172.16.0.50/index.php/videos/basic-courses/category/1772-quantum-physics 2. MIT Open Courseware: https://ocw.mit.edu/courses/physics/8-321-quantum-theory-i-fall-2002/ https://ocw.mit.edu/courses/physics/8-322-quantum-theory-ii-spring-2003/

School of Science
First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**
Course: Classical Mechanics **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) - 3Hrs.											

Prerequisite	9. Introduction and basic concepts of physics like Force, displacement, velocity, acceleration, speed impulse, momentum, work, Newton's laws of motion, energy etc. 10. Basic concept and equations of mathematics like simultaneous equations, quadratic equations.

Objectives	
1	Demonstrate an understanding of the structures, configuration and chracteristics of semiconductor devices.
2	Demonstrate the basic understanding of the structures, configuration, chracteristicsand applications of transistors.
3	Demonstrate the basic idea and applications of Op-amp for various operations.
4	To introduce students to basic digital techniques and train them to apply these concepts and ideas in technology by making use of case studies and problem-solving approach.
5	To introduce students to the basic idea of electronic communication with various types of analog and digital modulation technioques.

Unit Number	Details	Hours
I	**Basics, Characteristics and Designing of Semiconductor devices:** Basics of electronics, Band structure of materials, basics of semiconductors, P-N diode, Zener diode, rectifiers, clippers and clampers, LED photo diode, Laser diode, solar cell – characteristics,Tunnel diode, PIN Diode, Schottky barrier, **Numericals** (based on all diodes).	**12**
II	**Transistors:** Study of characteristics of BJT: Transistor Construction,Transistor Operation, CB, CE, CC configurations. FET –constructions – V.I. characteristics – FET as Voltage Variable Resistor (VVR) Construction and Characteristics of JFET, Construction and Characteristics of MOSFET, MOSFET (as a switch, chopper, linear voltage regulator), **Numericals** (based on designing of FET). UJT – construction – V.I. characteristics, UJT as a relaxation oscillator.	**12**
III	**Operational Amplifiers (Op-amp):** **Op-amp**: Important terminology of op-amp, Characteristics of Ideal operational Amplifier, Block diagram of an IC operational Amplifier, Analysis of inverting	**12**

	amplifier, Non-inverting amplifier, Op-amp as a adder, subtractor, differentiators, integrators (inverting Non-inverting mode). Applications of differentiators and integrators, Solution of differential equations using Op-amp, Comparator, Logarithmic amplifier and exponential amplifier, Analog computation, Square wave, Rectangular wave, Triangular wave and Sine wave generators. **Applications of Op-amps**: Filters, notches, comparators, sample and hold circuits, waveform generators, Numericals on designing of filters and notches.	
IV	**Digital Electronics:** **Introduction to logic gates** and **Boolean algebra**, **Minimization using Karnaugh map** (S-O-P and P-O-S representation), **Combinational circuits**: Demultiplexer, Multiplexer, **Flip flops**: R-S, D, T, J-K and J-K Master slave, **Sequential circuits**: Ripple and Synchronous counters – Registers: Types of Registers, Serial in Serial out, Serial in Parallel out, Parallel in Serial out and Parallel in Parallel out Registers – Shift registers –Pulse Generation.	**12**
V	**Electronics Communication System:** Communication system: Introduction, Block diagram, Concepts of modulation, demodulation, bandwidth, information capacity, noise, noise function, noise figure. **Amplitude Modulation (AM)**: Principle, single side band generation and detection, block diagram, AM modulator and receiver (Block diagram & waveforms). **Frequency Modulation**: Principle, frequency deviation, FM modulator and receiver (Block diagram & waveforms). Balanced slope F.M detector, Ratio F.M detectors.	**12**
	Total	**60**

Course Outcome	
Students should able to	
CO1	Student will be able to demonstrate an understanding of the structures, configuration and chracteristics of semiconductor devices.
CO2	Student will be able to demonstrate the basic understanding of the structures, configuration, chracteristicsand applications of transistors.
CO3	Student will be able to demonstrate the basic idea and applications of Op-amp for various operations.
CO4	Student will be able to introduce students to basic digital techniques and train them to apply these concepts and ideas in technology by making use of case studies and problem-solving approach.
CO5	Student will be able to introduce students to the basic idea of electronic communication with various types of analog and digital modulation technioques.

Resources	
Recommended Books	1. R P Jain, Modern digital electronics, Tata mac'Hill. 2. Robert G. Irvine, Operational Amplifier – Characteristics and Applications, 2nd Edition, Prentice Hall, New Jersey. 3.D. C. Green, Digital Electronics (5th Ed.), Pearson Education Ltd.
Reference Books	1.Albert Malvino, David J. Bates, Electronic Principles,Seventh Edition, Tata mac'Hill. 2. Digital Principles and Applications: Leach and Malvino 3.Operational Amplifiers: G. B. Clayton (5th edition) 4. Roddy and Coolen, Electronic Communications, Prentice Hall 4th Edition. 5. B. P. Lathi, Modern Digital and Analog Communication Systems 3rd Edition, Oxford University press 6. Thomas Floyd, Electronic Devices, 9th edition, pearson.
Web References	https://ndl.iitkgp.ac.in/,Online lectures: nptel

School of Science
First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**
Course: Numerical Methods **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) - 3Hrs.											

Prerequisite	11. Introduction and basic concepts of surveying and its principles. 12. Basic concept and equations of mathematics like area and angle calculations on field.

Objectives	
1	Describe commonly used numerical methods.
2	Explain the key principles of Numerical Methods
3	Estimate the amount of error inherent in different numerical methods.
4	Apply the knowledge of different numerical techniques to solve problems including those occur in Physics
5	Compare various numerical methods based on their efficiency

Unit Number	Details	Hours
I	**Errors in Numerical Methods:** Range Errors, Truncation/Rounding Errors, Bugs, Absolute, Relative and Percentage Errors, General Error formula, **Solution of Algebraic and Transcendental Equation:** Newton-Raphson method, Bisection method, The Method of false position, **Matrices & Linear System of Equations**: Solution of Linear Systems-Iterative Methods (Jacobi Method, Gauss-Seidel Method), Computation of Eigen values and Eigen Vectors of Matrices using Iterative Methods.	**12**
II	**Interpolation:** Finite Differences (forward, backward and central differences), Symbolic Relations, Differences of a Polynomial, Newton's formula for Interpolation (forward and backward), Lagrange's Interpolation formula and Divided Differences, Newton's General Interpolation Formula	**12**
III	**Curve Fitting:** Least-square curve fitting-(1) Fitting a straight line, (2) Nonlinear Curve Fitting (Power function, Polynomial of nth degree, Exponential function), (3) Curve fitting by a sum of exponentials,(4) Weighted least-square Approximation-Linear Weighted Least Squares Approximation, Nonlinear Weighted Least Squares	**12**

	Approximation. Method of Least squares for Continuous function	
IV	**Numerical Differentiation:**Differentiation using Newton's Forward Difference Formula, Errors in Numerical Differentiation, Maximum and Minimum values of a Tabulated function, **Numerical Integration:** Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule, Booles Rule, Newton-Cotes Integration Formulae, Gaussian Quadrature	**12**
V	**Ordinary Differential Equation:** Eulers Method, Improved Eulers Method, Runga Kutta Methods, Simultaneous and Higher Order Equations, Boundry Value Problems-Finite Difference Method, **Partial Differential Equations:** Finite Differencing, Elliptical PDE, Parabolic PDE, Hyperbolic PDE	**12**
	Total	**60**

Course Outcome	
Students should able to	
CO1	Student will be able to describe commonly used numerical methods.
CO2	Student will be able to explain the key principles of Numerical Methods
CO3	Student will be able to estimate the amount of error inherent in different numerical methods.
CO4	Student will be able to apply the knowledge of different numerical techniques to solve problems including those occur in Physics
CO5	Student will be able to compare various numerical methods based on their efficiency

Resources	
Recommended Books	1. Introductory Methods of Numerical Analysis: S S Sastry 2. Computer Oriented Numerical Methods: V Rajaraman 3. Computer oriented Numerical Methods: R.S.Salaria 4. Scheid: Schum's outlines in Numerical Analysis, Mc Graw Hill
Reference Books	1. Johnson and Rees: Numerical Analysis Addison Wesley 2. Young and Gregory: A survey of Numerical Mathematics Dover 2 volumes.

SANDIP UNIVERSITY

School of Science
First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**

Course: **Statistical Mechanics** **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
4	0	-	4	15	20	15		-	50	-	100
Max. Time, End Semester Exam (Theory) - 3Hrs.											

Prerequisite	3. Introduction and basic concepts of integrations and derivations. 4. Basic concept and equations of mathematics like area and angle calculations on field.

Objectives	
1	To develop the concept of work, heat transfer and entropy production within a framework of thermodynamics and introduction to the statistical thermodynamics
2	Introduction to the terms microstates, macrostates, phase space, ensembles, quantum states and energy levels to develop students understanding of statistical physics.
3	Study of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics
4	Apply all the statistics in physical systems, e.g., ideal gas, harmonic oscillator, etc.
5	To broaden their appreciation of how statistical mechanics integrates into the discipline of physics overall

Unit Number	Details	Hours
I	**Foundation of statistical mechanics:** Macrostates, microstates and connection of thermodynamics to the statistics, phase space, postulate of equal priori probabilities, Γ-space, μ-space, Partition function: Statistical interpretation of thermodynamic quantities using partition function.	**12**
II	**Statistical Ensembles:** Micro canonical, canonical and grand canonical ensembles. Partition function formulation. Fluctuation in energy and particle. Equilibrium properties of ideal systems: ideal gas, Harmonic oscillators, Paramagnetism: The statistics of Paramagnetism, concept of negative temperature.	**12**
III	**Maxwell-Boltzmann Statistics:** Boltzmann system (identical,	**12**

	distinguishable particles), Maxwell-Boltzmann distribution, Lagrange's multipliers, partition function (single particle), thermodynamics of gases, equipartition theorem, paramagnetic susceptibility.	
IV	**Bose-Einstein statistics:**B-E distribution law, Photon gas: Black body radiation, radiation properties such as pressure, density, emissivity and equilibrium number of photons in a cavity. Einstein's derivation of Planck's law, Bose Einstein condensation, Specific heat from lattice vibrations, Debye's model of solids: Phonon gas. Liquid He-Two Fluid model – Phonons – Rotons – Superfluidity.	**12**
V	**Fermi-Dirac Statistics:** Fermi-Dirac Distribution Law, Thermodynamic functions of an ideal Completely Degenerate Fermi Gas, Fermi energy, Mean energy of fermions at absolute zero temperature, Fermi energy as a function of temperature, White Dwarf Stars, Chandrasekhar Mass Limit, Electron specific heat, Pauli Paramagnetism.	**12**
	Total	**60**

Course Outcome	
Students should able to	
CO1	Student will be able to develop the concept of work, heat transfer and entropy production within a framework of thermodynamics and introduction to the statistical thermodynamics
CO2	Student will be able to introduction to the terms microstates, macrostates, phase space, ensembles, quantum states and energy levels to develop students understanding of statistical physics.
CO3	Student will be able to study of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics
CO4	Student will be able to apply all the statistics in physical systems, e.g., ideal gas, harmonic oscillator, etc.
CO5	Student will be able to broaden their appreciation of how statistical mechanics integrates into the discipline of physics overall

Resources	
Recommended Books	1. Statistical Mechanics- R. K. Patharia 2. Statistical Mechanics- S. K. Sinha 3. Introduction to statistical Mechanics- B. B. Laud
Reference Books	1. Fundamentals of statistical and Thermal Physics – F. rief 2.Statistical Mechanics- I.D.Landau & F. M. Lifshitz 3.Statistical Mechanics- R. Kubo 4. Problems and Solutions on Thermodynamics and Statistical Mechanics, Ed. by Yung – Kuo Lim, Sarat Book House

School of Science

First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**

Course: Laboratory III **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3		Lab	Theory	Lab	
0	0	4	2	-	-	-		50	-	50	100
Max. Time, End Semester Exam (Theory) - 2Hrs.											

Objectives	
1	To provide hands-on experience to the students, so that they are able to apply theoretical concepts in practice.
2	To give a specific design problem to the students, which after completion they will verify using the hardware implementation.

Sr. No.	Description
1	Dark and Illuminated Current-Voltage Characteristics of Solar Cell and Spectral Response Measurement of Solar cell
2	To study and measure the frequency response of FET amplifier
3	To study Drain Characteristics and Transfer Characteristics of a FET
4	Op-amp (using Negative Feedback) as Difference, Summing amplifier, Integrator and Differentiator
5	Op-amp(using Positive Feedback) as Function Generator (Triangular and Square)
6	Design, build and test first order & second order low pass and high pass filter using Op-amp
7	To design and verify the following digital circuits using basic gates: i) S-R flip-flops, ii) J-K flip-flops, iii) 4 input multiplexer iv) 7-segment demultiplexer v) Mod-5 and decade counters.
8	Study of AM modulator and demodulator
9	Build a very simple AM voice transmitter
10	Study of FM modulator and demodulator

Term Work:
Term Work assessment shall be conducted for the Project, Tutorials and Seminar. Term work is continuous assessment based on attendance, good laboratory practice (GPL), timely completion, journal/record book, oral/viva, respectively. It should be assessed by course teacher of the institute. At the end of the semester, the final grade for a Term Work shall be assigned based on the performance of the student and is to be submitted to the University.

Notes	
1	The regular attendance of the students during semester for practical course will be monitored and marks will be given accordingly (10 Marks).
2	Good Laboratory Practices (10 Marks)
3	Timely Completion (10 Marks)
4	Journal / Record Book (10 Marks)
5	Oral / Viva (10 Marks)
Practical/Oral/Presentation:	
Practical/Oral/Presentation shall be conducted and assessed jointly by at least a pair of examiners appointed as internal and external examiners by the University. The examiners will prepare the mark/grade sheet in the format as specified by the University, authenticate and seal it. Sealed envelope shall be submitted to the head of the department or authorized person.	

Notes	
1	One experiment from the regular practical syllabus will be conducted (40 Marks).
2	Oral/Viva-voce (10 Marks).

School of Science

First Year M.Sc Physics (Part Time)

Year: First Year **Semester: I**

Course: Laboratory IV **Course Code:**

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**		**Lab**	**Theory**	**Lab**	
0	0	4	2	-	-	-		50	-	50	100
Max. Time, End Semester Exam (Theory) - 2Hrs.											

Objectives	
1	Use computer software to solve problems related to numerical techniques
2	Demonstrate a knowledge and broad understanding of the key principles of Numerical Methods
3	Relate computer based skills with the requirements of Numerical Methods
4	Develop Numerical Method based skills relevant for solution of theoretical and experimental physics problems

Sr. No.	**Description**
1	To find out the root of the algebraic and transcendental equations
2	To find out the root of linear equations
3	To find out the Eigen value and Eigen vector of a Matrix by iterative method
4	To form a forward difference table from a given set of data values
5	To fit a streight line to a given set of data values
6	To fit a polynomial to a given set of data values
7	To find the first and second derivatives near the begining of table of values of (x and y)
8	To evaluate a definite integral by a Trapzoidal rule
9	To evaluate a definite integral by a Simpson’s 1/3 rule

10	To solve the differential equations by Euler Method
11	To find out the numerical solution of Partial Differential Equation

Term Work:
Term Work assessment shall be conducted for the Project, Tutorials and Seminar. Term work is continuous assessment based on Attendance, Good Laboratory Practice (GLP), Timely Completion, Journal/Record book and Oral. It should be assessed by subject teacher of the institute. At the end of the semester, the final grade for a Term Work shall be assigned based on the performance of the student and is to be submitted to the University.

Notes	
1	The above problems are to be solved by using appropriate computer software.
2	Each student is required to solve at least 80% of the above mentioned problems.
3	Attendance (10 Marks) + GLP (10 Marks) + Timely Completion (10 Marks) + Journal/Record Book (10 Marks) + Oral (10 Marks) = 50 Marks

Practical/Oral/Presentation:
Practical/Oral/Presentation shall be conducted and assessed jointly by internal and external examiners. The performance in the Practical/Oral/Presentation examination shall be assessed by at least a pair of examiners appointed as examiners by the University. The examiners will prepare the mark/grade sheet in the format as specified by the University, authenticate and seal it. Sealed envelope shall be submitted to the head of the department or authorized person.

Notes	
1	One experiment from the regular practical syllabus will be conducted (40 Marks).
2	Oral/Viva-voce (10 Marks).