Board of Studies in Physics

FACULTY OF SCIENCE AND TECHNOLOGY

GONDWANA UNIVERSITY, GADCHIROLI

Syllabus of

M. Sc. First Year Semester I & Semester II

SUBJECT – PHYSICS

DIRECTION RELATING TO THE EXAMINATION LEADING TO THE TWO YEAR / ONE YEAR MASTER OF SCIENCE DEGREE WITH SEMESTER PATTERN

AS PER NEP 2020

Session 2023-2024

Teaching and Examination Schemes:

Teaching and Examination Schemes for Two Year M.Sc. (of four semesters) programme in Subject Physics is as follows:

Table 1: M.Sc. Semester I

Course Category	Course Code	Name of the course (Title of the Paper)	Level	Teaching Scheme (hrs)				Examination Scheme					
				Theory	Pract.	Total	Total Credit	Duration of Exam (Hrs)	Maximum marks		Total	MiniPassing Marks	
									ESE (UA)	CIE (CA)		Theory	Practical
DSC	01MSCPH 1	Paper 1: Semiconductor Physics and Devices	6.0	4	--	4	3	3	80	20	100	40	
	01MSCPH 2	Paper 2: Electrodynamics		4	--	4	3	3	80	20	100	40	
	01MSCPH 3	Paper 3: Mathematical Physics		4	--	4	3	3	80	20	100	40	
DSE	01MSCPH4.1	Paper 4: Complex Analysis and Numerical Methods		4	--	4	3	3	80	20	100	40	
	01MSCPH4.2	Paper 4: Astrophysics											
	01MSCPH4.3	Paper 4: Energy Physics											
	01MSCPH4.4	Paper 4: Introduction to Python											
	01MSCPH4.5	Paper 4: Biophysics											
RM	01MSCPH 5	Paper 5: Research Methodology		4	--	4	3	3	80	20	100	40	
Lab-I	01MSCPH 6	Practical Based On (Paper I+ Paper II)		--	8	8	2	3-8	80	20	100		50
Lab-II	01MSCPH 7	Practical Based On (Paper 3+ Elective)		--	8	8	2	3-8	80	20	100		50
Ability Enhancement	01MSCPH 8	Seminar		2	--	2	1	--	--	50	50	20	
	Total --			22	16	38	20		560	190	750		--

Table 1: M.Sc. Semester II

Course Category	Course Code	Name of the course (Title of the Paper)	Level	Teaching Scheme (hrs)			Total Credit	Examination Scheme				
				Theory	Pract.	Total		Duration of Exam (Hrs)	Maximum marks		Total	MiniPassing Marks
									ESE (UA)	CIE (CA)		Theory / Practical
DSC	02MSCPH 1	Paper 1: Fundamentals of Quantum Mechanics	6.0	4	--	4	3	3	80	20	100	40 /
	02MSCPH 2	Paper 2: Solid State Physics		4	--	4	3	3	80	20	100	40 /
	02MSCPH 3	Paper 3: Classical and Statistical Mechanics		4	--	4	3	3	80	20	100	40 /
DSE	02MSCPH4.1	Paper 4:- Advanced Optoelectronics		4	--	4	3	3	80	20	100	40 /
	02MSCPH4.2	Paper 4: Plasma Physics and Space Science										
	02MSCPH4.3	Paper 4: Practical Electronics										
	02MSCPH4.4	Paper 4: Medical Physics										
	02MSCPH4.5	Paper 4: Data Science										
OJT/FP	02MSCPH5	Paper 5: Industrial Training/ Field Project/Research Project		4	--	4	3	5	80	20	100	50 /
Lab-I	02MSCPH 6	Practical Based On (Paper I+ Paper II)		--	8	8	2	3-8	80	20	100	/ 50
Lab-II	02MSCPH 7	Practical Based On (Paper 3+ Elective)		--	8	8	2	3-8	80	20	100	/ 50
Ability Enhancement	02MSCPH 8	Seminar		2	--	2	1	--	--	50	50	20 /
	Total --			22	16	38	20		560	190	750	/ --

Abbreviations: DSC: Discipline Specific Core, DSE: Discipline Specific Elective, OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP. ESE: End Semester Evaluation (UA), CIE: Continuous Internal Evaluation (CA).

M.Sc. Semester I Admission

1. **Details of Eligibility for M.Sc. Semester I Admission**

Subject to their compliance with the provisions of this direction and of other ordinances in force from time to time, the following applicant candidates shall be eligible for the admission to Master of Science in Physics and examinations their of

Table 1: Eligibility for M.Sc. Semester I Admission

For M.Sc. (Physics) Semester-I	For admission to the M. Sc. Semester I in Physics, a candidate shall have offered Physics as one of the Major subjects at the qualifying B.Sc. Examination

Candidates shall have passed any one of the above examinations from Gondwana University Gadchiroli or any other statutory University of India or abroad, recognized by the UGC or any other concerned apex regulatory authority / body of India.

2. **Duration of the Program, Student Progression Path and Provisions for Multiple Exit**

Duration of the M.Sc. shall be TWO years with the provision for exit at the end of first year

Exit Option: Students will have the flexibility to enter a program in odd semesters and exit a program after the successful completion of even semester as per their future career needs:

a. A student can exit the program after successful completion of semesters I & II having earned requisite number of credits as mentioned in the scheme of examination. Such a student shall be eligible for the award of **'PG Diploma in Major Subject'** by the affiliated colleges of Gondwana University, Gadchiroli. OR a student can continue the program in 2nd year.

b. A student, on successful completion of all the 4 semesters and having earned requisite number of credits as mentioned in the scheme of examination shall be eligible for the award of either **'Master of Science Degree with Major subject'**.

Table 2: Eligibility for Award of Certificate/Diploma/Degree/Honours or Research Degree

Qualification Title	Credit Earned	Semester	Year
PG Diploma in Major Subject	40	2	1
Master of Science Degree with Major subject	80	4	2

3. Credit Specifications:

a. Theory Courses: One hour/credit/week (a minimum of 15 hours of teaching per credit is required in a semester.

b. Laboratory/Performance Based Courses: A minimum of 30 hours in laboratory or Performance Based activities is required in a semester. Performance based activities include Workshop based activities, internship, Apprenticeship; Field based learning, community engagement learning, etc.

c. Each semester will consist of at least 15 weeks of Academic Work equivalent to 90 actual teaching days.

4. Assessment

Assessment Plan will consist of Continuous Internal Evaluation (CIE) and EndSemester Evaluation (ESE) for each course/subject taken together.

(A) Continuous Internal Evaluation (CIE) will be based

a) Attendance of the student during a particular semester
b) An assignment (min. two) based on curriculum to be assessed by the teacher concerned
c) Subject wise class test (min. two) or activities conducted by the teacher concernedwith proper rubrics.

(B) Expected classroom activities shall consist of Group Discussion, Seminars, Power Point Presentations, Elocution, Debate, Role Play, Case Studies, Educational Games etc . The teacher is expected to undertake a minimum of four of the aforesaid activity.

(C) The CIE marks will be communicated to the examination cell at the end of each semester, but before the semester end examinations / as instructed by the Examination Cell. These marks will be considered for the declaration of the results.

(D) The record of internal marks, evaluation & results should be maintained for a min. period of three year by the respective department for verification by the competent authority.

5. Standard of Passing

The scope of the course, percentage of passing in Theory and Project and Internal Assessment will be governed as per following rules:

(i) In order to pass the Master of Science (M.Sc.) 1st, 2nd, 3rd, and 4th Semester Examinations, an examinee shall obtain not less than 40 % (Grade 4) marks in each theory course / paper, taking CIE & ESE together. Whereas, for practical / performance-based examination an examinee shall obtain not less than 50 % marks in each practical, taking CIE & ESE together.

(ii) An examinee who is unsuccessful at the examination shall be eligible for admission to the subsequent examinations on payment of a fee prescribed for the examination together with the conditions of the ordinance in force from time to time.

6. General Guidelines

a. With effect from Academic Year 2023-24, Two years Master's Degree Program will be revamped as per the Illustrative Credit Distribution given in the above Table.

b. Under the One-year PG Diploma program, and two-year master's Degree program, the students must complete on-the-job training/internship of 04 credits during summer break, after completion of the second semester of the first year in the respective Major Subject.

c. The 4 Credits Research Methodology Component is mandatory in the First Year.

d. Electives selected in the PG program may be Relevant to OR Supportive of the Major Subject chosen.

e. The students will have to undertake a research project of 4 credits in Semester III and a research project of 6 credits in Semester IV in the second year of the two-year master's degree program. This is also applicable to the students admitted to one year PG program after completion of four years UG Program.

f. The exit option at the end of one year of the Master's degree program will commence from AY 2024-25. Students who have joined a two-year Master's degree program may opt for exit at the end of the first year and earn a PG Diploma.

g. The PG Diploma may be awarded to a student provided they have earned the requisite credits in one year including on-the-job training of 04 credits during summer break, after completion of the second semester of the first year in the respective Major Subject.

h. Successful examinees at the M. Sc. Sem I, II, III, and IV Examinations shall be entitled to receive a grade card signed by the **Controller of Examination and Evaluation of Gondwana University Gadchiroli** and successful examinees opting for the exit at the end M. Sc. Sem II and Sem IV Examinations shall, on payment of prescribed fees, receive a Degree certificate in the prescribed format from Gondwana University.

7. Pattern of Question Paper for M.SC. SEMESTER I &II Physics Core Course(DSC) / Open Elective (DSE) / Research Methodology (RM)

1. There will be four units in each paper.
2. Maximum marks of each theory paper will be 80.
3. Question paper will consist of five questions, each of 16 marks.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.

8. Practical Examination Assessment (2 Credits Each)

a. **Lab. I based on DSC-1 and DSC-2, of 100 marks -** (20 Marks for Practical CA + 80 marksfor Practical UA).

b. **Lab. II based on DSC-3 and DSE(one Elective), of 100 marks -** (20 Marks for Practical CA + 80 marks for Practical UA).

c. For passing, student must score minimum 50 marks out of 100 in practical examination based on Lab.-I and Lab.-II.

d. Each practical carries 100(80 Pr+20 Int) marks. The scheme of marking shall be 15 marks are on practical record , 15 marks on viva voce & 50 marks on experiment.

e. The students should perform one experiment at the time of university examination.

f. Practical performance shall be jointly evaluated by the External and Internal Examiner. In case of discrepancy, the External Examiner‟ s decision shall be final.

g. Duration of practical examination will be as per given in the syllabi of respective subjects.

h. The Practical Record of every student shall carry a certificate as shown below, duly signed by the teacher-in-charge and the Head of the Department. If the student fails to submit his / her certified Practical Record duly signed by the Teacher-In-Charge and the Head of the Department, he / she shall not be allowed to appear for the Practical Examination and no Marks shall be allotted to the student.

i. The certificate template shall be as follows:

C E R T I F I C A T E

Name of the college / institution _

Name of the Department: _

This is to certify that this Practical Record contains the bonafide record of the Practical work of Shri / Shrimati / Kumari _ of M. Sc. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Semester _ _ _ _ _ _ _ _ _ during the academic year _ _ _ _ _ _ _. The candidate has satisfactorily completed the experiments prescribed by Gondwana University Gadchiroli for the subject _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Dated _ _ _ / _ _ _ / _ _ _ _ _

Signature of the teacher who taught the examinee Head of the Department

1. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

2. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

9. OJT / FP Internship / Apprenticeship / Field Project/ Patent (Related to DSC) - (20 Marks of CA + 80 Marks of UA).

10. Seminar

Guidelines for Students, Supervisors and Examiners

In each semester, the student will have to deliver a seminar on any topic relevant to the syllabus / subject encompassing the recent trends and development in that field / subject. The topic of the seminar will be decided at the beginning of each semester in consultation- with the supervising teachers. The student has to deliver the seminar which will be followed by discussion. The seminar will be open to all the teachers of the department, invitees, and students.

The students should submit the seminar report typed and properly bound in one copy to the head of the department. The said Seminar shall be evaluated-by the concerned supervisor / head of the Department. The marks of the seminar shall be forwarded to the university within due period through head of the Department. The record of the seminar should be preserved till the declaration of the final result.

Table showing semester wise total marks in Theory and Practical

Semester	Theory	Practical	Total Marks	Credits
1	550	200	750	20
II	550	200	750	20
III	550	200	750	20
IV	550	200	750	20
For Honors	2200	800	3000	80

Total Credits:

Cumulative Credits required for PG in Major Subject (One Year PG Degree) = 40 Credits

Cumulative Credits required for PG in Major Subject (Two Year PG Degree) = 80 Credits

M.Sc. Semester I (DSC-1) Paper I (01MSCPH 1) Semiconductor Physics and Devices

Credit 03 **45 Hrs**

Course Objectives:

- To make the students understand the semiconductor Physics.
- To train them to apply the semiconductor devices in mostly used and important applications.

Course Outcomes:

Upon completion of the course successfully, students would be able to

- Apply the knowledge of basic semiconductor material Physics.
- Analyse the characteristics of various electronic devices like diode ,transistor etc.,.
- Classify and analyze the various circuit configurations of Transistor and MOSFETs.
- Become Aware of the latest technological changes in Display Devices.
- Understand the concept of microwave transmission.

UNIT I **11 Hrs**

Electronics Semiconductor discrete devices: characteristic curves and Physics of p-n Junction, Schottky, Tunnel and MOS diodes, Bipolar Junction Transistor (BJT), Junction Field Effect Transistor (JFET), Metal-oxide-Semiconductor Field Effect Transistor (MOSFET), Uni-Junction Transistor (UJT) and Silicon Controlled Rectifier (SCR)

Opto-electronics devices: Photo-diode, Solar Cell, LED, LCD and Photo transistor.

Unit II **11 Hrs**

Applications of semiconductor devices in linear and digital circuits: Zener regulated power supply, Transistor (Bipolar, MOSFFT, JFET) as amplifier, coupling of amplifier stages (DC, RC and Transformer coupling), RC-coupled amplifier.

Feedback in amplifiers and oscillators: Phase shift, Hartley, Colpitts and Crystal controlled Transistor as a switch OR, AND and NOT gates (TTL and CMOS gates).

Unit III **11 Hrs**

Digital integrated circuits: NAND and NOR gates as a building block, X-OR and X-NOR gates, simple combinational Circuits: Half and Full Adder, Half and Full Subtractor, X-OR as a parity generator, parity checker and comparator, RSFF, Clocked RSFF, DFF, JKFF, JKMSFF, Monostable, Bistable and Astable Multivibrators (using transistor).

Sweep generator using transistors, UJT and SCR. Shift registers, counters, A/D and D/A convertors. Linear integrated circuits: Operational amplifier and its applications as Inverting and non-inverting amplifier, adder, integrator, differentiator, waveform generator, comparator and Schmitrigger.

Unit IV **12 Hrs**

Klystrons, magnetrons and traveling wave tubes, velocity modulation, basic principles two cavity klystrons and reflex klystrons, principles of operation of magnetrons, Helix traveling wave tubes, wave modes, transferred electron devices, Gunn effect, principle of operations, read diode, IMPATT and TRAPATT diode.

Advantage and disadvantage of microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem, ground reflection, fading sources, detectors, components, antennas used in MWC system.

Text Books and Reference Books

1. A. Malvino and D. J. Bates, “Electronic Principles” Mc Graw Hill Education, India
2. Boylstad & Neshishkey, "Electronic Devices & Circuits", PHI
3. Milliman, J. Halkias, "Integrated Electronics", Tata McGraw Hill
4. J. J. Cathey Schaum's Outlines "Electronic Devices & Circuits" Tata McGraw Hill.
5. J. D. Ryder," Electronics Fundamentals and Applications", John Wiley-Eastern Publications.
6. A. P. Malvino, D.P. Leach, "Digital Principles and Applications", McGraw Hill Book Co., 4th Edition (1986).
7. Ramakant A. Gayakwad, "Op-amps and Linear Integrated Circuits", PHI
8. Anil Maini, Varsha Agrawal," Electronic Devices and Circuits", Wiley
9. George Kennedy, " Electronic Communication Systems", Tata McGraw Hill.
10. Dennis Roddy, John Coolen, "Electronic Communication Systems", Pearson
11. G. N. Navneeth, V. M. Gokhale and R. G. Kale, “Digital and Analogue Techniques”, Kitab Mahal
12. D. C. Tayal, “Concept of Electronics”, Himalaya Publishing House
13. Wayne Tomasi, “Advanced electronics communications systems”, PhI. 1987.
14. Taub and Schilling, “Principles of Communication Systems”, second edition, TMH, 1990
15. Simon Haykin, “Communication Systems”, third edition, John Wiley and Sons, 1994.
16. S. L. Gupta V. Kumar**, “**Hand Book of Electronics”**,** Pragati Prakashan, 2012.

M.Sc. Semester I (DSC-2) Paper II (01MSCPH 2) Electrodynamics

Credit 03 **45 Hrs**

Course Objectives:

- To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method.
- To inculcate fundamental concepts related to electromagnetic waves, their transmission via radiation.

Course Outcomes:

After learning this course, student will be able

- To understand the basics of electrostatics.
- To evaluate Poisson and Laplace equations, Boundary value problems for dielectrics.
- To understand Maxwell's equations, Poynting theorem, Gauge invariance and transformation.
- To use of Maxwell equations in analyzing the electromagnetic field.
- To describe the nature of electromagnetic waves and its propagation through different media and interfaces.

Unit I **12 Hrs**

Coulomb's law, Gauss's law, Poisson's equation, Laplace equation. Simple boundary value problems illustrating various techniques such as method of images, separation of variables, Green's functions, Multipole expansion. Electrostatics of dielectric media, multipole expansion, Boundary value problems in dielectrics; molecular polarizability, electrostatic energy in dielectric media.

Unit II **11 Hrs**

Review of Magnetostatics: Biot-Savart law, Ampere's theorem, Electromagnetic induction, examples of magnetostatic problems, Displacement current, Time varying fields, Maxwell's equations in free space and linear isotropic media (non-conducting) boundary conditions on the fields at interfaces. Poynting theorem, conservation laws for a system of charged particles and electromagnetic field.

Unit III **11 Hrs**

Scalar and vector potentials, Gauge symmetry, Coulomb and Lorentz gauges, Gauge invariance, Maxwell's Equations in terms of Electromagnetic Potentials, Electromagnetic wave equation, Gauge Transformations: Coulomb and Lorenz Transformation, Properties of Electromagnetic Fields.

Unit IV **11 Hrs**

Propagation of Electromagnetic Plane Waves in Vacuum, Non-conducting Medium, Conducting Medium, Reflection, Refraction, Polarization, interference, coherence and diffraction of Electromagnetic Waves, Fresnel Formulae, Total internal reflection and critical angle.

Text Books and Reference Books

1. David Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India (PHI) publication
2. J. D. Jackson, "Classical Electrodynamics", Wiley, New York (1995).
3. B. B. Laud, "Electromagnetics", Wiley Eastern Ltd., New Delhi (1983).
4. S. P. Puri, "Classical Electrodynamics", Tata McGraw-FEII Publishing Co. Ltd. New Delhi (1997).
5. Edward Jordan, Keith Balmain, "Electromagnetic Eaves and Radiating System", Prentice-Hall of India (PHI) publication
6. L.D. Landau and E.M. Lifshitz, "Classical Theory of Electrodynamics", Butterworth-Heinemann. Germany, 4th Edition, 1987.
7. A.D. Capri and P.V. Panat, "Introduction to Electrodynamics", Narosa Publication.

M.Sc. Semester I (DSC-3) Paper III (01MSCPH 3) Mathematical Physics

Credit 03 **45 Hrs**

Course Objectives:

- To study the special functions and theory of Fourier transforms emphasizing their applications in physical sciences.
- To deals with tensor algebra along with applications related to physics problems, introduces the techniques of calculus of variations with applications in classical and quantum mechanics.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To understand the basic mathematicalmethods that will be used in solving physical problems.
- To solve advanced problems in various fields of Physics.
- To understand the vector spaces and transformations.
- To solve transfer functions in Instrumentation using Laplace transforms.
- To apply Fourier transforms to transform the signal into different domains.
- To understand the concept and application of tensor and Bessel's Function.

Unit I **12 Hrs**

Linear vector spaces: linear independent bases, Dimensionality, inner product, matrices, linear transformation.

Matrices: Inverse, Orthogonal and Unitary matrices, Cayley Hamilton theorem, Eigen vectors and Eigen value problem, Diagonalization, Complete orthonormal sets of function.

Unit II **11 Hrs**

Laplace Transforms: Properties of Laplace transform, differential equation method of finding Laplace transform, Inverse Laplace transform.

Fourier Transforms: Fourier series, properties of Fourier series, Fourier integral, Fourier transform of derivatives, Applications of Fourier transform.

Unit III **11 Hrs**

Linear differential equations, Special Function: Laguerre, Hermite, Legendre polynomials, Special Bessel's function, Spherical harmonics, Generating Function and recursion relations, differential and integral forms, Fourier-Bessel expansion and Ber and Bei Functions.

Unit IV **11 Hrs**

Tensors: Elementary idea of tensors, Cartesian tensors, differential of Cartesian tensors, gradient, divergence and curl, Laplacian of Cartesian tensors.

Non-Cartesian tensors, Tensor densities and capacities, Differentiation of Non-Cartesian tensors, Chrisoffel symbols, Gradient, divergence and curl, Laplace transform of elementary functions.

Text Books and Reference Books

1. A.W.Joshi, "Matrices and Tensors in Physics", 2nd Edition, Wiley Eastern Limited.
2. H. K. Dass, "Mathematical Physics"
3. Newell, "Vector Analysis"
4. B. S. Rajput, "Mathematical Physics", Pragati Prakashan (Meerat) 1999.
5. Lipschutz, "Laplace Transform Seymour", Schaum Outline Series
6. Lipschutz, "Fourier Series Seymour", Schaum Outline Series
7. Satya Prakash, "Mathematical Physics", S. Chand & Sons.
8. Kalani and Hemrajani, "Mathematical Physics", Himalaya Publishing House.

M.Sc. Semester I (DSE-1) Paper IV (01MSCPH 4.1) Complex Analysis and Numerical Methods

Credit 03 **45 Hrs**

Course Objectives:

- Provide students with a solid understanding of complex analysis and numerical techniques.
- Develop students' analytical and problem-solving skills, enhance their mathematical maturity, and equip them with tools for practical applications.

Course Outcomes:

After learning this course, student will be able

- To learn the concepts Complex numbers and their properties and operations with Complex number.
- To analyze complex functions including meromorphic, differentiability, and the Cauchy-Riemann equations.
- To understand the convergence properties of complex series and be able to classify singularities of complex functions.
- To evaluate complex integrals using various techniques, including the Cauchy Integral Formula and the Residue Theorem.
- To apply the knowledge gained in the course to solve problems in physics, engineering, economics, and other scientific fields.

Unit I **12 Hrs**

Definition of Complex Numbers, Equality of Complex Number, Complex Algebra, Conjugate Complex Numbers, Geometrical representation of Complex Number, Geometrical representations of the sum, difference, product and quotient of Complex Number, Cauchy Rieman Conditions, Analytic functions, Multiply connected regions, Cauchy Theorem, Cauchy Integration formula, Derivatives, numericals.

Unit II **11 Hrs**

Singularities: Poles, Branch Points, Calculus of Residues - Residues Theorem, Cauchy Principle value, Pole Expansion of Meromorphic Functions, Product expansion of entire Functions, numericals.

UNIT III **11 Hrs**

Methods for determination of zeros and linear and non-linear single variable algebraic transcendental equations (Bisection method, false position method, iteration method, Newton-Raphson method, Secant method), Finite differences, Newton's formulae (no proof), numericals.

Unit IV **11 Hrs**

Lagrange's interpolation, Divided differences, Numerical integration, trapezoid rule, Simpson's 1/3rd rule, Simpson's $3/8^{th}$ rule, Linear least squares.

Euler and Runge-Kutta methods for solving ordinary differential equations (No proofs), numericals.

Text Books and Reference Books

1. B. S. Rajput, "Mathematical Physics", Pragati Prakashan (Meerat) 1999
2. S. Sastry, "Introductory Methods of Numerical Analysis"
3. V. Rajaraman, "Computer Oriented Numerical Methods"
4. R. V. Churchill, "Complex variables and Applications", 7th Edition McGraw Hill
5. R. S. Salaria, "Computer oriented Numerical Methods"
6. H. K. Dass, "Mathematical Physics"
7. B. S. Grewal, "Higher Engineering Mathematics"

M.Sc. Semester I (DSE-2) Paper IV (01MSCPH 4.2) Astrophysics

Credit 03 **45 Hrs**

Course Objectives:

- To understand the fundamentals, principles, physical concepts and recent developments in the Astrophysics area.
- To provide a basic knowledge of the Universe outside the Solar System, sufficient to prepare students for more advanced astronomy courses.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To understand the fundamentals in the Astrophysics
- To understand the spherical astronomy, distance measurement in astrophysics, and physics of solar system and extra solar planets.
- To understand the optics of the different astronomical instruments such as: telescopes, CCD camera etc. It has wide spared in use of R& D sector.
- To understand the basic physical mechanisms about the solar activities, this will help to probe the Sun- Earth connection.

Unit I **11 Hrs**

Spherical Astronomy Celestial sphere, Celestial coordinate system (equatorial and alt-azimuth): altitude and azimuth, right ascension and declination, hour angle, sidereal time, mean solar time, summer and winter solstice, seasons. Distance measurements: AU, parsec, standard candles, distance measurement by

geometric means (parallax, distances to open clusters).

Unit II **11 Hrs**

Solar System Idea of solar system, Study of planets and their satellites, Earth-Moon system, tidal forces, asteroids, meteors, comets and their origin, composition and dynamical evolution, extra solar planets and their detection.

Unit III **12 Hrs**

Telescopes: Basic Optics, Types of telescopes. Telescope mounting systems. Optical telescopes, Infrared, Ultraviolet, X- ray and Gamma-ray telescopes. Schmidt telescopes. Solar telescopes. Design and construction of a simple optical telescopes. Active and adoptive optics in astronomical study.
Sky charts and their importance.

Unit IV **11 Hrs**

Sun as a star: Solar spectrum, effective temperature, luminosity, photosphere absorption lines, limb darkening; energy source: Kelvin time scale, nuclear fusion; energy transport in the sun, Thomson scattering, mean free path, photon diffusion inside the Sun; photosphere, chromospheres, transition region, corona.

Text Books and Reference Books

1. Baidhnath Basu, "An Introduction to Astrophysics", PHI Course Pvt. Ltd. New Delhi. (2^{nd} edition) 2014.
2. K. D. Abhyankar, "Astrophysics – Stars and Galaxies", Tata McGraw Hill Publishing Company (1^{st} edition) 1992.
3. Zeilik Michael and A. Stephen, "Introductory Astronomy and Astrophysics", Gregary Saunders College Publishing, (4^{th} edition) 1997).
4. Martin Harwit A and A Library, "Astrophysical Concepts", Springer, USA. (4^{th} edition) 2006.
5. K. S. Krishnaswamy, " Astrophysics: A Modern Perspective"
6. Mark A. Garlick, "The Story of the Solar System"

M.Sc. Semester I (DSE-3) Paper IV (01MSCPH 4.3) Energy Physics

Credit 03 **45 Hrs**

Course Objectives:

- To provide students with a comprehensive understanding of the principles and concepts related to energy and world energy features.
- To explore the various forms and sources of energy.

- To introduces the principle and working of solar cells and wind energy.

Course Outcomes:

After learning this course, student will be able

- To understand the fundamental principles of energy sources and gain knowledge about various energy sources and prospect of renewable energy sources.
- To understand energy policies, regulations, and international agreements governing energy production, distribution, and consumption.
- To assess the concept of energy sustainability, considering factors like resource availability, long-term viability of different energy sources, and their impact on future generations.
- To understand different renewable energy technologies, such as solar photo voltaic, wind turbines and their applications.
- To design and implement renewable energy projects, considering technical feasibility, economic viability, and sustainability.

UNIT I : Introduction to Energy Sources **11 Hrs**

Energy sources, Types of energy sources, World energy futures, Energy sources and their availability, Prospects of renewable energy sources.

UNIT II : Solar Cells **11 Hrs**

Solar Cells: Solar cells for direct conversion of solar energy to electric powers, Solar cell parameter, Solar cell electrical characteristics, Efficiency, Single crystal silicon solar cells, Polycrystalline silicon solar cells, Cadmium sulphide solar cells.

UNIT III : Applications of Solar Energy **11 Hrs**

Solar water heating, space heating and space cooling, solar photo voltaics, agricultural and industrial process heat, solar distillation, solar pumping, solar furnace, solar cooking, solar green house.

UNIT IV: Wind Energy **12 Hrs**

Base principles of wind energy conversion wind data and energy estimation, Base components of wind energy conversion systems (WECS) types of wind machines, Generating systems, scheme for electric generation, generator control, load control, Applications of wind energy.

Text Books and Reference Books

1. F. Kreith and J. F. Kreider, “Principles of Solar Engineering”, Tata McGraw Hill (1978).
2. A. B. Meinel and A. P.Meinel, “Applied Solar Energy”, Addison Wesley Publishing Co. (1976).
3. M. P. Agarwal, “Solar Energy”, S. Chand and Co., New Delhi (1983).
4. S. P. Sukhatme, “Solar Energy”, Tata McGraw Hill (1997).
5. G. D. Rai, “Non-conventional Energy sources", Khanna Publications,Delhi (2009).

M.Sc. Semester I (DSE-4) Paper IV (01MSCPH 4.4) Introduction to Python

Credit 03 45 Hrs

Course Objectives:

- To provide basic knowledge of Python.
- To construct basic Python programs using functions.
- To learn data plotting and analysis using Python.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To learn the number, math/physics function and data plotting.
- To understand object oriented Python programs
- To perform error analysis in the data.
- To perform numerical differential and integration using Python.

Unit I **12 Hrs**

Fundamentals of Python: Introduction to programming in Python, installation and writing, and running Python programs on Windows and Linux.

Python programming for a Physicist, structure of a python program, running python program in console and in editor. constant and variables, numbers-integers, long integer, floating point number, complex number, sequences string, list, tuples, dictionaries, operators – arithmetic operators, relational operators.

Unit II **11 Hrs**

Handling data: Data types and variables, user input and output, mathematical operators. Logical operators, assignment operators, conditional operator. Control statements if, if else, if-elif-else, while, for loop, nested if and nested for loops, break and continue.

Importing modules, File handling operation with files, opening and closing a file. Formatting inputs and outputs, visualizing data, 2D, 3D, scatter graphs, animating graphs, statistical analysis of data- mean, median, mode, variance

Unit III **11 Hrs**

Arrays and Functions: Lists, tuples, sets, special arrays, writing and calling user-defined functions. Numerical integration and differentiation, ODE solvers, Fourier transform, PDE solvers, Diffusion equation and Wave equation, Schrodinger Equation, Data Processing and Data Visualization using Matplotlib and Pandas.

Data plotting and fitting: scattered plots, bar plots, histograms, reading data and plotting, linear or quadratic

least square fitting.

Unit IV **11 Hrs**

Data plotting and fitting: scattered plots, bar plots, histograms, reading data and plotting, linear or quadratic least square fitting . Curve fitting, least squares method principle, Fourier Transform, symbolic computation, numerical computation.

Error analyses: Propagation of errors, significant figures, Gaussian distribution, mean, median, standard deviation, variance, weighted average.

Text Books and Reference Books

1. S. C. Chapra and R. P. Canale, "Numerical Methods for Engineers", Tata McGraw Hill, (2016)
2. David J. Pine, "Introduction to Python for Science and Engineering", CRC Press, Taylor and Francis Group (2018)

M.Sc. Semester I (DSE-5) Paper IV (01MSCPH 4.5) Biophysics

Credit 03 **45 Hrs**

Course Objectives:

- To overview the interdisciplinary field of biophysics, which combines principles from physics, biology, chemistry, and other related disciplines.
- To study biological systems at the molecular, cellular, and organismal levels.
- To explore how their physical properties relate to their biological roles. Familiarize students with some biophysical techniques used to study biological systems.

Course Outcomes:

After learning this course, student will be able

- To understand physical processes underlying biological systems.
- To understand biophysical phenomenon at the molecular and cellular scale.
- To discuss the interplay between physics and biology in understanding complex biological systems.
- To understand the structure and function of biological macromolecules, such as proteins, nucleic acids (DNA and RNA), and lipids.

Unit I **11 Hrs**

Introduction to Biology: Origin and evolution of life, prokaryotic cells, eukaryotic cells, introduction to Biological energy, Energy production, photosynthesis, ATP synthesis, Biomolecules.

Essential physical principles related to life processes, Chemical bonding, Ionization energy, Electron affinity, Electro-negativity, strong bonds and weak bonds, Inter atomic potentials, Non central processes, Bond energy, Spring constituents.

Unit II **11 Hrs**

Free energy, Internal energy, Thermodynamic principles, water, acids, basis and aqueous reactions, Transport process, Diffusion, Viscosity, Thermal conduction. Enzyme: types of enzymes, factor affecting rate of enzyme activity. Cell mechanics and motility, Signal transduction, Ion channels and their function.

Unit III **11 Hrs**

Base pairing, Nucleic acids, Types of DNA, Properties of RNA, Transcription & Translation. Protein structure: 4 levels, Ramachandran plot, Interpretations, Classification (by structure, function).
Conformation Analysis: Asymmetric Carbon, Fisher conventions, L-D type systems, Torsion angle, Newmann projection, Cis-trans peptide.

Unit IV **12 Hrs**

Neurobiophysics: Structure & Function of Neuron, Types of synapses, Resting potential, Local depolarization, Action potential: Generation & propagation, Equivalent circuit of cell, Voltage clamp, Na^+-K^+ pump, Equivalent circuits.

Biophysical Techniques: Electrophoresis : Coulomb's Law, How it separates molecule of different molecular weight and configuration, UV-visible, IR and Fluorescence spectroscopy, Thermoluminescence (TL) : TL origin, detection and utility.

Text Books and Reference Books

1. Rodney Cotterill, "Biophysics – An Introduction", John Willey & Sons, Ltd, 2002
2. I. W. Sherman and V. G. Sherman, "Biology: A Human Approach", (Oxford University Press), 1979.
3. E. R. Kandel & J. H. Schwaz, "Principles of Neural Science", Elsevier, North Holland, 1982.
4. P. S. Nobel, "Biophysical Plant Physiology and Exology", University of California, Los Angeles and W. H. Freeman & Co., Sanfranscisco, 1983.
5. S. W. Kuffler and J. G. Nichols, "Neuron to Brain", Sinacuer Asso. Inc. 1995.
6. L. Dickerson & J. Geis, "The Structure and Function of Proteins", Harpes & Row, 1975.

M.Sc. Semester I Paper V (01MSCPH 5) Research Methodology

Credit 03 **45 Hrs**

Course Objectives:

- To understand some basic concepts of research and its methodologies
- To identify appropriate research topics
- To select and define appropriate research problem and parameters
- To prepare a project proposal (to undertake a project)
- To organize and conduct research (advanced project) in a more appropriate manner
- To understand the concepts of IPR and Patent.

Course Outcomes:

After learning this course, student will be able

- To understand and comprehend the basics in research methodology and applying them in research/ project work.
- To select an appropriate research design.
- To take up and implement a research project/ study.
- To collect the data, edit it properly and analyse it accordingly.
- To demonstrate the ability to choose methods appropriate to research objectives.

Unit-I **12 Hrs**

Foundation of Research: meaning of research, objectives and motivation of research. Deductive and inductive theory, concept of theory. Type of research (only concept and definition)- basic research, applied research, correlational research, descriptive research, ethnographic research, experimental research, exploratory research, historical research, qualitative and quantitative research. Scientific research method – Understanding the language of research, concept, construct, definition, variable and research process.

Unit-II **11 Hrs**

Identification of Problem: Importance of research design, characteristics of a good research design. Exploratory research design, descriptive research design, Scientific research design and experimental design. Hypothesis: Qualities of a good hypothesis, null hypothesis and alternative hypothesis. Hypothesis testing, logic and importance.

Online available database/websites for physical science research papers. Use of Encyclopedias, research guides, open database, and academic database of physical science. Indian database- Shodhganga, Shodhgangotri and concept of UGC-listed and peer-reviewed papers.

Unit-III **11 Hrs**

Research Paper: Concept, importance of research papers and research paper publishers. Types of research paper, original research paper, review paper, experimental research paper, survey research paper, interpretative research paper and argumentative research paper. Concept of impact factor and cite index. Ethical issues, plagiarism and self-plagiarism.

Use of tool: Reference management software like endnote, Mendeley etc. Software for paper formatting like Latex/MSOffice. Software for detection of Plagiarism.

Unit-IV **11 Hrs**

Intellectual Property Rights (IPR): Patents, Designs, Trademark, Copyright, technological research, innovation, techniques of writing a patent. Patent rights and new developments in IPR Licensing and transfer of technology, royalty, geographical indications, rights of patentee, new developments in IPR

Text Books and Reference Books

1. C. R. Kothari, "Research Methodology"
2. K. Prathapan, "Research Methodology for Scientific Research"
3. Anil Kumar Singh, "Research Methodology and Techniques in Physics"
4. E. Balagurusamy, "Fundamentals of Computers"
5. Use internet for useful tools – https://onlinecourses.nptel.ac.in/noc22_ge08/preview, https://www.youtube.com/watch?v=_Mb_cNqfsdc

M.Sc. Semester I Lab.-I (01MSCPH 6) Practicals Based On (Paper I & Paper II)

Credit 02 **30 Hrs**

List of Experiments of Semiconductor Physics and Devices and Electrodynamics

1. To study the regulated power supply.
2. To study the characteristics of Silicon Controlled Rectifier (SCR).
3. To study common emitter transistor amplifier.
4. To design and study of Asteable, Monostable and Bistable multivibrator.
5. To study the characteristics of FET and MOSFET and application as an amplifier.
6. To study Uni-junction transistor and its application.
7. To design and study Basic, NAND and NOR Gates by using TTL.

8. To design and study Combinational logic.
9. To design and study of different Flip-Flops.
10. To construct and study Half & Full Adder
11. To design and study of Half & Full Subtractor
12. To study the applications of Operational Amplifier.
13. To study Differential Amplifier.
14. To study MOSFET common source amplifier
15. To verify Biot-Savart law.
16. To verify Faraday's Law.
17. To study dissociation energy of iodine molecule.
18. To study nonlinear applications of op-amps.
19. To construct and study the working of an active low pass, high pass and band pass filter using op-amps.
20. To construct and study phase shift oscillator using op-amps.
21. To determine the characteristics parameters of an optical fiber.
22. To determine energy band gap of a semiconductor by four probe method.
23. To determine energy band gap of semiconductor by studying give luminescence spectra.
24. To study direct and indirect band of semiconductor using given absorption spectra.
25. To study photo-conductivity of a semiconductor material.
26. To study of lifetime of minority carriers of a semiconductor.

M.Sc. Semester I Lab.-II (01MSCPH 7) Practicals Based On (Paper III & any one Elective)
Credit 02 30 Hrs

List of Experiments of Mathematical Physics and Complex Analysis and Numerical Method

1. Write algorithm, draw a flowchart and write a program to find the solution of transcendental or polynomial equations by Newton Raphson method.
2. Write algorithm, draw a flowchart and write a program to solve matrix summation, subtraction and multiplication.
3. Write algorithm, draw a flowchart and write a program to solve matrix inversion and solution of simultaneous equation.
4. Write algorithm, draw a flowchart and write a program to solve numerical integration of given problem using Simpson's 1/3 rule.
5. Write algorithm, draw a flowchart and write a program to solve numerical integration of given problem using Gaussian quadrature method.

6. Write algorithm, draw a flowchart and write a program to solve given first order differential equation using the Runge-Kutta method.
7. Write algorithm, draw a flowchart and write a program for Lagrange Interpolation.
8. Write algorithm, draw a flowchart and write a program to find the solution of ordinary differential equation by Method of successive approximation
9. Write algorithm, draw a flowchart and write a program to find the roots of the given equation by Bisection Method.
10. Write algorithm, draw a flowchart and write a program to solve a system of linear equations by Gaussian Elimination Method.
11. Write algorithm, draw a flowchart and write a program to find the line of best fit by Linear Least Squares Fit Method.
12. Write algorithm, draw a flowchart and write a program to evaluate the definite integral by Simpson's 3/8 th rule.

List of Experiments of Astrophysics

1. To estimate the temperature of an artificial star by photometry
2. To study the characteristics of a CCD camera
3. To study the solar limb darkening effect
4. To study the polar alignment of an astronomical telescope.
5. To estimate the night sky brightness with a photometer
6. To estimate the distance to the moon by parallax method

Experiment List of Energy Physics

1. Determine Rydberg's constant by solar spectrum.
2. Determination of Planck's constant using photocell.
3. Study the energy spectrum of gamma rays using gamma ray spectrometer.
4. Study the V-I Characteristics of the solar cell and hence determine the fill factor.
5. Determine the value of Stefan's constant.
6. Determine the band gap energy of the given semiconductor.

List of Experiments of Introduction to Python

1. Write a basic arithmetic and Hello world programs.
2. Write programs for Variables, and Operators and Data types.
3. Write a program for declaring and assigning value to a constant.
4. Write a program for to calculate length of string.
5. Write a program for user defined functions.
6. Write a program for Conditional statements (if, elif, else) and Loops.
7. Write a program to find whether given number is odd or even.
8. Write a program to reverse the order of the items in a list.
9. Write a program for Numerical integration and differentiations – Monte-Carlo Methods and Random number generation : Estimation of pi and serial auto-correlation.
10. Write a program for Linear algebraic equation – Guass Jordon method.
11. Write a Python function to calculate the factorial of a number. The function accepts the number as an argument.

List of Experiments of Biophysics

1. To study the charge characteristics of cells through micro-Electrophoresis.
2. Study of DNA-Protein interaction using fluorimetry.
3. PAGE and SDS PAGE
4. Gel filtrations chromatography
5. Osmolarity: Determination of osmotic pressure of salts.
6. Verification of Beer's & Lamber's Law
7. Study of infrared spectrum of a given material theoretically.
8. Study of Ramachandran diagrams of moni and dipepetides.
9. Theoretical study of absorption and fluorescence spectra of biomolecule.
10. Audiometry

Note:

1) **Teacher can introduce new and relevant experiments which are not in the list of Lab. I and Lab. II.**
2) **It is expected that Teacher should select some experiments from the elective paper that he has chosen.**

M.Sc. Semester II (DSC-1) Paper I (02MSCPH 1) Fundamentals of Quantum Mechanics

Credit 03 45 Hrs

Course Objectives:

- To understand the different formalism of quantum mechanics.
- To solve Schrodinger equations for different systems.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To learn the basic concepts of Quantum mechanics which applies to all the physical systems irrespective of their size and can be beautifully perceived at atomic and subatomic level.
- To understand the various operators used to represent dynamic variables.
- To obtain the eigen values and eigen functions of linear harmonic oscillator and Hydrogen atom which will help students to understand the behavior of microscopic systems.

Unit I **12 Hrs**

Brief journey from Classical to Quantum Mechanics, Concept of normalized and orthogonal wave functions, expectation value of a dynamic variable, Equation of continuity, Coordinate and momentum representation, Schrodinger equation in momentum representation, Schrodinger Time Dependent and Time Independent wave equations, Application for 1D infinite, finite square well and tunneling through square potential barrier. Ehrenfest‟s theorem, momentum eigen functions in the coordinate representation, box normalization and Dirac delta function. Numericals.

Unit II **11 Hrs**

Linear vector space, Dirac notations of Bra - Ket notation, Matrix representation of Observables and states, Determination of eigen values and eigen state for observables using matrix representations, Change of representation and unitary transformations, Coordinate and momentum representations, Equations of motion in Schrödinger and Heisenberg pictures. Numericals.

Unit III **11 Hrs**

Symmetry invariance and conservation laws, relation between rotation and angular momentum commutation rule, matrix representation, addition of angular momentum and Clebsch Gordon coefficients, Pauli's spin matrices. Green's function, method of solving inhomogeneous differential equations, Boundary Conditions, Application to One dimensional problems. Numericals.

Unit IV **11 Hrs**

Operator formulations, Hermitian operators and their spectrum, Projection operator, Parity operator, Commuting operators, Eigen values and eigen functions of linear harmonic oscillator by Schrodinger equation and by operator method. Motion in a central field, Schrodinger Equation in spherical coordinates, Hydrogen atom problem, Eigen values and eigen functions of angular momentum operators L2 and Lz, Spherical harmonics. Numericals.

Text Books and Reference Books

1. Eugen Merzbacher, "Quantum Mechanics"3rd Ed., Wiley, 1997.
2. Aurthur Beiser, "Concept of Modern Physics", 6th Ed. Tata McGraw Hill
3. B. H. Bransden & C. J. Joachain, "Quantum Mechanics", Pearson, 2000.
4. L. I. Schiff, "Quantum Mechanics", 3rd revised edition, 1968 McGraw Hill Higher Education.
5. Arul Das, "Quantum Mechanics", 2nd Ed. PHI
6. David J Griffiths, "Introduction to Quantum Mechanics" Pearson, 2015.
7. Ajoy Ghatak, "Quantum Mechanics -Theory and Applications" Trinity, 2015.
8. R. Shankar, "Principles of Quantum Mechanics", 3rd Ed., Springer, 2008.
9. J. J. Sakurai, "Modern Quantum Mechanics" Addison-Wesley, 1993.
10. B.K. Agrawal and Hari Prakash, "Quantum Mechanics", PHI

M.Sc. Semester II (DSC-2) Paper II (02MSCPH 2) Solid State Physics

Credit 03 **45 Hrs**

Course Objectives:

- To study the defects in crystals
- To learn the properties of superconducting materials.
- To understand the characterization techniques like NMR, NQR, FMR, ESR and its applications
- To know about the theory of Lattice Specific Heat.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To have a brief idea about different defects in crystal.
- To understand the types of superconductor and its type of transition.
- To know about the characterization techniques like NMR, NQR, FMR, ESR and their applications
- To better understanding of AC and DC Josephson effect.

UNIT I **12 Hrs**

Point defects: Impurities, Vacancies and Interstitials, Schottky and Frenkel defects, Concentration of Schottky & Frenkel defects as function of temperature, Diffusion through Solids and ionic Conductivity, Colours of Crystals, Experimental facts about F-center and F-band Spectra, de Boer model of F-center, Line defects or Dislocations, Edge dislocation, Screw dislocation, Burger's vector and Burger Circuuit.

UNIT II **11 Hrs**

Superconductivity: Meissner effect, Type & Type II Superconductors, Entropy and Heat capacity, Energy gap, Microwave and Infrared properties, Isotope effect, Thermodynamics of superconducting transition- Rutger's formula, Electrodynamics of superconducting transition- London equations, Coherence length, BCS theory, High Tc Superconductors, Superconducting Tunneling (D.C, and A.C.), Josephson effects.

UNIT III **11 Hrs**

Nuclear Magnetic Resonance (NMR), Equations of motion, longitudinal and transverse relaxation times, Line width, Experimental method, applications: Determination of nuclear magnetic moments, structural studies, diffusion in solids. Nuclear Quadrupole Resonance (NQR), Ferromagnetic Resonance (FMR). Electron Spin Resonance (ESR): Nature of the phenomenon. experimental study, Few applications.

UNIT IV **11 Hrs**

Theories of lattice specific heat, Dulong and Petit's law, Einstein and Debye Model (T^3 law) Electron moving in one, two & three-dimensional potential well, Density of state, Relaxation time, mean the path and Thermionic emission. Quantum state of electron, Spectrum of Hydrogen, LS & JJ Coupling, Auger Transition.

Text Books and Reference Books

1. H. E. White, “Introduction to Atomic Spectra”
2. Charles Kittel, “Solid State Physics”, John Willey & Sons
3. C. Kittle, “Introduction to Solid State Physics”
4. S. O. Pillai, “Solid State Physics”
5. Babbar Puri, “Solid State Physics”
6. A. J. Dekker, “Solid State Physics”

7. Board and Huano, “Dynamic Theory of Crystal Lattice”
8. Herzberg, “Spectra of Diatomic Molecules”
9. J. M. Brown, “Molecular Spectroscopy”
10. Jeane L. McHale, “Molecular Spectroscopy”

M.Sc. Semester II (DSC-3) Paper III (02MSCPH 3) Classical and Statistical Mechanics

Credit 03 **45 Hrs**

Course Objectives:

- To study the concepts of generalized coordinates and D’Alembert’sprinciple.
- To understand canonical transformation and Poisson Bracket and their properties
- To learn about LudwigBoltzmann relation and Sackur-Tetrode equation.
- To study the MB, BE and FD statistics.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To know about the Lagrangian dynamics and the importance of cyclic coordinates.
- To understand the Lagrangian and Hamiltoniandynamics.
- To recognize the difference between macro-state and microstate.
- To know about different statistics and their applications.

UNIT I **12 Hrs**

Mechanics of a system of particles, Constraints, Classification of Constraints, Generalized Co-ordinates, Generalized momenta, Cyclic Co-ordinates, Virtual displacement and principle of virtual work, D’Alembert Principle, Lagrange’s Equation.

Calculus of variation, Euler-Lagrange Equation, Application of Variational Principle, Variation under constraints, Lagrange’s multipliers, Principle of least action, Hamilton’s principle, Hamilton’s equations and its applications.

UNIT II **11 Hrs**

Canonical Transformation, Generating function, Infinitesimal canonical transformation, Conditions for canonical transformation and problems, Poisson Brackets and their properties, Invariance of Poisson Bracket under canonical transformation, Hamilton-Jacobi Equations, Action and Angle Variables. The Rigid body motion, Euler Angles, Euler’s

Equation of motion, Motion of heavy symmetrical Top, Theory of small oscillations, Free vibration of a lineartri-atomic molecule, Transition from a discrete to a continuous system.

UNIT III **11 Hrs**

Macrostates and Microstates, Phase Space and Quantum states, LudwigBoltzmann relation and Entropy, Condition for statistical equilibrium, Postulate of equal a prior probability, chemical potential, Ensembles, Partition Function, Partition function for microcanonical, canonical and grand canonical ensembles. Gibbs Paradox, Sackur-Tetrode equation.

UNIT IV **11 Hrs**

Maxwell-Boltzmann distribution law, Bose-Einstein Distribution law, Density of states for relativistic and non-relativistic particles, Degeneracy of Boson gas, Derivation of energy, pressure and specific heat of Boson gas. Bose-Einstein condensation, Properties of liquid Helium II. Fermi-Dirac Distribution Law, Degeneracy of Fermi gas, Energy and pressure of Fermi gas at absolute zero, Fermi energy, Fermi temperature, Heat capacityof electron gas.

Text Books and Reference Books

1. Herbert Goldstein, Charles P. Poole, John L. Safko, "Classical Mechanics",Pearson Education, India, 2011,
2. N. C. Rana, P. S. Joag, "Classical Mechanics", McGraw Hill, 2017
3. R. G. Takwale, P. S. Puranik, "Introduction to Classical Mechanics",McGraw Hill, 2017
4. R.K. Patharia, Paul D. Beale, "Statistical Mechanics", Elsevier Ltd.
5. Keith Stowe, "An Introduction to Thermodynamics and StatisticalMechanics", second Edition, Cambridge University Press.
6. Richard Fitzpatrick, "Thermodynamics and Statistical Mechanics".
7. Sanchez and Bowley, "Introductory Statistical Mechanics", Oxford; 2nd
8. F. Reif, "Fundamentals of Statistical and Thermal Physics" McGraw-Hill,New York NY, 1965.
9. S.C. Garg, R.M. Bansal & C.K. Ghosh, "Thermal Physics" Tata McGraw-Hill Education.

M.Sc. Semester II Paper IV (DSE-1) (02MSCPH 4.1) Advanced Optoelectronics

Credit 03 **45 Hrs**

Course Objectives:

- The primary objective is to introduce the physics of Laser systems, non-linear optical phenomena, optical phase conjugation and Optical fibers.
- Another objective is to go deeper in laser physics and fiber-optic communication.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To gain the knowledge of basic concepts of optical communication and of different types of optical fibers thereby getting enabled to appreciate the huge advantage of such systems.
- To know about various types of fiber optic sensors and their use in the areas of security, safety, medical and space ventures.
- To learn the fundamental mechanism in Lasers like Mode selection, Mode Locking and Q-switching.
- To know about various types of lasers available and their applications.

Unit I **11 Hrs**

Fiber as a guiding medium, Total Internal reflection, Acceptance angle, Numerical aperture, Types of fiber, Refractive index profiles, Concept of modes, Electromagnetic analysis of guided modes in symmetric step index, planar wave guide and step index fiber, Concept of Normalized Frequency, V Parameter, Pulse dispersion in step index fibers, Concept of Dispersion shifted and Dispersion flattened Fibers, Fiber attenuation, Misalignment losses, Fiber material, Fiber fabrication, Splices and Connectors.

Unit II **11 Hrs**

Luminescence, Direct and indirect band gaps materials, Principle of electroluminescence, LED source materials and emission wavelengths, Surface emitting and Edge emitting LED structures, Double hetro-junction (DH) LED structure, Emission properties and efficiency of LED, Semiconductor Lasers, Laser Modes, Condition for lasing action, Principle of the operation of photo-detector, Materials for Photo-detectors, Types of photo detectors.

Unit III **12 Hrs**

Losses in the cavity-quality factor, line width of the laser, Mode selection-Transverse and longitudinal, free spectral range and finesse of etalon, Q-Switching-Peak Power, Total Energy, Pulse duration, Techniques for Q Switching- Mechanical, electro-optic and acousto-optic, Mode locking in lasers. Theory, Techniques for mode locking – Acousto-optic and electro-optic, Laser Systems –Excimer Laser, Free Electron Lasers –

Introduction, Single particle dynamics, wiggler, electron trajectory, FEL Gain, Spontaneous Emission, effect of input wave polarization on FEL gain, Properties of Lasers – Directionality, Coherence.

Unit IV **11 Hrs**

Quantization of Analog signal, A/D and D/A conversion, Bit Rate, Pulse Code Modulation, NRZ, RZ and Manchester Coding, Base Line Wander Effect Advantages of Optical Communication, Eye pattern Technique Direct Detection and Coherent Heterodyne Detection, Fabrication of Integrated optical Devices: Substrate, cleaning of the substrate., Methods used to produce wave guiding layers, Sputtering and Dipping, Ion migration, Fiber optic sensors: Phase and polarization fiber sensors, Intrinsic sensors, Extrinsic fiber sensors, Sagnac Effect, Gyroscope.

Text Books and Reference Books

1. William T. Silfvast, "Laser Fundamentals", Cambridge University Press.
2. Rajesh Shukla, "Introduction to Optical Fibers and its Applications", Lap LambertAcademic Publishing.
3. A. Ghatak and K. Thyagrajan, "Optical Electronics", Cambridge University Press
4. Joseph H Eberly and Peter W Miloni, "Laser Physics", Wiley
5. Orazio Svelto, "Principle of Lasers", Springer
6. John M Senior, "Optical Fiber Communication Principle and Practice", Pearson Education
7. John Gower, "Optical Communication Systems", Prentice Hall of India
8. Palais, "Fiber Optics Communication", University Press.
9. B. B. Laud, "Lasers and non-linear Optics", New Age International (P) Limited Publishers

M.Sc. Semester II Paper IV (DSE-2) (02MSCPH 4.2) Plasma Physics and Space Science

Credit 03 **45 Hrs**

Course Objectives:

- To understand the characteristic properties of plasmas, including how they can be created and where they appear.
- To learn plasma physics concepts and phenomena by considering applications ranging from fusion energy generation and microwave techniques to space science.

Course Outcomes:

Upon completion of the course successfully, students would be able

- To understand the basic concepts of Plasma Physics and will have very good knowledge of

mathematical models for plasma and will be able to distinguish the dynamics of plasmas and neutral fluid media.

- To describe the propagation of waves in plasmas and applications of Plasma Physics.
- To know about the atmospheric structures, the Sun-Earth system and space weather.
- To deal of excitement with our current understanding into the mysteries of the stars and universe.

Unit I **11 Hrs**

Elementary Concept of Plasma: Definition of Plasma, Plasma as ionized gas, Saha's ionization equation, Concept of Plasma temperature, Debye shielding, Quasi-neutrality, Plasma parameters, Plasma approximation, Hydro dynamical description of plasma, fundamental equations.

Occurrence of Plasma, Applications of Plasma in brief with special reference to nuclear fusion and particle acceleration. Single-particle motion, Dynamics of charged particles in electro-magnetic fields, particle drifts, EXB drifts, Grad-B drift, Curvature drift, Polarization drift

Unit II **11 Hrs**

Wave phenomena in magneto plasma: polarization, phase velocity, group velocity, cutoff, resonance for electromagnetic wave propagating parallel, perpendicular to magnetic field, Appleton-Hartree formula. Kinetic theory of Plasma: Vlasov equations, Solution of linearized Vlasov equation, Langmuir waves, Wave-particle interaction and Landau damping. Fluid theory of Plasma oscillations, Electron-acoustic waves, Ion-acoustic waves. Applications of plasma physics (only theory in brief) to nuclear fusion and particle acceleration.

Unit III **11 Hrs**

Atmosphere, atmospheric layers, composition. Elements of Ionosphere and Magnetosphere, structure and density profile, ionosphere-magnetosphere coupling. Structure of the Sun: solar interior, solar atmosphere, photosphere, chromospheres, corona. Sunspots and their properties, Sun-Earth interactions, basic concept of storm and substorm phenomena. Solar activity cycles, solar wind, solar flares, coronal mass ejections (CMEs), Space weather, causes and consequences, space climate.

Unit IV **12 Hrs**

Stellar structure (equilibrium, nuclear reactions, energy transport) and stellar evolution (with example of our Sun). Chandrasekhar limit for white dwarfs. Neutron stars and Black holes. Exoplanets. Morphology and types of galaxies: Our Milky Way. Concept of dark matter. Cosmic microwave background radiation. HST and Planck observations. Redshifts. Accelerated expansion of the Universe and current explanations with and without dark energy. Evolution of the Universe.

Text Books and Reference Books

1. R.P. Singhal, "Element of Space Physics", Prentice Hall of India, New Delhi.
2. Baidyanath Basu, "Introduction to Astrophysics", Prentice Hall of India, 2013.
3. J. A. Bittencourt, "Fundamentals of Plasma Physics", Springer, New York, 2004).
4. P. M. Bellan, "Fundamentals of Plasma Physics", Cambridge, UK, 2006.
5. A. Piel, "Plasma Physics: An Introduction to Laboratory, Space and Fusion Plasmas" Springer, Heidelberg, 2010.
6. S.A. Ackerman and J.A. Knox, "Meteorology Understanding the Atmosphere, Thomson Learning".

M.Sc. Semester II Paper IV (DSE-3) (02MSCPH 4.3) Practical Electronics

Credit 03 **45 Hrs**

Course Objectives:

- To understand the various memory devices.
- To make familiar with 8085/8086 microprocessor and its applications.
- To understand the various types of display devices.
- To learn about the different types of modulations and oscillators.

Course Outcomes:

After learning this course, student will be able

- To know about the memory, types of memory devices and its applications.
- To know about the basics of electronic display devices.
- To understand 8085/8086 Microprocessor and its various operations.
- To know the concept of modulation and demodulation.

Unit I **11 Hrs**

Memory Devices: Read Only Memory (ROM): PROM, EPROM, EEPROM, Applications, Programming a ROM, Random Access Memory (RAM): SRAM, DRAM, Applications, Memory Storage cell, Read and Write operations, Programmable Logic Devices (PLD) Digital Display, Seven segment display

Unit II **11 Hrs**

Basics of Microprocessor-8085/8086, PIN description, Internal microprocessor architecture, bus buffering and latching, bus timings, ready and wait states, minimum mode versus and maximum mode. Real and protected mode of memory addressing, memory paging, addressing modes, data addressing modes, programme memory addressing mode, stack memory addressing modes, instruction sets, data movement instruction, arithmetic and logic instruction, programme control instruction, clock generator (8284A).

Assembly language programming. 8085/8086 instruction, Microprocessor Applications, Recent trends in Microprocessor Technology.

Unit III **12 Hrs**

Display Devices: Introduction to displays. Requirements of displays. Display technologies, CRT, Flat panel and advanced display technologies. Technical issues in displays. Head mounted displays. Displays less than and greater than 0.5 m diagonal, Low power and light emitting displays.

Operation of TFTs and MIMS. LCDs, Brightness. Types of LCD displays, Emissive displays, ACTFEL, Plasma display and Field emission displays, operating principle and performance. Types of Displays: 3D, HDTV, LED, Touch screen.

Unit IV **11 Hrs**

Basic principle of amplitude frequency and phase modulation. Simple circuits for amplitude modulation and demodulation, digital (PCM) modulation and demodulation. Fundamentals of optical communication, Microwave Oscillators (reflex, klystron, magnetron and Gunn diode), Cavity resonators, Standing wave detector.

Text Books and Reference Books

1. B. Ram, “Fundamentals of Microprcessor and Microcomputers”, Dhanpat Rai & Sons
2. Anil Maini, Varsha Agrawal," Electronic Devices and a Circuits" Wiley
3. A. Malvino and D. J. Bates, “Electronic Principles”, Mc Graw Hill Education, India
4. Boylstad & Neshishkey, "Electronic Devices & Circuits", PHI
5. Milliman, J. Halkias, "Integrated Elctronics", Tata McGraw Hill
6. J. J. CatheySchaum's Outlines, "Electronic Devices & Circuits" Tata McGraw Hill.
7. A. P. Malvino, D.P. Leach, "Digital Principles and Applications", McGraw Hill Book Co., 4th Edition (1986).
8. George Kennedy," Electronic Communication Systems", Tata McGraw Hill.
9. Dennis Roddy, John Coolen, "Electronic Communication Systems ", Pearson

M.Sc. Semester II Paper IV (DSE-4) (02MSCPH 4.4) Medical Physics

Credit 03 **45 Hrs**

Course Objectives:

- To introduce biosignals, their characteristics.
- To understand the basic principles and working of various electrodes and sensors.

- To provide understanding of ECG, EEG, ENG, MRI, Tomography, ultrasonography and applications of Laser.

Course Outcomes:

After learning this course, student will be able

- To learn and understand characteristics of biosignals.
- To understand basic principles of various types of bioelectrodes & sensors.
- To discuss basic principle of ECG, EEG, ENG, MRI and various imaging techniques in medical field.

UNIT I **11 Hrs**

Signals & classification, Biosignals and origin, volume conduction, Time & frequency domain, characteristics of biosignals such as ECG, EEG, EP, EMG, MEG Signal acquisition & processing basics.

Unit II **12 Hrs**

Electrode-electrode interface, polarization, Electrode behaviour & circuit model, Electrode skin interface, Body surface electrodes, internal electrodes, Microelectrodes, Biosensors, Pulse Sensors, temperature measurement, fibre-optic sensors, radiation sensors for biomedical uses.

UNIT II **11 Hrs**

Sphygmomanometer: Measurement of heart rate, Basic Principles of EGC, Basic Principles of EEG, Basic Principles of Electroneurography (ENG), basic Principles of MRI.

UNIT IV **11 Hrs**

Basic Principles of X-ray Tomography, Endoscopes, Thermography, Liquid Crystal thermography, Microwave thermography, Basic Principles of ultrasonography, Laser, Uses of Lasers in Medicine.

Text Books and Reference Books

1. Biomedical Instrumentation, Dr. M. Arumugam, Anuratha Agencies (2002).
2. Hand book of Biomedical Instrumentations, R.S. Khandpur, TMG, New Delhi (2005).
3. Bio-Medical Electronics and Instrumentation, K.Venkata Ram, Galgotia Publications, New Delhi (2001).
4. Medical Physics, John R. Cameron, J. G. Skofronick, John Wiley and Sons, Inter. Publications.

M.Sc. Semester II Paper IV (DSE-5) (02MSCPH 4.5) Data Science

Credit 03 **45 Hrs**

Course Objectives:

- To introduce the principles, techniques, and tools used in data science.
- To cover the core principles, methodologies and tools used to extract knowledge and insights from data.
- To manipulate, analyze, and visualize data, as well as how to interpret and communicate the findings effectively.

Course Outcomes:

After learning this course student will be able to

1. Understand the fundamental concepts of data science and its applications.
2. Demonstrate proficiency in data acquisition, manipulation, and cleaning.
3. Apply various data analysis and visualization techniques.
4. Appreciate the ethical considerations in data science and data privacy.
5. Learn various data science tools use for various applications.

Unit I **11 Hrs**

Introduction to Data Science: Definition of Data Science and its applications, Basic Terminology of Data science, Venn diagram, Types of data, Structured versus Unstructured data, Quantitative versus Qualitative data, The four levels of data, Five steps of Data Science, Data Science Process Overview, Data science classification, Data Science Algorithms, Components of Data Science.

Unit II **12 Hrs**

Getting to Know Your Data: Data Objects, Attribute Types, Properties of Attribute values, types of data sets, Basic Statistical Descriptions of Data – central tendency, dispersion of the data. Measuring Data Similarity and Dissimilarity: Euclidean, Jaccard's Index & Cosine Similarity, Data visualization, Types of Data visualization, Various visualization techniques.

Data Pre-processing on Big Data: Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization (ETL Operations), Feature Generation and Feature Selection, Feature Selection algorithms: Filters- Wrappers - Decision Trees - Random Forests

Unit III **11 Hrs**

Data Modelling and Analytics: Introduction to Data Modelling and Analytics, Types of Data Modelling, Analytics for Data Science, Data Analytics Examples, Data Analytics Life Cycle, Data Discovery, Data preparation, Model Planning, Model Building, Operationalization.

Data Privacy and Security: Risks and best practices, Ethical Considerations in AI and Data Collection.

Unit IV **11 Hrs**

Introduction to Data Science Tools- Apache Cassandra, BigML, Excel, Tableau, Matplotlib, Python and Jupyter Notebook.

Applications: Hands-on with Solving Data Problems, Introduction-Collecting and Analyzing Twitter Data, Collecting and Analyzing YouTube Data.

Text Books and Reference Books

1. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, Fundamentals of Data Science, 1st Edition, 2022.
2. Daimi, Kevin, Ed. Hamid R. Arabnia, Principles of Data Science, Springer, 2020.
3. Sinan Ozdemir, Principles of Data Science, Packt Publishing, December 2016.
4. Cielen, Davy, Arno DB Meysman, Mohamed Ali, Introducing Data Science: Big Data, Machine Learning, and more, using Python Tools, Manning Publications Co., 2016.
5. Andreas François Vermeulen, Practical Data Science, APress, 2018.

M.Sc. Semester II Lab.-I (02MSCPH 6) Practicals Based On (Paper I & Paper II)

Credit 02 **30 Hrs**

List of Experiments Fundamentals of Quantum Mechanics and Solid State Physics

1. To study of measurement of hall coefficient of a given semiconductor.
   Identification of types of semiconductor & determination of charge carrier concentration.
2. To determine dielectric constant of a substance by using resonance method.
3. To construct and study the model of crystal.
4. To study the Screw & Edge dislocation.
5. To determine the Lande g-factor by using electronic spin resonance spectrometer.
6. To determine the energy band gap of semiconductor (Ge) using four probe method.

7. To determine magnetic susceptibility of a solution of different concentration and to find magnetic susceptibility of each $FeCl_3$ using Quinck's method.
8. To determine the thermal conductivity of a bad conductor by using lee's disc method.
9. To colour plot magnetic hysteresis loop of a ferromagnetic rod.
10. To determine the energy gap of Thermister.
11. To determine Planck's constant.
12. To determine Steafan's constant.

M.Sc. Semester II Lab.-II (02MSCPH 7) Practicals Based On (Paper III & any one Elective)
Credit 02 30 Hrs

List of Experiments of Classical and Statistical Mechanics

1. Study of Focault pendulum
2. Study of Bifilar pendulum
3. Simulation of simple pendulum
4. Simulation of compound pendulum
5. Simulation of planetary motion.

List of Experiments of Advanced Optoelectronics

1. Thickness of thin wire with lasers
2. Measurement of wavelength of He-Ne laser light using ruler.
3. To study Faraday Effect by using He-Ne laser.

List of Experiments of Plasma Physics and Space Science

1. To study of Plasma parameters such as Electron density, ion density, Electron temp, potential, Plasma Potential etc. by using Single and Double Langmuir probe.
2. Verification of Paschen curve.
3. To study of Plasma coating of different materials on substrate.
4. To study of Plasma cleaning of substrate surfaces
5. To demonstrate microwave plasma.
6. To study of collective behavior of a plasma by launching and detecting ion acoustic waves.
7. To study the conditions of occurrence of striations.

List of Experiments of Practical Electronics

1. To design and study PROM and EPROM using ICs.
2. To perform 4 bit DAC and ADC operations
3. To arrange a data set in ascending order using 8085/8086 microprocessor.
4. To study various operations of Arithmetic logic Unit (ALU).
5. To perform the addition and subtraction of n 8 bit numbers using 8085/8086 microprocessor
6. To perform the multiplication and division of two 8 bit number using 8085/8086 microprocessor.
7. To write a program to arrange an array of data in ascending order using 8085/8086 microprocessor
8. To design and construct multiplexer and demultiplexer and verify their truth tables.
9. To study the encoders and decoders
10. To perform BCD to Binary operation using 8085/8086 microprocessor.
11. To study modulation and demodulation (AM & FM).
12. To design and study Seven Segment Display.

List of Experiments of Medical Physics

1. Concept of ECG system and placement of electrodes ECG signal recording with surface electrodes.
2. Use of sphygmomanometers for measurement of blood pressure.
3. Measurement of pulse parameter using pulse oxymetry/pulse measuring instrument.
4. To study Thermistor Characteristics.
5. Active filters for Bio-signals- Design and Filtering (Low pass and High pass filter)

List of Experiments of Data Science

1. Install Python and Jupyter Notebook:
   - Download and install Python from the official website (https://www.python.org/).
   - Install Jupyter Notebook using pip: pip install jupyter
2. Data Cleaning:
   - Download a dataset from a reliable source (e.g., Kaggle, UCI Machine Learning Repository).
   - Load the dataset into a Pandas Data Frame.
   - Explore the dataset to identify missing values, duplicates, and outliers.
   - Clean the data by handling missing values, removing duplicates, and dealing with outliers.
3. Data Exploration:

- Select a dataset with multiple columns (features).
- Use Pandas to calculate summary statistics (mean, median, standard deviation, etc.) for numeric columns.
- Create frequency distributions for categorical columns.
- Visualize the data using histograms, box plots, scatter plots, and bar charts.

4. Data Visualization:

- Use Matplotlib or Seaborn to create a line plot, bar plot, scatter plot, and box plot.
- Customize the visualizations by adding titles, labels, and changing colours.
- Create a heatmap to visualize correlations between different numeric variables.

5. Basic Statistics:

- Calculate measures of central tendency and dispersion (mean, median, variance, etc.) for a numeric variable.
- Perform hypothesis testing (e.g., t-test) to compare two groups in the dataset.
- Use correlation analysis to explore relationships between numeric variables.

6. Data Analysis:

- Choose a dataset with a target variable and several features.
- Split the dataset into training and testing sets.
- Implement a basic machine learning model (e.g., linear regression, decision tree) using Scikit-learn.
- Train the model on the training set and evaluate its performance on the testing set.

Note:

1) **Teacher can introduce new and relevant experiments which are not in the list of Lab. I and Lab. II.**
2) **It is expected that Teacher should select some experiments from the elective paper that he has chosen.**