पूर्वोत्तर क्षेत्रीय विज्ञान एवं प्रौद्योगिकी संस्थान

North Eastern Regional Institute of Science & Technology

(मानद् विश्वविद्यालय, शिक्षा मंत्रालय, भारत सरकार)

(Deemed to be University, MoE, Govt of India)

निर्जुली, ईटानगर अरुणाचल प्रदेश – 791 109

Nirjuli, Itanagar, Arunachal Pradesh- 791 109

भौतिकी विभाग

DEPARTMENT OF PHYSICS

Four Year B.Sc. (Physics)

To be implemented from Academic Year 2025-2026

Syllabus of B.Sc.(Physics) as per NEP- 2020

Abbreviations Used:

- CO : Course Outcomes
- PS : Programme Structure
- TLP : Teaching-Learning Process
- UG : Undergraduate
- CC : Core Course
- MC : Minor Course
- MDC : Multidisciplinary Course
- OE : Generic Electives
- OP : Open Electives
- VSC : Vocational Skill Courses
- SEC : Skill Enhancement Courses
- CVAC : Common Value-Added Course
- AEC : Ability Enhancement Courses
- MNC : Mandatory non-credit Course

1. Introduction to Undergraduate Degree Course in Physics:

The undergraduate (UG) degree program in Physics is a VI-semester course spread over three academic years *or* an VIII-semester course spread over four academic years, as per UGC-F-2022 recommendations. The focus of the Teaching Learning Process (TLP) is the students. It has included both theoretical and practical aspects. It assures that students receive in-depth knowledge and a strong foundation in the subject while permitting flexibility in the program's structure. In addition to the Core Course, students can choose minor courses, vocational courses, and exit courses from the curriculum. The interdisciplinary and multidisciplinary approach as well as adherence to innovative techniques within the curriculum framework will thus be emphasized. Additionally, it provides students with the greatest amount of flexibility in their undergraduate (UG) studies, even granting them the freedom to eventually design a degree with several exit options. Without sacrificing instruction or learning outcomes, both qualitatively and quantitatively, students have various exit options based on their requirements and desires regarding their life goals. This will meet students' current needs in terms of guaranteeing their pathways to further education or employment.

2. *Programme Duration and Exit Options:*

The minimum credit to be earned by a student per semester is 15 credits. However, students are advised to earn maximum credits of that semester. This provision is meant to provide students the comfort of the flexibility of semester-wise academic load and to learn at his/her own pace. Students exiting the program after securing **40 credits** will be awarded ***UG Certificate*** in the relevant **Discipline/Subject** provided, they will earn **4 additional credits** in (exit course) work-based vocational courses offered during the summer vacation or internship/apprenticeship in addition to **6 credits** from skill-based courses during the first and second semesters. Students exiting the program after securing **80 credits** will be awarded a **UG Diploma** in the relevant **Discipline/Subject** provided they secure additional **4 credits** in skill based vocational courses offered during the first year or second-year summer vacation. Students exiting the program after securing **120 credits** will be awarded **UG Degree** in the relevant Discipline**/Subject**. Students for a 4-year **UG Degree (Honors)** need to complete additional **(3, 3, 2) Credits** major/minor courses in place of **MOOC** courses or need to complete additional **(4, 4, 4) Credits** major courses in place of Project.

A. **Major Discipline (Physics):** A student who completes the eighth semester of a four-year undergraduate program in Physics (core courses) will receive a B.Sc. Honors degree with a major in Physics, if they earn at least 50% of the total credits or at least 80 credits out of 160 credits.

B. Minor Discipline: A student of B.Sc. (Hons.) Physics may be awarded Minor in a discipline, other than Physics, on completion of VIII Semester, if he/she earns minimum 28 credits from six minor courses of that discipline.

3. Objectives of the Program

The undergraduate (UG) degree course in Physics aims to provide:

- The ability and knowledge to pursue higher education and research in physics and related multidisciplinary fields, which will facilitate students' career and entrepreneurial endeavors.
- Teamwork, scientific reasoning, critical and analytical thinking, problem-solving, and communication skills.
- The ability to solve problems involving both theoretical and applied physics with competence and proficiency.
- A thorough understanding of physics by comprehension of fundamental ideas, theories, and applications.
- Knowledge of the most recent developments in physics and related fields and research.
- A favorable learning atmosphere to guarantee students' cognitive growth.
- Adequate knowledge of the subject topic, which helps students prepare for competitive exams like the Civil Services Examinations, GATE, GRE, IIT-JAM, UGC-CSIR NET/JRF, and others.
- Moral and ethical consciousness, competence, innovation, and a commitment to lifelong learning.
- Proficiency in multiple languages and cultures.

4. Program Outcomes:

The physics program aims to produce graduates who have a solid understanding of physical concepts, scientific inquiry, critical thinking, and problem-solving abilities in addition to excellent laboratory, research, and communication skills.

The following are the learning objectives for the physics course for undergraduates:

- Role of Physics:

  Students will gain an understanding and admiration of the important role that physics plays in contemporary global and societal concerns. The skills and knowledge they will gain from the program will enable them to address and contribute to such situations. To manage a project through to completion and adhere to safety and laboratory hygiene rules and practices, as well as responsible and ethical scientific conduct, they will be able to identify and mobilize the necessary resources.

- Physical Concepts:

  Recognize and use basic physical concepts to evaluate and resolve issues in a variety of settings.

- Development of Research Skills:

  This course gives students the chance to develop their research and innovation skills through internships, projects, community engagement, dissertations, entrepreneurship, and academic projects. Students will be able to exhibit advanced abilities in data analysis, research ethics, information management, and literature surveys.

- Scientific Inquiry:

  To test theories, and hypotheses and find answers to scientific questions, design, carry out, and present experiments and studies.

- Hands-on/ Laboratory Skills:

  Analytical, computational, and instrumentation abilities will be imparted through extensive practical/laboratory activities and demonstration of expertise. When it comes to gathering, assessing, analyzing, and presenting data- both quantitative and qualitative students will be able to exhibit mature skills.

- Problem-Solving:

  Employ mathematical methods and physical concepts to tackle complex physics and related problems.

- In-depth disciplinary knowledge:

The student will gain thorough knowledge and comprehension of the basic ideas, theoretical principles, and procedures in the primary and related fields of physics. The core papers will offer a comprehensive grasp of the subject. Elective courses offered to the student will provide specialized understanding rooted in the core and interdisciplinary areas.

- Interdisciplinary Approach:

Utilize physical concepts to comprehend and address issues in various fields, including biology, engineering, and environmental science.

- Critical and Lateral Thinking:

The program of study will foster creativity, ingenuity, and the capacity to apply the fundamental ideas and concepts of physics and related subjects outside of the classroom to practical situations. Students will be able to differentiate between essential and insignificant facts and information, identify between objective and biased information, use logic to reach firm conclusions, determine whether conclusions are supported by enough evidence, derive accurate quantitative results, make logical assessments, and reach qualitative judgments by predetermined guidelines. Analyze arguments, evidence, and physical phenomena critically to draw well-informed judgments.

- Ethical Practice:

Exhibit knowledge of the ethical issues of data management, scientific research, and professional conduct.

5. ***Program Structure:***

The detailed Credit framework of the undergraduate degree program in Physics is provided below:

6. Teaching-Learning Process:

- The goal of the undergraduate physics program is to give students a solid theoretical foundation as well as practical insight into all facets of physics and research.
- It will assist students in acquiring an understanding of the significance of physics in various settings.
- The program covers both basic and advanced courses covering the conventional subfields of physics.
- ICT-enabled teaching-learning tools (PowerPoint presentations, audiovisual resources, e-resources, models, software, simulations, virtual labs, etc.) will be used in conjunction with the traditional chalk-and-talk method, laboratory work, projects, case studies, fieldwork, seminars, and hands-on training/workshops to deliver physics courses in a demanding, interesting, and inclusive way Students will be encouraged to carry out short term projects and participate in industrial and institutional visits and outreach programs.
- Complementing the theoretical concepts taught in the classroom, the laboratory training involves practical experience with contemporary instruments, modeling, error estimation, computational data processing, and laboratory safety protocols.
- Whenever feasible, a variety of pedagogies will be employed, including inquiry-based learning, project-based learning, experiential learning, participatory learning, and blended and flipped learning, which integrates ICT pedagogy.
- Group projects will be promoted to help students improve their interpersonal abilities, such as cooperation and communication.
- Students will establish a solid basis for a prosperous career in academia, industry, research, entrepreneurship, and community service through their conscientious and active involvement in industrial visits, internships, academic projects, and dissertations.

7. Assessment Methods:

The key objective of the evaluation will be to measure the course's learning outcomes about the overall objectives of improving foundational theoretical knowledge, research, and practical laboratory abilities. Assessment will be based on continuous evaluation of Class Tests (CT), Quiz, Assignments, and end semester examinations of North Eastern Regional Institute of Science and Technology (NERIST), Arunachal Pradesh.

- Internal Assessment or Continuous Evaluation:

Throughout a semester, Class Tests (CT), Quiz, and Assignments will be used to evaluate students' understanding of the various learning outcomes outlined in the syllabus. Each theory paper and practical paper will have 10 and 20 marks for internal assessment, respectively. The critical analysis of internal assessment or continuous evaluation outcomes will provide opportunities to improve the teaching-learning process by focusing on the areas that need conceptual strengthening, laboratory exposure or design of new experiments, and research.

- End Semester University Examinations:

The summative end-semester university examinations will be conducted for both theory and practical courses. Besides internal assessment, each theory paper and each practical paper will be of 100 marks for end semester examination of the institute.

Semester I (First Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC101	Electricity and Magnetism	3	0	0	3	CC
2	PHCC103	Mechanics	3	0	0	3	CC
3	CYMC101	Basic Chemistry	4	0	0	4	MC
4	PHSE102	General Physics Lab I	0	0	6	3	SEC
5	MAMD101	Calculus	3	0	0	3	MDC
6	HSAC101	Communication Skill	1	0	0	1	AEC
7	HSAC102	Communication Skill Lab	0	0	2	1	AEC
8	HSVA101	Essence of Indian Knowledge and Tradition	1	0	0	1	CVAC
9	SNVA102	Sports/Yoga or NSS/NCC	0	0	4	2	CVAC
Total						21	

Category	**CC**	**MC**	**CVAC**	**MDC**	**AEC**	**SEC/Intern./ Diss.**	**Course Category**
Semester Credit	6	4	3	3	2	3	21
Cumulative Sum	6	4	3	3	2	3	21

Semester II (First Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC201	Concepts of Physics and Applications	3	0	0	3	CC
2	PHCC203	Fundamentals of Electronics	3	0	0	3	CC
3	MAMC203	Linear Algebra	3	1	0	4	MC
4	CSSE201	Programming for problem solving	2	0	0	2	SEC
5	CSSE202	Programming for problem solving Lab	0	0	4	2	SEC
6	CYMD201	General Chemistry	3	0	0	3	MDC
7	HSAC201	Advance Communication Skill	1	0	0	1	AEC
8	HSAC202	Advance Communication Skill Lab	0	0	2	1	AEC
9	UHVA201	Universal Human Values	3	0	0	3	CVAC
10	SNVA202	Sports/Yoga or NSS/NCC	0	0	4	2	CVAC
		Total				23	

Category	CC	MC	CVAC	MDC	AEC	SEC/Intern./ Diss.	Course Category
Semester Credit	6	4	5	3	2	4	24
Cumulative Sum	12	8	8	6	4	7	45

Semester III (Second Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC301/ PHMD301	Wave and Oscillations	3	0	0	3	CC/MD
2	PHCC302/ PHMD302	Wave and Oscillations Laboratory	0	0	2	1	CC/MD
3	PHCC303	Optics I	3	0	0	3	CC
4	PHCC304	Optics Laboratory I	0	0	2	1	CC
5	MAMC301	Statistics and Probability	3	0	0	3	MC
6	CSSE301	Python and its applications	2	0	0	2	SEC
7	CSSE302	Python and its applications Lab	0	0	2	1	SEC
8	HSMD301	Principles of Economics/ Organizational Behaviour	3	0	0	3	MDC
9	HSAC301	English for Technical writing	2	0	0	2	AEC
10	HSAC302	English for Technical writing Lab	0	0	2	1	AEC
		Total				20	

Category	CC	MC	CVAC	MDC	AEC	SEC/Intern./ Disser.	Course Category
Semester Credit	8	3	0	3	3	3	20
Cumulative Sum	20	11	8	9	7	10	65

Semester IV (Second Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC401/ PHMC401	Mathematical Physics I	3	1	0	4	CC/MC
2	PHCC403	Analog Electronics	3	1	0	4	CC
3	PHCC405	Classical Physics I	3	1	0	4	CC
4	PHCC402	General Physics Laboratory II	0	0	4	2	CC
5	MAMC401	Analytical Geometry	4	0	0	4	MC
6	CYMC401	Environmental Science	2	0	0	0	MC
7	HSAC401	Digital Communication Tools	1	0	0	1	AEC
8	HSAC402	Digital Communication Tools Lab	0	0	2	1	AEC
9	HSAU301	Indian Constitution (Audit)	2	0	0	0	MNC/AU
		Total				20	

Category	CC	MC	CVAC	MDC	AEC	SEC/Intern./ Disser.	Course Category
Semester Credit	14	6	0	0	2	0	20
Cumulative Sum	34	17	8	9	9	10	87

Semester V (Third Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC501/ PHMC501	Solid State Physics I/ Solid State Physics	3	1	0	4	CC/ MC
2	PHCC503	Mathematical Physics II	3	1	0	4	CC
3	PHCC505	Electrodynamics I	3	1	0	4	CC
4	PHMC501	Radiation Physics	3	0	0	3	MC
5	CYMC501	Green Chemistry	3	0	0	3	MC
6	PHIN502	Internship	0	0	4	2	SEC/Inter
		Total				20	

Category	CC	MC	CVAC	MDC	AEC	SEC/Intern./ Disser.	Course Category
Semester Credit	12	6	0	0	0	2	20
Cumulative Sum	46	23	8	9	9	12	107

Semester VI (Third Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC601	Atomic and Molecular Physics I	3	1	0	4	CC
2	PHCC603	Nuclear Physics	3	1	0	4	CC
3	PHCC605	Digital Electronics	3	1	0	4	CC
4	PHCC606	Electronics Lab	0	0	4	2	CC
5	ECMC601	Electromagnetic Field Theory	3	0	0	3	MC
6	MAMC601	Vector Calculus	3	0	0	3	MC
		Total				20	

Category	CC	MC	CVAC	MDC	AEC	SEC/Intern./ Disser.	Course Category
Semester Credit	14	6	0	0	0	0	20
Cumulative Sum	60	29	8	9	9	12	127

Semester VII (Fourth Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC701	Mathematical & Computational Methods in Physics	3	1	0	4	CC
2	PHCC703	Quantum Mechanics I	3	1	0	4	CC
3	PHCC705	Classical Physics II	3	1	0	4	CC
4	PHCC702	General Physics Lab III	0	0	6	3	CC
5	PHMC701	Research Methodology	3	0	0	3	MC
6	ECMC701/ ECMC703	Antenna Engineering/ Optical Fiber Communication	3	0	0	3	MC
		Total				21	

Category	CC	MC	CVAC	MDC	AEC	SEC/Intern./Disser.	Course Category
Semester Credit	15	6	0	0	0	0	21
Cumulative Sum	75	35	8	9	9	12	148

Semester VIII (Fourth Year)

Sl. No.	Course Code	Course Title	L	T	P	Course Credit	Course Category
1	PHCC801/ MOCC801	Lasers Technology/MOOC	3	0	0	3	CC
2	PHCC803/ MOCC803	Energy Studies/MOOC	3	0	0	3	CC
3	PHCC805/ MOCC805	Modern Physics/MOOC	2	0	0	2	MC
4	PHPR802	Final year project (#)	0	0	24	12	Project
	OR						
	PHCC807	Electrodynamics II	3	1	0	4	CC
	PHCC809	Quantum Mechanics II	3	1	0	4	CC
	PHMC811	Statistical Mechanics	3	1	0	4	MC
Total						20	

Category	CC	MC	CVAC	MDC	AEC	SEC/Intern./Disser.	Course Category
Semester Credit	6	2	0	0	0	12	20
Cumulative Sum	81	37	8	9	9	24	168

Additional (3,3,2) Credits Major/Minor Course in place of MOOC course for the completion of 4-Years UG Degree (Honors).

#Additional (4,4,4) Credits Major Course in place of Project for the completion of 4-Years UG Degree (Honors). Final year project, student can perform at industry or at any other research laboratory.

Course Category (UGC)		First	Second	Third	Fourth	3 yrs	4 yrs
Core Course	CC	12	22	26	21	60	81
Mainor Course (Program elective and open elective)	MC	8	9	12	8	25	35
Common Value-Added Course	CVAC	8	0	0	0	8	8
Multidisciplinary Course	MDC	6	3	0	0	9	9
Ability Enhancement Course	AEC	4	5	0	0	9	9
Skill Enhancement Course	SEC	7	3	0	0	10	10
	Internship	0	0	2	0	2	2
	Research Project	0	0	0	12	0	12
	Total	45	42	40	40	125	168

List of Courses

Note: **Every theory/practical subject has 3 credits.**

List of Core Courses

Semester I

PHCC101: Electricity and Magnetism
PHCC103: Mechanics

Semester II

PHCC201: Concepts of Physics and Applications
PHCC203: Fundamental of Electronics

Semester III

PHCC301: Waves and Oscillation
PHCC302: Waves and Oscillation Laboratory
PHCC303: Optics I
PHCC304: Optics Laboratory I

Semester IV

PHCC401: Mathematical Physics
PHCC403: Analog Electronics
PHCC405: Classical Physics I
PHCC402: General Physics Laboratory II

Semester V

PHCC501: Solid State Physics-I
PHCC503: Mathematical Physics-II
PHCC505: Electrodynamics I

Semester VI

PHCC601: Atomic and Molecular Physics-I
PHCC603: Nuclear Physics I
PHCC605: Digital Electronics
PHCC606: Digital Electronics Laboratory

Semester VII

PHCC701: Mathematical & Computational methods in Physics
PHCC703: Quantum Mechanics I
PHCC705: Classical Physics II
PHCC702: General Physics Laboratory-III

Semester VIII

PHCC801/MOCC801: Laser Technology/MOOC
PHCC803/ MOCC803: Energy Studies/MOOC
PHCC807: Electrodynamics II

PHCC809: Quantum Mechanics II
PHCC811: Statistical Mechanics

List of Minor (MN) Courses:

Semester-I: (3 Credit)
CYMC101: Basic Chemistry

Semester-II: (03 Credit)
MAMC203: Linear Algebra

Semester-III : (3 Credits)
MAMC301: Statistics & Probability

Semester-IV : (3 Credits)
MAMC401: Analytical Geometry

Semester-V : (3 Credits) (T)
CYMC507: Green Chemistry
ECMC501/ECPC501: Electomagnetic Field Theory

Semester-VI : (6 Credits) (T)
MAMC601: Vector Calculus
PHMC601: Radiation Physics

Semester-VII : (6 Credits) (T)
PHMC701: Research Methodology
ECMC701: Antenna Engineering

Semester-VIII : (2 Credits) (T)
PHMC805/ MOCC805: Modern Physics/MOOC
PHMC811: Statistical Mechanics

List of Ability Enhance Courses (AEC):

Semester-I:
HSAC101: Communication Skill
HSAC102: Communication Skill Laboratory

Semester-II:
HSAC201: Advance Communication Skill
HSAC202: Advance Communication Skill Laboratory

Semester-III:
HSAC301: English for Technical Writing
HSAC302: English for Technical Writing Laboratory

Semester-IV:
HSAC401: Digital Communication Tools
HSAC402: Digital Communication Tools Laboratory

List of Co-Curricular Courses (CC):

Semester-I: Select any one
Select from University Bucket e.g. NSS, NCC, Yoga, etc……

Semester-II: Select any one
Select from University Bucket e.g. NSS, NCC, Yoga, etc……

Syllabus of Courses

I – Year: I – Semester

Course Code: PHCC101	ELECTRICITY AND MAGNETISM	Credits 3-0-0: 3

Course Objectives:

This course aims to introduce the Physics of Electricity and Magnetism to the students.

Objectives are.

- To Study the basic concepts of Electrostatics.
- To Study the basic concepts of Magnetostatics.
- To Study the basic concepts of Magnetism.
- To study the basic concepts of Electromagnetic Induction and dielectrics.

Course Outcomes: After completion of the course, students will be able to:

CO1	Explain the basic concept of Coulomb's law and Gauss's law, the principle of a capacitor, etc.
CO2	Describe the basic concept of magnetic flux, magnetic induction, magnetic field due to current carrying conductor, etc.
CO3	Outline the basic concepts of magnetism.
CO4	Explain the basics of electromagnetic induction, dielectric materials, etc.

Syllabus:

Unit I	**Electrostatics:** Coulomb's inverse square law, Electric Field and potentials, Field due to a uniformly charged sphere, Derivations of Poisson and Laplace Equations, Gauss Theorem, and its applications: for an Infinite Line of Charge, a Charged Cylindrical Conductor, an Infinite Sheet of Charge and Two Parallel Charged Sheets, Electric dipole, Field and potential due to an electric dipole, Principle of a capacitor-Capacity of a spherical and cylindrical capacitor, Energy stored in a capacitor, Loss of energy due to sharing of charges.	12 lectures
Unit II	**Magnetostatics:** Magnetic Effect of Currents, Magnetic Field, Magnetic force on a current, Magnetic Flux, Magnetic Induction, Biot-Savart's Law: a Straight Current Carrying Conductor. Magnetic Dipole, Magnetomotive force, Lorentz Force, Vector and Scalar Magnetic potentials, Ampere's Circuital law and its applications to calculate magnetic field due to wire carrying current and solenoid.	10 lectures
Unit III	**Magnetism:** Intensity of magnetization, Susceptibility, Types of magnetic materials, Properties para, dia and ferromagnetic materials, Cycle of magnetization, Curie temperature, Hysteresis, B-H curve, application of BH curve– Magnetic energy per unit volume.	10 lectures

Unit IV	**Electromagnetic Induction:** Laws of electromagnetic induction, Faraday's laws, and Lenz's Law, Self and mutual induction, Self-inductance of a solenoid, and mutual induction of a pair of solenoids, Vector potential in varying Magnetic fields, Skin effect, Motion of Electron in changing magnetic field, induced magnetic field, Displacement current, Maxwell's equations, Electromagnetic waves in free space, Theory and working of moving coil ballistic galvanometer. **Dielectrics:** Dielectric constant, polarization, Electronic, Atomic or ionic polarization, polarisation charges, Electrostatic equation with dielectrics, Field, force, and energy in Dielectrics.	10 lectures

Learning Resources:

Text Books:

1. Electricity and Magnetism, Brijlal and Subramaniyam, S. Chand & Co. 2020
2. Electricity and Magnetism, R. Murugesan, S. Chand & Co.2019
3. Electricity and Magnetism. By D C Tayal, Himalaya Publishing House. 2024
4. Electromagnetism for Engineers: An Introductory Course, P. Hammond, oxford science publication, 4th edition ,1997
5. Magnetism and Magnetic Materials, J.M.D. Coey, Cambridge University Press. 2010

Reference Books:

1. Electricity and Magnetism, Narayana Moorthy and Nagaratnam, NPC, Chennai.
2. Magnetic Materials: Fundamentals and Applications, Nicola A. Spaldin, Cambridge University Press, 2nd edition, 2010.

I – Year: I – Semester

Course Code: PHCC103	MECHANICS	Credits 3-0-0: 3

Course Objectives:

This course aims to introduce the Physics of Mechanics to the students.

Objectives are.

- To Study the basic concepts of Fundamentals of Dynamics.
- To Study the basic concepts of Fluid Mechanics.
- To Study the basic concepts of Rigid Body Dynamics.
- To study the basic concepts of Simple harmonic motions.

Course Outcomes: After completion of the course, students will be able to:

CO1	Outline the basic concept of laws of motion, the concept of conservation of energy, momentum, angular momentum, planetary motion, etc.
CO2	Explain the basic properties of matters such as viscosity and surface tension and the determination of various parameters associated with it.
CO3	Define the concepts of rigid body and its related dynamics.
CO4	Analyze the basics of harmonic motion.

Syllabus:

Unit I	**Fundamental of Dynamics:** Reference Frames, Newton's Laws of Motion and its limitations, Invariance of Newton's law under Galilean transformations, Fictitious forces, Effects of Centrifugal and, Coriolis forces due to earth's rotation. Significance of conservation laws, Law of conservation of energy, Concepts of Work, Power, and Energy, Conservative forces, Conservative force as the negative gradient of potential energy. Non-conservative forces–General law of conservation of energy, Conservation of momentum (linear and angular), Motion of a planet in an elliptical orbit around the sun. Potential Energy and Energy diagram. Kepler's laws of planetary motion. Concept of elastic and inelastic collisions. Derivation of final velocities in case of elastic collision and inelastic collision in mass and the laboratory frame of reference.	14 lectures
Unit II	**Fluid Mechanics:** Surface tension, Surface energy, the relation between surface tension and surface energy, the pressure difference across the curved surface, excess pressure inside the spherical liquid drop, and contact angle. Determination of surface tension by Ferguson method. Applications of surface tension. Effect of temperature, and impurity on surface tension. Viscosity, Streamline flow, turbulent flow, equation of continuity, Bernoulli's Theorem, determination of coefficient of viscosity by Poisulle's method, Stoke's method (with derivation). Effect of temperature and pressure on viscosity.	12 lectures
Unit III	**Rigid Body Dynamics**: Degrees of freedom, Rigid body-translational and rotational motion, Torque, Angular impulse, Radius of gyration, General theorems on moment of inertia, Derivation of expressions for moment of inertia: (i) rectangular lamina (ii) circular disc. Euler's equations of motion, Moment of inertia of a flywheel.	6 lectures

Unit IV	**Simple Harmonic Motion (SHM):** Periodic and Harmonic Motion, Harmonic oscillator, Differential equation of SHM, Phase relationship between displacement, velocity, and acceleration of SH Oscillator, Energy of a harmonic oscillator, Some examples of S.H.M.: simple pendulum, bar pendulum. Damped harmonic motion – Damping (Frictional effects), over-damped, critically damped, and lightly-damped oscillators; Power dissipation, Quality factor, examples of damped harmonic oscillators.	10 lectures

Learning Resources:

Text Books:

1. Mechanics, S P Taneja, R Chand & Co , 3rd edition, 2019
2. Mechanics, D.S. Mathur, S. Chand and Company Limited. 2000
3. Properties of Matter , D.S. Mathur, S. Chand and Company Limited.2010
4. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, Cambridge university press, 2nd edition,2021
5. Mechanics: Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. , McGraw-Hill education ,2nd edition,2017

Reference Books:

1. Analytical Mechanics, G.R. Fowles and G.L. Cassiday., Brooks/cole,1993
2. Engineering Fluid Mechanics, Dr. KL Kumar, S. Chand, 2010

I – Year: I – Semester

Course Code: CYMC101	BASIC CHEMISTRY	Credits 4-0-0: 4

Course Objectives:

This course may be divided into three broad areas of chemistry- inorganic, organic and physical chemistry. In this course students will be taught basics of organic chemistry so that the students can acquire the necessary foundation for a better understanding of other organic chemistry topics in subsequent semesters, basics of atomic structure, which is a prerequisite to understand the nature of chemical bonding in compounds. The course further covers the basic and advanced concepts regarding gaseous states and liquid states of matter.

Objectives are.

Course Outcomes: After completion of the course, students will be able to:

CO1	Understand the quantum mechanical model of atoms, quantum numbers, electronic configuration, radial and angular distribution curves, and shapes of s, p, and d orbitals.
CO2	Understand the role of various electronic factors (such as inductive, electromeric, resonance and mesomeric effects).
CO3	Have a clear idea of aromaticity and its influence in acidity & basicity, stability and reaction kinetics.
CO4	Understand the differences between ideal and real gases, to derive the kinetic gas equation, deviation from ideal behaviour and reason thereof.
CO5	Understand fundamental properties of liquids such as vapour pressure, surface tension and coefficient of viscosity.

Syllabus:

Unit I	**Atomic Structure :** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.	15 lectures
Unit II	**Basics of Organic Chemistry I**: Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.	10 lectures
Unit III	**Basics of Organic Chemistry II:** Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples.	15 lectures

Unit IV	**Gaseous State :** Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Vander Waals equation of state, its derivation and application in explaining real gas behaviour, Boyle temperature. critical state, relation between critical constants and van der Waals constants, law of corresponding states.	15 lectures
Unit V	**Liquid State :** Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Temperature variation of viscosity of liquids and comparison with that of gases.	5 lectures

Learning Resources:

Text Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Oxford University Press, 2008.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts and Models of Inorganic Chemistry, 3rd Ed. Wiley India, 2006.
3. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).

Reference Books:

1. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
2. Advanced Organic Chemistry; Reactions, Mechanisms and Structure; Jerry March
3. Organic Chemistry by T. W. Graham Solomons and Craig B. Fryhle
4. Greeves, N.; Clayden, J.; Warren, S., Organic Chemistry, 2nd Ed., Oxford University Press, New Delhi (2012).
5. Puri, B. R.; Sharma, L. R.; Pathania, M. S., Principles of Physical Chemistry, 47th Ed., Vishal Publishing (2017).

Online Resources:

https://swayam.gov.in/explorer

I – Year: I – Semester

Course Code: PHSE102	GENERAL PHYSICS LABORATORY I	Credits 0-0-6: 3

Course Objectives:

This course introduces the practical related to Mechanics and Physics Principles and its applications.

Course Outcomes:

The students should able to explain the concepts of diffraction, refraction, and dispersion by using Prism, grating, and rectangular slabs.

Complete any seven practical's from the given experiments:

Sl. No.	Title of the experiments
1	To study the use of various measuring instruments 1. Vernier caliper 2. Micrometer screw gauge 3. Spherometer.
2	To determine an acceleration due to gravity "g" by using a bar pendulum
3	To determine the coefficient of viscosity by using Stoke's method.
4	To determine the moment of inertia of a flywheel.
5	To determine the Planck's constant.
6	To determine the surface tension using the capillary rise method.
7	To determine the spring constant of a spring hence determine acceleration due to gravity "g".
8	To determine the dispersive power of the material of a prism.
9	To determine the Cauchy's constants a and b of the material of a prism.
10	To trace the course of different rays of light through a rectangular glass slab.

Learning Resources:

Text Books:

1. Engineering Practical Physics, S.Panigrahi and B. Mallick, CENGAGE learning,2015)
2. B.Sc. Practical Physics, C.L. Arora. S.Chand ,2010
3. Physics in laboratory, Electricity & Magnetism, Wave & Optics, Supriya Das and Mili Das, Santra Publication Pvt Ltd ,1st edition 2020

Online Resources:

https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham

I – Year: I – Semester

Course Code: MAMD101	CALCULUS	Credits 3-0-0: 3

Course Objectives:

The course objectives of a calculus course are to teach students the skills and knowledge needed to understand how things change. Calculus is a branch of mathematics that studies rates of change, and is used to model systems that change.

Course Outcomes**:** After going through this course, the students will be able to

CO1	Learn the concepts of limit, continuity and differentiability of different functions.
CO2	Apply the geometrical properties of different functions and use their applications.
CO3	Evaluate some fundamental results in calculus related to differentiation and expansions.
CO4	Use higher realms of integral calculus and their applications.
CO5	Learn the concept of application of definite integral and its applications.

Syllabus:

Unit I	Functions, limit and continuity, Differentiation of functions, product rule, quotient rule, chain rule, Differentiation of transcendental functions. Basic ideas of Partial derivatives.	8 lectures
Unit II	Application of derivatives, Tangent and normal, Curvatures, Asymptotes, tracing of curves, maxima and minima of functions of one variable, Indeterminate forms, L-Hospital's rule, Intermediate Value theorem, Rolle's theorem, mean value theorem, Cauchy's mean value theorem.	10 lectures
Unit III	Integral Calculus, Techniques of Integration by substitution method, trigonometric substitutions, integration by parts. Integration of rational and irrational functions.	8 lectures
Unit IV	Applications of the Integral, area under plane curves, area between two curves, rectification of plane curves (Cartesian, parametric and polar curves), application of integration in determining volumes, areas of surface of revolution.	8 lectures
Unit V	Order and degree of ordinary differential equation, formation of differential equation, General solution, variable separable form, Homogeneous differential equations, Equation reducible to Homogeneous form.	8 lectures

Learning Resources

Texts Books

1. T. G. B. Thomas and R.L. Finney, *Calculus*, 13th ed. Pearson Education. (2017).
2. T.M. Apostol: Calculus, Vol I, John Wiley and Sons, Inc., New York, 1967.
3. R.G. Bartle; D.R. Sherbert: Introduction to Real Analysis, John Wiley and Sons, Inc., New York, 2011.
4. S.R. Ghorpade; B.V. Limaye: A Course in Calculus and Real Analysis, 2nd Edition, Springer, 2018.

Reference Books

1. A. Habib, Calculus, Cambridge University Press, 2024.
2. G. Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad, 2000.
3. G. Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad, 2000.

I – Year: I – Semester

Course Code: HSAC101	COMMUNICATION SKILL	Credits 2-0-0: 2

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the fundamental principles of communication and overcome common barriers.
CO2	Develop proficiency in academic writing, including research papers and essays.
CO3	Demonstrate effective oral presentation skills using various tools and techniques.
CO4	Master the art of professional electronic correspondence and digital communication.
CO5	Understand prose forms

Syllabus:

Unit I	**Fundamentals of Communication:** Introduction to communication process; Verbal and non-verbal communication; Barriers to effective communication. Basic Communication Skills	6 lectures
Unit II	**Academic Writing:** Essay writing techniques; Research paper structure and formatting; Citation and referencing styles; Functional Grammar.	6 lectures
Unit III	**Oral Presentation Skills:** Preparing and delivering effective presentations; Using visual aids and multimedia; Handling Q&A sessions.	6 lectures
Unit IV	**Electronic Correspondence:** Email etiquette and best practices; Writing professional emails; Managing digital communication platforms.	5 lectures
Unit V	**Reading and Comprehension** Essays: Characteristics and types; Text - I (General/Personal/Technical essay) for detailed study.	5 lectures

Textbooks:

Stephen Bailey, *'Academic Writing: A Handbook for International Students,'* (2018), Routledge.
Suzy Siddons, '*The Complete Presentation Skills Handbook: How to Understand and Reach Your Audience for Maximum Impact and Success,'* (2008), Kogan Page.
Andrea J. Rutherford, '*Basic Communication Skills for Technology,'* (2nd edition), (2001), Pearson Education
Sajitha Jayapraksh, '*The Art of Writing Effective Emails,'* (2021), Himalaya Publishing House
Philip Vassallo, '*The Art of E-mail Writing,'* (2010), First Books

Recommended Books:

Judy Apps, '*Art of Communication: How to be Authentic,'* (2019), Capstone
Carmine Gallo, '*Talk Like TED,'* (2014), Macmillan
David Shipley and Will Schwalbe, '*SEND: Why People Email so badly and How to Do it Better,'* (2010), Knopf
Stella Cottrell, '*Critical Thinking Skills: Effective Analysis, Argument, and Reflection'* (2023), Bloomsbury

Web Resources:

https://www.skillsyouneed.com/ips/communication-skills.html
https://virtualspeech.com/blog/improve-communication-skills
https://www.mindtools.com/cawh8bu/communication-skillshttps://open.umn.edu/opentextbooks/textbooks/1288
https://online.berklee.edu/courses/digital-storytelling

I – Year: I – Semester

Course Code: HSAC102	COMMUNICATION SKILL LABORATORY	Credits 0-0-2: 1

Course Outcomes: At the end of the course, the student will be able to

CO1	Demonstrate effective verbal and non-verbal communication skills in various scenarios.
CO2	Produce well-structured academic writings with proper citations and referencing.
CO3	Deliver engaging presentations with appropriate visual aids and handle Q&A sessions effectively.
CO4	Compose professional digital communications and navigate various digital platforms proficiently.
CO5	Apply critical thinking skills to analyse case studies and participate in scientific debates.

Syllabus:

1. **Effective Communication Exercises**
   Role-playing communication scenarios; Non-verbal communication interpretation; Active listening practice.
2. **Academic Writing Workshop**
   Peer review sessions for essays; Citation and referencing exercises; Research paper outline development.
3. **Presentation Skills Practice**
   Impromptu speaking drills; Visual aid creation and usage
4. **Electronic Communication Practice**
   Email composition and analysis; Virtual meeting etiquette practice; Digital platform navigation exercises
5. **Critical Thinking Challenges**
   Group discussions; Group problem-solving activities; Debates and extempore.

Textbooks:

1. Stephen Bailey, *'Academic Writing: A Handbook for International Students,'* (2018), Routledge.
2. Suzy Siddons, '*The Complete Presentation Skills Handbook: How to Understand and Reach Your Audience for Maximum Impact and Success,'* (2008), Kogan Page.
3. Andrea J. Rutherford, '*Basic Communication Skills for Technology,'* (2nd edition), (2001), Pearson Education
4. Sajitha Jayapraksh, '*The Art of Writing Effective Emails,'* (2021), Himalaya Publishing House
5. Philip Vassallo, '*The Art of E-mail Writing,'* (2010), First Books

Recommended Books:

1. Judy Apps, '*Art of Communication: How to be Authentic,'* (2019), Capstone
2. Carmine Gallo, '*Talk Like TED,'* (2014), Macmillan
3. David Shipley and Will Schwalbe, '*SEND: Why People Email so badly and How to Do it Better,'* (2010), Knopf
4. Stella Cottrell, '*Critical Thinking Skills: Effective Analysis, Argument, and Reflection'* (2023), Bloomsbury.
5. Peter Garber, '*50 Communications Activities: Icebreakers and Exercises,'* (2010), HRD

Web Resources:

1. https://www.mindtools.com/pages/main/communication-skills.htm

I – Year: I – Semester

Course Code: HSVA101	ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	Credits 2-0-0: 2

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the concept of Bharatvarsha and Indian Knowledge System
CO2	Distinguish between different forms of Indian foundational literatures
CO3	Understand Indian Sciences, Mathematics, and Methodology of IKS
CO4	Familiarize with traditional Indian Agriculture and architectural practices
CO5	Understand traditional Indian Polity, Economy, and its outreach.

Syllabus:

Unit I	Basic Structure of Indian Knowledge System; Introducing Bharatvarsha, its geography and culture.	5 lectures
Unit II	Foundational Literatures; Vedangas and other streams of IKS; Classical literature in Sanskrit and other Indian languages; Indian Education	6 lectures
Unit III	Indian Sciences, Mathematics, Health Sciences, and Indian Astronomy; Methodology of Indian Knowledge System	6 lectures
Unit IV	Indian Architecture and Town Planning; Fine Arts; Indian Agriculture; Textiles, and Metallurgy	6 lectures
Unit V	Foundations of Indian Polity, Economy; Outreach of Indian Knowledge Systems	5 lectures

Recommended Books:

1. Baladev Upadhyaya, *Samskrta Śāstrom ka Itihās,Chowkhambha*, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śarīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, Some Aspects of Earlier Indian Society and Polity and Their Relevance Today, New Quest Publications, Pune, 1987.
5. Dharampal, *Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
6. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
7. J. K. Bajaj and M. D. Srinivas, *Indian Economy and Polity in Eighteenth century Chengalpattu*, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995, pp. 63-84.
8. J. K. Bajaj and M. D. Srinivas, Annam Bahu Kurvita, *Recollecting the Indian Discipline of Growing and Sharing Food in Plenty*, Centre for Policy Studies, Chennai, 1996.
9. J. K. Bajaj and M. D. Srinivas, *Timeless India Resurgent India*, Centre for Policy Studies, Chennai, 2001.
10. M. D. Srinivas, *The methodology of Indian sciences as expounded in the disciplines of Nyāya, Vyākarana, Ganita and Jyotisa*, in K. Gopinath and Shailaja D. Sharma (eds.), The Computation Meme: Explorations in Indic Computational Thinking, Indian Institute of Science, Bengaluru, 2022.

I – Year: II – Semester

Course Code: PHCC201	CONCEPTS OF PHYSICS AND APPLICATIONS	Credits 3-0-0: 3

Course Objectives:

This course aims to develop an understanding of the workings of the universe and to extend the body of scientific knowledge.

Objectives are.

- To Study the basic concepts of Physics in Earth's Atmosphere.
- To Study the basic concepts of Physics in the Human Body and Sports.
- To Study the basic concepts of Physics in Technology.
- To study the basic concepts of Physics in the Universe.

Course Outcomes: After completion of the course, students will be able to:

CO1	Outline the basic concept of physics on a deeper level and its uses to navigate everyday life.
CO2	Describe the basic principle working principle of human eyes, and ears as well as the basic use of physics in sports.
CO3	Interpret the role of physics in day-to-day technology.
CO4	Explain the concept of basic astrophysics.

Syllabus:

Unit I	**Physics in Earth's Atmosphere:** Sun, Earth's atmosphere as an ideal gas; Pressure, temperature, and density, Pascal's Law and Archimedes' Principle, Corioli's acceleration and weather systems, Rayleigh scattering, the red sunset, Reflection, refraction, and dispersion of light, Total internal reflection, Rainbow.	12 lectures
Unit II	**Physics in Human Body and Sports:** The eyes as an optical instrument, Vision defects, Rayleigh criterion and resolving power, Sound waves and hearing, Sound intensity, Decibel scale, Energy budget, and temperature control. Physics in Sports: The Sweet Spot, Dynamics of rotating objects, Motion of a spinning ball, Running, Jumping and pole vaulting, Continuity and Bernoulli equations, Turbulence and drag	12 lectures
Unit III	**Physics in Technology:** Microwave ovens, Rockets, Lorentz force, Global Positioning System, CCDs, Lasers, Displays, Optical recording, CD, DVD Player, Tape records, Electric motors, Hybrid car, Telescope, Microscope, Projector, etc.	8 lectures
Unit IV	**Physics in the Universe:** Solar system, Kepler's laws of Planetary motion, the life cycle of a star, white dwarf, orbital motion, The Big Bang, Dark matter and dark energy, Cosmic microwave background, Gravitational waves, Black holes, Wormholes.	10 lectures

Learning Resources:

Text Books:

1. Concepts of Physics, H. C. Verma, Bharati Bhawan (publishers and distributors), 2024
2. Sears and Zemansky's University Physics ,pearson,10th edition,1999

3. Electricity and Magnetism, R Murugeshan , S Chand Publishing,2019
4. Physics in Daily Life, Jo Hermans, EDP Sciences ,2012
5. Fundamentals of Physics: The Universe Unveiled, J. K. Kushwaha ,2022

Reference Books:

1. Optics ,E. Hecht, Pearson Education Limited,2001
2. Advanced Level Physics, Nelkon & Parker, **CBS,7th edition 1995**
3. How Things Work, The Physics of Everyday Life, Louis A. Bloomfield, Wiley,4th edition 2009.

I – Year: II – Semester

Course Code: PHCC203	FUNDAMENTAL OF ELECTRONICS	Credits 3-0-0: 3

Course Objectives:

This course aims to introduce an understanding of electronics, elements, and their functionality.
Objectives are.

- To Study the basic concepts of the Basic Resistive circuit.
- To Study the basic concepts of Semiconductors.
- To Study the basic concepts of Bipolar junction transistors.
- To study the basic concepts of Operational amplifiers.

Course Outcomes: After completion of the course, students will be able to:

CO1	Explain the basic concept of current voltage, resistance, and some theorems and laws of electronics.
CO2	Elucidate the basic properties of semiconductors and their applications as diodes and rectifiers.
CO3	Describe the concepts of bipolar junction transistors and their application as amplifiers.
CO4	classify the basics of Operational Amplifier as summer, integrator, and differentiator.

Syllabus:

Unit I	**Basic Resistive circuit:** Ohm's law, Resistors in parallel and series combination, DC voltage and current sources: ideal and non-ideal cases, Kirchoff's current and voltage law, Voltage divider circuit, Current divider circuit, source transformation-voltage source to current source and current source to voltage source, Thevenin's Theorem. Norton's Theorem, Reciprocity Theorem, Maximum Power Transfer Theorem.	11 lectures
Unit II	**Semiconductors:** Types of Semiconductors, doping, the effect of temperature on semiconductors, PN junction diode: unbiased PN junction, Forward and reversed biased condition, Formation of Depletion Layer, Diode Equation, and I-V characteristics. Idea of static and dynamic resistance, DC load line analysis, Quiescent (Q) point. Zener diode, Reverse saturation current, Zener, and avalanche breakdown, Zener diode as a voltage regulator. Diode as Rectifiers-Half wave rectifiers, Full wave rectifiers (center tapped and bridge), circuit diagrams, working and waveforms, ripple factor, and efficiency. Filter-Shunt capacitor filter, its role in power supply, output waveform, and working.	13 lectures
Unit III	**Bipolar Junction Transistor:** NPN and PNP transistors, Review of the characteristics of transistor in CE and CB configurations, Regions of operation (active, cut off, and saturation), Current gains α and β. Relations between α and β, Dc load line, and Q point. Transistor as a two-port network, h-parameter equivalent circuit. Small signal analysis of single-stage CE amplifier. Input and Output impedance, Current and Voltage gains. Class A, B, and C Amplifiers. Two-stage RC Coupled Amplifier and its Frequency Response. Concept of feedback, negative and positive feedback, advantages of negative feedback (Qualitative only)	11 lectures
Unit IV	**Operational Amplifier (Op-amps)**: Ideal Op-amp, Differential amplifier: differential and common mode operation common mode rejection ratio (CMRR), Practical op-amp circuits: inverting amplifier, non-inverting amplifier, weighted summer, integrator, differentiator.	8 lectures

Learning Resources:

Text Books:

1. A Textbook of Applied Electronics, R. S. Sedha, S.Chand & Co. 2019
2. Basic Electronics: Principles and Applications, C. Saha, A. Halder, D. Ganguly, Cambridge University Press , 1st edition,2018
3. Basic Electronics: Solid State, B. L. Theraja, S. Chand & Co. 2006
4. Electronics Fundamentals and Applications, P. C. Chattopadhyay, D. Rakshit, New age international private limited, 16th edition, 2020
5. Electronics: Principles and Applications, C. A. Schuler, MacGraw Hill Education. 5th edition,1999

Reference Books:

1. Basic Electronics (Includes Solved Problems and MCQs), B. Somanathan Nair, I. K. International Publishing House pvt.Ltd, 2013o
2. Electronic Principles, A. Malvino, D. J. Bates, MacGraw Hill Education, 7th edition,2017

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I – Year: II – Semester

Course Code: MAMC203	LINEAR ALGEBRA	Credits 3-1-0: 4

Course Objectives:

The primary objective of a linear algebra course is to teach students the fundamental concepts of vectors, matrices, and linear transformations, enabling them to solve systems of linear equations and apply these tools to various fields like engineering, computer science, and statistics, by developing a deep understanding of vector spaces, matrix operations, and concepts like eigenvalues and eigenvectors

Course Outcomes (CO): After completion of the course, students will be able to:

CO1:	To learn about Vector spaces and Linear transformations.
CO2:	To learn about Matrix of a linear Transformation and System of linear equations and their solutions.
CO3:	To learn about Inner product spaces and their properties.
CO4:	To learn about Orthogonal and Unitary transformations, Hermitian and skew Hermitian matrices. Invariant subspaces, Eigenvalues and eigenvectors and Cayley-Hamilton Theorem.
CO5:	To learn Diagonalization and triangularization, Nilpotent transformations, Canonical Forms. Bilinear form, matrix representation, Quadratic forms

Syllabus:

Unit I	Vector spaces, Subspaces, Span, Bases, Dimension, sum and quotient of Vector spaces, Maps of vector spaces, Linear transformations, Isomorphism, Rank and nullity, Dual space, Transpose, and annihilator.	12 lectures
Unit II	Matrix of a linear Transformation, similar matrices, change of basis, Rank of Matrix, Normal form, System of linear equations and their solutions.	12 lectures
Unit III	Inner product spaces and their properties, orthogonality, and orthonormalization, Orthogonal complement Adjoint of a linear transformation.	12 lectures
Unit IV	Orthogonal and Unitary transformations. Hermitian and skew Hermitian matrices. Invariant subspaces, Eigenvalues and eigenvectors, Characteristic polynomial, Cayley-Hamilton Theorem.	12 lectures
Unit V	Diagonalization and triangularization, Nilpotent transformations, Canonical Forms. Bilinear form, matrix representation, Quadratic forms, and application to classification of curves and surfaces.	12 lectures

Learning Resources:

Text Books:

1. Artin, M., Algebra, Prentice-Hall, 1994.
2. Herstein, I. N., Topics in Algebra, Wiley Eastern, 1987.
3. Hoffman, K. and Kunze, R.: Linear Algebra, Prentice-Hall, 1972.

Reference Books:

1. Halmos, P. R., Finite-Dimensional Vector Spaces, Springer-Verlag, 1993.
2. Kwak, Jin Ho and Hong, Sungpyo, Linear algebra. Second edition. Birkhäuser Boston, Inc., Boston, MA, 2004.

I – Year: II – Semester

Course Code: CSSE201/ CSMC201	PROGRAMMING FOR PROBLEM SOLVING	Credits 2-0-0: 2

Course Outcomes: After completion of the course student will be able to:

CO1	Develop algorithms and C++ programs to solve basic arithmetic and logical problems using appropriate programming constructs.
CO2	Implement decision-making and iterative processes using control structures, functions, and loops in C++ to solve various problems.
CO3	Apply object-oriented principles such as classes, objects, and functions to model and solve real-world problems in C++.
CO4	Use templates, pointers, and dynamic memory to implement efficient, generic solutions for handling different data types and managing memory.
CO5	Perform file handling in C++ to store, manipulate, and retrieve data from files, applying these concepts to real-world scenarios.

Syllabus:

Unit I	Introduction to computer systems, programming environments, and programming languages. Basic concepts of algorithms, flowcharts, and pseudo-code. Introduction to C++: History, structure of C++ programs, compiling and running C++ programs, tokens, keywords, identifiers, constants, strings, special symbols, variables, data types, and I/O statements (using cin and cout). Problem-Solving Aspect: Solve simple problems to demonstrate the use of flowcharts and algorithms, solving arithmetic and logical problems using C++	7 lectures
Unit II	Operators in C++ (arithmetic, relational, logical, assignment, increment/decrement, bitwise, and conditional). Operator precedence and associativity. Decision statements: if, switch; Loop control statements: while, for, do-while; jump statements: break, continue, goto. Function declarations, parameter passing (by value and by reference), and recursion. Problem-Solving Aspect: Implement decision-making and looping programs, such as a grading system or calculator using control structures and functions in C++.	7 lectures
Unit III	One-dimensional and multi-dimensional arrays. Array manipulation. Introduction to object-oriented programming (OOP) concepts: classes, objects, constructors, destructors, member functions, and function overloading. Problem-Solving Aspect: Develop programs using arrays and functions, and introduce classes to model real-world objects like creating a student record system using classes.	8 lectures
Unit IV	Introduction to function templates and class templates in C++. String handling using character arrays and the string class. Pointers in C++: pointer basics, pointer arithmetic, pointers to pointers, dynamic memory allocation using new and delete. Arrays of pointers, pointers with classes. Problem-Solving Aspect: Implement programs using templates to perform generic operations (e.g., sorting arrays of different data types), string manipulation (e.g., palindrome check), and dynamic memory management using pointers.	7 lectures

Unit V	File handling in C++: file streams (fstream), file operations (read, write, append, seek, tell), handling text and binary files, and command-line arguments. Advanced file handling techniques including error handling during file operations, reading/writing structured data, and file I/O optimization. Problem-Solving Aspect: Write programs to handle complex file operations such as creating logs, reading structured data from files, or performing file-based calculations.	7 lectures

Learning Resources:

Textbooks:

1. "Programming: Principles and Practice Using C++" by Bjarne Stroustrup, Addison-Wesley, 2nd Edition, 2014.
2. "Object-Oriented Programming with C++" by E. Balagurusamy, McGraw Hill, 8th Edition, 2020.
3. "The C++ Programming Language" by Bjarne Stroustrup, Addison-Wesley, 4th Edition, 2013.

Reference Books:

1. "C++ Primer" by Stanley B. Lippman, Josée Lajoie, and Barbara E. Moo, Addison-Wesley, 5th Edition, 2012.
2. "Effective C++: 55 Specific Ways to Improve Your Programs and Designs" by Scott Meyers, Addison-Wesley, 3rd Edition, 2005.
3. "C++ How to Program" by Paul Deitel and Harvey Deitel, Pearson, 10th Edition, 2021.
4. "Data Structures and Algorithm Analysis in C++" by Mark A. Weiss, Pearson, 4th Edition, 2013.
5. "Accelerated C++: Practical Programming by Example" by Andrew Koenig and Barbara E. Moo, Addison-Wesley, 2000.

Online Resources:

- https://www.cplusplus.com/doc/tutorial/
- https://www.udemy.com/course/beginning-c-plus-plus-programming/

I – Year: II – Semester

Course code: CSSE202/ CSMC202	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	Credits 0–0–4: 2

Course Outcomes: After completion of the course student will be able to:

CO1	Write and debug C++ programs using loops, control structures, and basic I/O operations.
CO2	Apply functions and recursion to solve tasks like factorials and Fibonacci series.
CO3	Design and implement classes to manage real-world data, such as student or bank account systems.
CO4	Use templates and pointers to write generic functions and manage dynamic memory.
CO5	Perform file handling operations to read, write, and manipulate data in text and binary files.

List of Experiments:

1. Write a C++ program to perform basic arithmetic operations (addition, subtraction, multiplication, division) using `cin` and `cout`.
2. Create a program that converts temperature from Celsius to Fahrenheit and vice versa.
3. Develop a program to find the sum of the digits of a given integer.
4. Write a C++ program to swap two numbers without using a third variable.
5. Write a program that calculates the area and circumference of a circle when the radius is provided by the user.
6. Implement a program to check if a given year is a leap year using if-else conditions.
7. Write a program to find the factorial of a number using a recursive function.
8. Create a program that accepts a student's marks and assigns grades using a switch-case statement.
9. Develop a program to generate the Fibonacci series up to N terms using a loop.
10. Implement a program that checks whether a given number is prime using a function.
11. Write a program to calculate the sum and average of elements in an array.
12. Implement a program to multiply two matrices.
13. Create a class `Student` that stores and displays student information (name, roll number, marks) using member functions.
14. Develop a class `BankAccount` with functions to deposit, withdraw, and check the balance for a user.
15. Write a program to compare two objects of a class (e.g., comparing the dimensions of two rectangles).
16. Write a program that checks whether a given string is a palindrome using the `string` class.
17. Implement a template function in C++ that sorts an array of any data type (int, float, etc.).
18. Write a program that dynamically allocates memory for an array of integers and calculates the sum of the elements.
19. Implement a program to modify and display elements of an array using pointers.
20. Write a program that demonstrates pointer arithmetic (incrementing and decrementing pointers to traverse an array).
21. Create a program to write data to a file and then read the data back from the file.
22. Write a program to copy the contents of one text file to another.
23. Implement a program that writes and reads data (e.g., student records) to and from a binary file.
24. Create a program to count the number of lines, words, and characters in a given text file.
25. Write a program that demonstrates the use of command-line arguments by passing a file name and printing its content.

Learning Resources:

Textbooks:

4. "Programming: Principles and Practice Using C++" by Bjarne Stroustrup, Addison-Wesley, 2nd Edition, 2014.
5. "Object-Oriented Programming with C++" by E. Balagurusamy, McGraw Hill, 8th Edition, 2020.
6. "The C++ Programming Language" by Bjarne Stroustrup, Addison-Wesley, 4th Edition, 2013.

Reference Books:

6. "C++ Primer" by Stanley B. Lippman, Josée Lajoie, and Barbara E. Moo, Addison-Wesley, 5th Edition, 2012.
7. "Effective C++: 55 Specific Ways to Improve Your Programs and Designs" by Scott Meyers, Addison-Wesley, 3rd Edition, 2005.
8. "C++ How to Program" by Paul Deitel and Harvey Deitel, Pearson, 10th Edition, 2021.
9. "Data Structures and Algorithm Analysis in C++" by Mark A. Weiss, Pearson, 4th Edition, 2013.
10. "Accelerated C++: Practical Programming by Example" by Andrew Koenig and Barbara E. Moo, Addison-Wesley, 2000.

Online Resources:

- https://www.cplusplus.com/doc/tutorial/
- https://www.udemy.com/course/beginning-c-plus-plus-programming/

I – Year: II – Semester

Course Code: CYMD201	GENERAL CHEMISTRY	Credits 3-0-0: 3

Course Objectives:

This course may be divided into three broad areas of chemistry- physical, organic and inorganic chemistry. In this course students will be taught solid state, ionic equilibria, stereochemistry and periodicity of elements.

Course Outcomes: After completion of the course student will be able to:

CO1	learn the fundamental concepts of solid state.
CO2	learn the fundamental concepts ofionic equilibria along with conductance.
CO3	understand the periodic properties of elements.
CO4	learn basic ideas stereochemistry.
CO5	Know two dimensional and three-dimensional representation of organic molecules.

Syllabus:

Unit I	**Solid State** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Liquid crystals (Introductory idea)	8 lectures
Unit II	**Chemical Equilibrium and Conductance** Reversible reaction, law of mass action, its application to chemical equilibrium and heterogeneous equilibrium, Le-chatelier's principle and its application. Electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of acids. Salt hydrolysis, pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation.	12 lectures
Unit III	**Stereochemistry I** Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. Atropisomerism and their R/S designation.	9 lectures
Unit IV	**Stereochemistry II** Types of cycloalkanes and their relative stability, Baeyer strain theory, theory of strainless rings Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.	6 lectures
Unit V	**Periodicity of Elements** Long form of periodic table. s, p, d, f block elements. Detailed discussion of the following properties of the elements, with reference to s & p-block: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table; Atomic radii (van der Waals); Ionic and crystal radii; Covalent radii (octahedral and tetrahedral); Ionization enthalpy, Successive	10 lectures

	ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy; Electron gain enthalpy, trends of electron gain enthalpy; Electronegativity, Pauling's/Mulliken's/Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.	

Learning Resources:

Text Books:

1. Lee, J. D. *Concise Inorganic Chemistry*, 5th Ed., Oxford University Press, 2008.
2. Douglas, B.E. and Mc Daniel, D.H., *Concepts and Models of Inorganic Chemistry*, 3rd Ed. Wiley India, 2006.
3. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Reference Books:

1. Finar, I. L. *Organic Chemistry* (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Peter, A. & Paula, J. de. *Physical Chemistry* 9th Ed., Oxford University Press (2011).
3. Castellan, G. W. *Physical Chemistry* 4th Ed., Narosa (2004).

Online Resources:

https://swayam.gov.in/explorer

I – Year: II – Semester

Course Code: HSAC201	ADVANCE COMMUNICATION SKILL	Credits 1-0-0: 1

Course Outcomes: At the end of the course, the student will be able to

CO1	Demonstrate proficiency in advanced professional writing and documentation.
CO2	Create professional CVs, resumes, and online profiles for career advancement.
CO3	Apply effective interpersonal communication skills in various professional settings.
CO4	Develop expertise in technical writing specific to scientific fields.
CO5	Excel in public speaking and debate, showcasing persuasive communication abilities.

Syllabus:

Unit I	**Professional Writing:** Report writing; Proposal development; Case studies	4 lectures
Unit II	**Professional Development:** Creating impactful CVs and résumés; Crafting compelling cover letters; Building and optimising LinkedIn profiles.	3 lectures
Unit III	**Interpersonal Communication:** Active listening techniques; Conflict resolution strategies; Emotional intelligence in communication.	2 lectures
Unit IV	**Technical Writing:** Writing scientific abstracts and summaries; Developing research posters; Crafting grant proposals.	3 lectures
Unit V	**Public Speaking and Debate:** Persuasive speaking techniques; Participating in panel discussions; Mastering impromptu speaking	2 lectures

Recommended Books:

1. Bryan Garner, '*HBR Guide to Better Business Writing,'* (2013), Harvard Business School
2. Martin Yate, *'Knock'em Dead Resumes: A Killer Resume Gets More Job Interviews,'* (2014), Adams Media
3. Kerry Patterson et al., '*Crucial Conversations: Tools for Talking when Stakes are High,'* (2022), McGraw Hill
4. Joshua Schimel, '*Writing Science: How to Write Papers that get Cited and Proposals that get Funded'* (2012), OUP USA
5. Chris Anderson, '*TED Talks: The Official TED Guide to Public Speaking'* (2018), Nicholas Brealey

Web Resources:

1. https://www.skillsyouneed.com/ips/communication-skills.html
2. https://virtualspeech.com/blog/improve-communication-skills
3. https://www.mindtools.com/cawh8bu/communication-skills
4. https://open.umn.edu/opentextbooks/textbooks/1288
5. https://online.berklee.edu/courses/digital-storytelling

I – Year: II – Semester

Course Code: HSAC202	ADVANCE COMMUNICATION SKILLS LABORATORY	Credits 0-0-2: 1

Course Outcomes: At the end of the course, the student will be able to

CO1	Craft professional business documents including reports, proposals, and case study analyses.
CO2	Develop a comprehensive professional portfolio including an optimized CV, resume, and LinkedIn profile.
CO3	Apply interpersonal communication techniques to resolve conflicts and build effective teams.
CO4	Produce well-structured scientific documents including abstracts, posters, and grant proposals.
CO5	Deliver persuasive speeches, participate effectively in panel discussions, and excel in impromptu speaking.

Syllabus:

1. **Advanced Business Writing**
   Reports, Memo, Manuals.
2. **Portfolio Development and Personal Branding**
   CV and Resume writing exercises; Video CVs; Hands-on LinkedIn Profile optimization exercises
3. **nterpersonal Communication Exercises**
   Conflict resolution role-play; Emotional intelligence assessment and improvement activities; Team-building exercises
4. **Professional Writing Practice**
   Abstract writing; Poster designs and presentation
5. **Public Speaking and Debate Practice**
   Persuasive speaking techniques; Group Discussions and Extempore extended.

Recommended Books:

1. Bryan Garner, '*HBR Guide to Better Business Writing,'* (2013), Harvard Business School
2. Martin Yate, *'Knock'em Dead Resumes: A Killer Resume Gets More Job Interviews,'* (2014), Adams Media
3. Kerry Patterson et al., '*Crucial Conversations: Tools for Talking when Stakes are High,'* (2022), McGraw Hill
4. Joshua Schimel, '*Writing Science: How to Write Papers that get Cited and Proposals that get Funded*' 2012), OUP USA
5. Chris Anderson, '*TED Talks: The Official TED Guide to Public Speaking'* (2018), Nicholas Brealey

Web Resources:

1. https://www.skillsyouneed.com/ips/communication-skills.html
2. https://virtualspeech.com/blog/improve-communication-skills
3. https://www.mindtools.com/cawh8bu/communication-skills
4. https://open.umn.edu/opentextbooks/textbooks/1288
5. https://online.berklee.edu/courses/digital-storytelling

I – Year: II – Semester

Course Code: UHVA201	UNIVERSAL HUMAN VALUES-II	Credits 2-1-0: 3

Course Outcomes: By the end of the course, students are expected:

CO1	To develop a deeper awareness of themselves and their environment, including their family, society, and nature.
CO2	To cultivate a greater sense of responsibility in their lives and in addressing problems with sustainable solutions, while keeping human relationships and human nature in mind.
CO3	To strengthen their ability to think critically, analyze situations, and evaluate information more effectively.
CO4	To become more responsive to their role in upholding human values, nurturing healthy relationships, and contributing positively to society.
CO5	To apply the insights and skills they've gained in real-life situations, making a conscious effort to incorporate these learnings into their daily lives and decision-making processes.

Syllabus:

Unit I	**Introduction to Value Education:** Right understanding, relationship and physical facility (Holistic development and the role of education); Understanding value education; Self-exploration as the process for value education; Continuous happiness and prosperity – the basic human aspirations; Happiness and prosperity – Current scenario; Method to fulfill the basic human aspirations.	9 lectures
Unit II	**Harmony in the Human Being:** Understanding human being as the co-existence of the self and the body; Distinguishing between the needs of the self and the body; The body as an instrument of the self; Understanding harmony in the self; Harmony of the self with the body; Programme to ensure self-regulation and health.	9 lectures
Unit III	**Harmony in the Family and Society:** Harmony in the family – the basic unit of human interaction; Trust – the foundational value in relationship; Respect – as the right evaluation; Other feelings, justice in human-to-human relationship; Understanding harmony in the society; Vision for the universal human order.	9 lectures
Unit IV	**Harmony in the Nature/Existence:** Understanding harmony in the nature; Interconnectedness, self-regulation and mutual fulfilment among the four orders of nature; Realizing existence as co-existence at all levels; The holistic perception of harmony in existence.	6 lectures
Unit V	**Implications of the Holistic Understanding – A look at Professional Ethics:** Natural acceptance of human values; Definitiveness of (Ethical) human conduct; A basis for humanistic education, humanistic constitution and universal human order; Competence in professional ethics; Holistic technologies, production systems and management models-typical case studies; Strategies for transition towards value-based life and profession.	9 lectures

Learning Resources:

Text Books:

1. R. R. Gaur, R. Asthana and G. P. Bagaria, A Foundation Course in Human Values and Professional Ethics, UHV Publications, 3rd Ed., New Delhi (2023).
2. R. S. Naagarazan, A Textbook on Professional Ethics and Human Values, New Age International Publishers, 1st Ed., New Delhi (2006).
3. A. N. Tripathi, Human Values, New Age International Publishers, New Delhi (2009).

Reference Books:

1. R. R. Gaur, R. Asthana and G. P. Bagaria, Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, UHV Publications, 3rd Ed., New Delhi (2023).
2. A. Nagraj, Jeevan Vidya - Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak, India (2018).
3. S. Mazumdar, Values and Ethics in Profession, Everest Publishing House, 3rd Ed., Pune (2013).

I – Year: II – Semester

Course Code: PHEX101	EXPERIMENTAL SKILLS IN PHYSICS	Credits 0-0-4: 2

Course Objectives:

This course aims to introduce an understanding of instruments' working principles and their physical applications. To impart knowledge about the measurement of physical quantity and its analysis of the practical related to mechanics and physics principles and their applications.

Course Outcomes (CO): Upon completion of the course, the students will be able to:

CO1	Analyze the working principles of various measuring instruments
CO2	Acquire scientific information of various physical and electrical instruments used in physics practicals.
CO3	Identify the errors in the instrument.

Syllabus - *(Any **12** experiments + **3** Experimental Activities)*

List of Experiments:

1. To plot the graph of distance vs time, and velocity vs time by given data and write the conclusion.
2. To determine the least count of instruments like Vernier Calliper, Micrometer Screw Gauge, Travelling Microscope, Spectrometer, etc.
3. To determine the inner and outer radius of the given pipe by using Vernier Calliper and determine the diameter of the pin by using a micrometer screw gauge.
4. To determine the radius of curvature of the lenses by using a spherometer.
5. To measure AC, and DC voltage of signals by using CRO.
6. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
7. To measure the 'Q' factor using an LCR circuit.
8. Study of diode characteristics.
9. To measure the frequency of different signals by using CRO.
10. To check and repair the fault of the DC circuit.
11. To study how to plot the graph of any single observation on graph paper and how to observe the readings from graphs (e.g. I-V, V-T, I-T, etc.)
12. Verification of formula for voltage divider theorem
13. Verification of formula for current divider theorem.
14. To measure the viscosity of a liquid.
15. To study and repair of Power supply.
16. Skill of soldering in Printed circuit board.
17. Skill to use a breadboard, hood up wire, laboratory experiment.

Additional Activities to be conducted related to the subject (Any-3)

1. Mini Projects with report.
2. Industrial /Research organization /Working organization /Field visit with report.
3. Any one computer-aided demonstrations.

4. Demonstrations -Any one demonstrations.

** Students must perform 12 experiments and participate in an additional three activities equivalent to 3 experiments with 12 experiments. Total laboratory work with additional activities should be 15 experiments.*

**Students must prepare a notebook with all laboratory experiments performed in the semester and have to submit it to the department before the examination.*

Learning Resources:

Text Books:

1. Digital Circuits and systems , K. R. Venugopal, Tata McGraw Hill Publishing Company Ltd. 2011
2. Electronic circuits: Handbook of design and applications , U. Tietze, Ch. Schenk , Springer-Verlag Berlin and Heidelberg Gmb, 2008
3. A textbook in Electrical Technology ,B. L. Thareja, S. Chand and Co. (Volume III) Publishers. 2008
4. BSc Practical Physics, H. Singh, S Chand Publishers ,2022
5. Advanced Practical Physics, B.L. Worsnop and H. T. Flint, Khosla Publishing House, New Delhi 2021
6. B.Sc. Practical Physics, C. L. Arora, S Chand & Company, New Delhi. 2010

I – Year: II – Semester

Course Code: PHEX103	BASIC LABORATORY ELECTRIC DEVICES AND CIRCUITS	Credits 0-0-4: 2

Course Objectives:

This course aims to introduce Electric circuits and Networks to contribute the knowledge of electric elements and their uses, and also awareness of Instrumentation and its Industrial Application.

Course Outcomes:

CO1	Describe basic concepts of electric elements and their functions.
CO2	Provide adequate knowledge about the Industrial applications of electric instruments.
CO3	Provide adequate knowledge about its applications.
CO4	Students can study Electrical Engineering.

Course Content- *(Any **12** experiments + **3** Experimental Activities)*

List of Experiments:

1. To study CRO.
2. To study V-I Characteristics of the p-n Junction Diode.
3. To study V-I Characteristics of Zener Diode and Zener Regulator Characteristics.
4. To study V-I Characteristics of LED.
5. To study Half-Wave Rectifier with and without Filter.
6. To study Full-Wave Rectifier with and without Filter.
7. To study Bridge-Wave Rectifier with and without Filter
8. To study output characteristics of transistors in CB mode.
9. To study output characteristics of transistors in CE mode.
10. To measure h-Parameters of CB Configuration.
11. To study a comparison of the performance of Self Bias and Fixed Bias Circuits.
12. To study applications of Diodes.
13. To study characteristics of Thermistor.
14. To study oscillators.
15. To study simple power supply.
16. To study introduction to Integrated Circuits (IC).

Additional Activities to be conducted related to the subject (Any-3)

1. Mini Projects with report.
2. Industrial /Research organization /Working organization /Field visit with the report.
3. Computer-aided demonstrations.
4. Demonstrations -Any one demonstrations.

**Students have to perform 12 experiments and participate in an additional three activities equivalent to 3 experiments with 12 experiments. Total laboratory work with additional activities should be 15 experiments.*

**Students have to prepare a notebook with all laboratory experiments performed in the semester and have to submit it to the department before the examination.*

Learning Resources:

Text Books:

1) Basic Electronics and Linear Circuit ,NN Bhargava, Kulshreshta and SC Gupta, Tata McGraw Hill Education Pvt Ltd.2017
2) Principles of Electrical and Electronics Engineering ,VK Mehta; S Chand and Co. 2015
3) Electrical and Electronics Engineering ,SK Bhattacharya, Pearson Education 2022
4) Principles of Electronics ,SK Bhattacharya and Renu Vig, SK Kataria & Sons. 2007
5) Electronics Devices and Circuits ,Millman and Halkias; McGraw Hill ,2017

*Students exiting the program after securing **40 credits** will be awarded **UG Certificate** in the relevant **Discipline/Subject** provided. They will earn **4 additional credits** in (exit course) work based vocational courses offered during the summer term or internship/Apprenticeship in addition to **6 credits** from skill-based courses during the first and second semesters*.

II – Year: I – Semester

Course Code: PHCC301/ PHMD301	WAVES AND OSCILLATIONS	Credits 3-0-0: 3

Course Objectives:

This course aims to introduce the Physics of Waves and Oscillations to the students.

Objectives are.

- Revisiting and building upon foundational concepts of waves and oscillations learnt in school.
- Starting with understanding free oscillations and how harmonic motions superpose.
- Progressing to the physics behind damped and forced oscillations.
- Introducing the ideas of coupled oscillators and normal modes of oscillation.

Course Outcomes: After completion of the course, students will be able to:

CO1	Explain simple harmonic motion
CO2	Illustrate the superposition of N collinear harmonic oscillations
CO3	Illustrate the superposition of two perpendicular harmonic oscillations
CO4	Classify free, damped, and forced oscillations and Identify coupled oscillators and normal modes of oscillations.

Syllabus:

Unit I	**Simple Harmonic Motion:** Differential equation of simple harmonic oscillator, its solution and characteristics, energy in simple harmonic motion, linearity and superposition principle, rotating vector representation of simple harmonic oscillation, motion of simple and compound pendulum (Bar and Kater's pendulum), loaded spring. Superposition of N collinear harmonic oscillations with (1) equal phase differences and (2) equal frequency differences, Beats Superposition of two perpendicular harmonic oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies, the effect of variation of phase	11 lectures
Unit II	**Damped Oscillations:** Equation of motion, dead beat motion, critically damped system, lightly damped system: relaxation time, logarithmic decrement, quality factor Forced Oscillations: Equation of motion, complete solution, steady state solution, resonance, sharpness of resonance, power dissipation, quality factor. Coupled oscillators, normal coordinates, and normal modes, energy relation and energy transfer, di-atomic molecules, representation of a general solution as a linear sum of normal modes, normal modes of N coupled oscillators.	11 lectures
Unit III	**Superposition of Two Harmonic Waves:** Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.	10 lectures
Unit IV	**Wave Motion:** One-dimensional plane wave, classical wave equation, standing wave on a stretched string (both ends fixed), normal modes. Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave.	10 lectures

Learning Resources:

Text Books:

1. Vibrations and Waves, A. P. French, CBS Pub. and Dist., First Edition,1987.
2. The Physics of Waves and Oscillations, N.K. Bajaj, First Edition, Tata McGraw-Hill, 1988.
3. Fundamentals of Waves and Oscillations, K. Uno Ingard, Cambridge University Press, 1988.
4. An Introduction to Mechanics, Daniel Kleppner, Robert J. Kolenkow, Second Edition, Cambridge University Press, 2013.
5. Waves: BERKELEY PHYSICS COURSE by Franks Crawford, Tata McGrawHill Education, 2017.

Reference Books:

1.Fundamentals of Physics, Resnick, Halliday and Walker, Wiley,10th Edition, 2013.
2.University Physics, H. D. Young, R. A. Freedman, Pearson Education,14th Edition, 2015.

II – Year: I – Semester

Course Code: PHCC303	OPTICS I	Credits 3-0-0: 3

Course Objectives:

This course aims to introduce the Physics of Optics.

Objectives are.

- To provide students with a solid understanding of Fermat's principle and its applications in optical systems.
- To equip students with a thorough understanding of wave theory and interference of a light.
- To provide students with an in-depth understanding of Haidinger fringes and fringes of equal inclination.
- To provide a comprehensive understanding of laser systems

Course Outcomes: After completion of the course, students will be able to:

CO1	Explain Fermat's Principle
CO2	Illustrate the phenomenon of interference of light
CO3	Analyze the principles behind Haidinger fringes and fringes of equal inclination leads to the ability to apply interferometric techniques.
CO4	Outline the basic ideas of LASER

Syllabus:

Unit I	**Fermat's principle:** Principle of extremum path, the aplanatic points of a sphere and other applications. General theory of image formation: cardinal points of an optical system, general relationships. Thick lens and lens combination, Lagrange equation magnification, telescopic combinations, telephoto lenses and eyepieces.	11 lectures
Unit II	**Wave Theory:** 3D wave equation, Huygen's Principle, Laws of reflection and Refraction from wave theory and total internal reflection of light. **Interference of a light:** The principle of superpositions, two-slit interference, coherence requirement for the sources, optical path retardations, lateral shift of fringes, Rayleigh refractometer and other applications. Localized fringes; thin films, applications for precision measurements for displacements.	12 lectures
Unit III	**Haidinger fringes:** Fringes of equal inclination. Michelson interferometer, its application for precision determination of wavelength, wavelength difference and the width of spectral lines. Twymann-Green interferometer and its uses. Intensity distribution in multiple beam interference, Tolansky fringes, Fabry-Perot interferometer and etalon.	11 lectures
Unit IV	**Laser system:** Einstein's A and B coefficients, Spontaneous and induced emissions, conditions for laser action, population inversion. Types of Lasers, Characteristics and application of Lasers	8 lectures

Learning Resources:

Text Books:

1. Optics, A K Ghatak, McGraw Hill India, Eighth Edition, 2024.

2. Optics and Atomic Physics, D P Khandelwal, Himalaya Publishing House, 2015.
3. Manchester Physics series; Optics, F Smith and J H Thomson, English Language Book Society and John Wiley, Second Edition, 1988.
4. Optics, Born and Wolf, Cambridge University Press, 60th Anniversary Edition, 2019.
5. Atomic and Molecular Spectra: Laser, Raj Kumar, Knrn,2020 edition,2012.

Reference Books:

1. Optics, K D Moller, Oxford University Press, First edition,2007.
2. Fundamental of Optics, Jenkins and White, McGraw-Hill, Fourth Edition,2017.
3. Lasers and Non-linear Optics, B B Laud, New Age International Private Limited, 2011
4. Optics, Smith and Thomson, John Wiley and Sons, First edition,1971.

II – Year: I – Semester

Course Code: PHCC302/ PHMD302	WAVES AND OSCILLATIONS LABORATORY	Credits 0-0-2: 1

Course Objectives:

This course aims to introduce the practical's related to Waves and Oscillations

Course Outcomes:

After completion of the course, students will be able to:

CO1	Determine the expected value of time period for SHM
CO2	Determine the value of g using bar pendulum
CO3	Determine the effect of area of the damper on damped oscillations
CO4	Calculate the damping coefficient and Q factor for different dampers
CO5	Study the applications of CRO

List of Experiments:

Sl. No.	Title of the experiments
1	Estimate limits on angular displacement for SHM by measuring the time period at different angular displacements and compare it with the expected value of time period for SHM.
2	Testing of active and passive components using CRO.
3	Determine the value of g using Kater's pendulum.
4	Study the effect of area of the damper on damped oscillations.
5	Plot amplitude as a function of time and determine the damping coefficient and Q factor for different dampers
6	Understand the applications of CRO by measuring voltage and time period of a periodic waveform using CRO.
7	Study the superposition of two perpendicular simple harmonic oscillations using CRO (Lissajous figures).

Learning Resources:

Text Books:

1. Engineering Practical Physics, S. Panigrahi and B. Mallick, CENGAGE Learning, 2015.
2. B.Sc. Practical Physics, C.L. Arora, S Chand and Company Limited, 12th Edition,2010
3. Physics in laboratory, Electricity & Magnetism, Wave & Optics, Supriya Das and Mili Das, Santra Publication Pvt Ltd, 1st edition, 2020

II – Year: I – Semester

Course Code: PHCC304	OPTICS LABORATORY I	Credits 0-0-2: 1

Course Objectives:

This course aims to introduce the practical related to Optics.

Course Outcomes: In the successful completion of this laboratory course, students will be able to:

CO1	Gain hands-on experience in using various optical instruments
CO2	Make finer measurements of the wavelength of light using Newton Rings experiment, Fresnel Biprism, etc.
CO3	Determine Resolving power of optical equipment can be learnt firsthand.

List of Experiments:

Sl. No.	Title of the experiments
1	Determination of minimum angle of deviation of a prism.
2	Familiarization with Schuster's focusing and determination of the angle of prism.
3	To determine the refractive index of the material of a prism using sodium light.
4	To determine the dispersive power of a prism using mercury light
5	Diffraction grating using LASER
6	To determine wavelength of sodium light using Fresnel Biprism.
7	To determine wavelength of sodium light using newton's rings.
8	To determine dispersive power and resolving power of a plane diffraction grating.
9	To determine the wavelength of sodium source using Michelson's interferometer.

Learning Resources:

Text Books:

1. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, Asia Publishing House,1971.
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna, ,Kitab Mahal, 11th Edition, 2011.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, Heinemann Educational Publishers, 4th Edition, reprinted 1985.
4. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, Vani Pub, 1985.
5. Practical Physics, G.L. Squires, Cambridge University Press, 4th Edition, 2015.

II – Year: I – Semester

Course Code: MAMC301	STATISTICS AND PROBABILITY	Credits 3-0-0: 3

Course Objectives :

The primary objective of a "Probability and Statistics" course is to equip students with a foundational understanding of probability theory and statistical methods, enabling them to analyze data, interpret patterns, and draw meaningful conclusions from uncertain situations, often with applications in various fields like science, engineering, and business; this includes learning about data collection, descriptive statistics, probability distributions, hypothesis testing, confidence intervals, regression analysis, and more

Course Outcomes**:** After going through this course, the students will be able to

CO1	Learn the basic concepts of probability and applications of Baye's theorem.
CO2	Learn various discrete and continuous distribution and their properties.
CO3	Learn the concepts of statistics.
CO4	Learn central limit theorems and applications of Markov chain
CO5	Apply the various test of significance in real-world problems.

Syllabus

Unit I	Sample space and events, probability axioms, addition and multiplication law of probability, independence events, Baye's theorem and its applications.	8 lectures
Unit II	Random Variables (Discrete and Continuous), Probability mass function and density function, Probability distribution- binomial distribution, negative binomial distribution, Poisson distribution, geometric distribution, normal distribution- their properties (mathematical expectations and variance), moments, moment generating function	9 lectures
Unit III	Measure of central tendency, moments, correlation coefficients, rank correlation, regression, line of regression, principle of least squares and curve fitting (straight Line and parabola)	9 lectures
Unit IV	Chebyshev's inequality, statement and interpretation of weak law of large numbers and strong law of large numbers, central limit theorem, Markov chain	8 lectures
Unit V	Introduction to sampling distributions, standard error, type-I and type-II errors, level of significance. Test of Significance - t- test, Z- test, testing of equality of variance (F- test), chi-square test.	8 lectures

Learning Resources

Text Books:

1. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 10th Edition, 2000.
2. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Reference Books:

1. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
2. J.R. Magnus; H. Neudecker: Matrix differential calculus with applications in statistics and econometrics, John Wiley and Sons, Third Ed. 2007.

II – Year: I – Semester

Course Code: CSSE301	PYTHON AND ITS APPLICATIONS	Credits 2-0-0: 2

Course Outcomes: After completion of the course student will be able to:

CO1	Develop algorithms and Python programs to solve basic arithmetic and logical problems using appropriate programming constructs.
CO2	Implement decision-making and iterative processes using control structures, functions, and loops in Python to solve various problems.
CO3	Apply object-oriented principles such as classes, objects, and methods to model and solve real-world problems in Python.
CO4	Utilize built-in data structures (lists, tuples, dictionaries, and sets) and file handling techniques to manage and process data efficiently.
CO5	Perform file handling in Python, working with text and binary files, and applying these concepts to real-world scenarios such as data analysis and automation.

Syllabus:

Unit I	Introduction to Python: Python overview; Interactive mode and Script mode; variables; keywords; datatypes: numeric, dictionary, Boolean, set, list, tuple, string; creation, deletion, access in different datatypes; operators: arithmetic, relational, assignment, logical, bitwise, membership, identity; input/output functions.	7 lectures
Unit II	Conditional statements in Python: Statements: IF, IF-ELSE, nested IF-ELSE. Iteration and Loops: Loops: FOR loop, WHILE loop, Nested loops; control statements: break, continue, pass.	8 lectures
Unit III	Functions in Python: arguments: required, keyword, default, variable-length; creating function; return statements.	7 lectures
Unit IV	Matrix in Python: Numpy module for matrix in Python; creation, deletion, access, manipulation; types of matrices; matrix operations: determinant, minor, inverse, rank, eigen value and vectors; solving linear equations.	7 lectures
Unit V	Matplotlib for data visualization: Matplotlib module for plotting, bar graph, pie chart, histogram, scatter plot, contour plot etc. Introduction to Pandas for data handling.	7 lectures

Learning Resources:

Textbooks:

1. "Automate the Boring Stuff with Python" by Al Sweigart, No Starch Press, 2nd Edition, 2019.
2. "Python Crash Course" by Eric Matthes, No Starch Press, 2nd Edition, 2019.
3. "Learning Python" by Mark Lutz, O'Reilly Media, 5th Edition, 2013.

Reference Books:

1. "Python Programming: An Introduction to Computer Science" by John Zelle, Franklin, Beedle & Associates, 3rd Edition, 2016.
2. "Python for Data Analysis" by Wes McKinney, O'Reilly Media, 2nd Edition, 2017.
3. "Fluent Python" by Luciano Ramalho, O'Reilly Media, 2nd Edition, 2022.

Online Resources:

- Official Python Documentation
- W3Schools Python Tutorial
- Coursera: Python for Everybody
- Udemy: Complete Python Bootcamp

II – Year: I – Semester

Course Code: CSSE302	PYTHON AND ITS APPLICATIONS	Credits 0-0-2: 1

Course Outcomes: After completion of the course student will be able to:

CO1	Develop algorithms and Python programs to solve basic arithmetic and logical problems using appropriate programming constructs.
CO2	Implement decision-making and iterative processes using control structures, functions, and loops in Python to solve various problems.
CO3	Apply object-oriented principles such as classes, objects, and methods to model and solve real-world problems in Python.
CO4	Utilize built-in data structures (lists, tuples, dictionaries, and sets) and file handling techniques to manage and process data efficiently.
CO5	Perform file handling in Python, working with text and binary files, and applying these concepts to real-world scenarios such as data analysis and automation.

List of Experiments:

1. Write a program to demonstrate different number data types in python(script.py)
2. Write a program to perform different arithmetic operations on numbers in python
3. Write a python script to print the current date in the following format ”Sun May 29 02:26:23 IST 2017”
4. Write a program to create, append, insert at a specific location and remove lists in python
5. Write a program to demonstrate working with tuples in python
6. Write a program to demonstrate working with dictionaries in python
7. Write a program to find the largest number among the three input numbers
8. Write Program to convert temperature in Celsius to Fahrenheit
9. Write a python program to find the factorial of a number using recursion
10. Write a program that accepts the lengths of three sides of a triangle as input, the program output should indicate whether or not the triangle ,is right triangle(recall from the Pythagorean theorem that in a right triangle ,the square of one side equals the sum of the squares of the other two sides)
11. Write a python program to define a module to find Fibonacci numbers and import the module to another program
12. Write a program that input a text file and the program should print all of the unique words in the file in alphabetical order.
13. Create a function that takes a variable-length argument list to calculate the average of any number of inputs.
14. Create a 3x3 matrix and perform basic operations (addition, subtraction, and multiplication) with another 3x3 matrix. Delete a row and a column from the matrix using NumPy functions.
15. Create a line plot of a mathematical function (e.g., $y=x^2$) over a specified range of x. Generate a bar graph to compare sales data of different products.
16. Create a pie chart to represent the market share of different companies. Customize the appearance of each plot (titles, labels, colors).
17. Create a scatter plot to visualize the relationship between two datasets (e.g., height vs. weight). Add labels, legends, and titles to the scatter plot to enhance clarity.
18. Generate random data using NumPy and create a histogram to show the distribution of the data.
19. Create a vector with values ranging from 10 to 49
20. Use the NumPy module to create a 2D matrix. Perform the following operations: creation, deletion, access, and manipulation (e.g., transpose, reshape). Display the matrix before and after each operation.
21. Write a Python program that calculates the determinant, inverse, rank, and eigenvalues of a given matrix using NumPy. Test the program with a sample 2x2 matrix.

22. Create a Python script that generates a bar graph and a pie chart based on sample data (e.g., sales data). Label the axes and include titles for each plot.
23. Develop a program that generates a histogram of a dataset and a scatter plot showing the relationship between two variables. Use Matplotlib for visualization and provide appropriate titles and labels.
24. Design a program that takes user input for a series of numbers, processes this data to calculate the mean and standard deviation, and then displays the results in a histogram and a line plot. Use NumPy for calculations and Matplotlib for plotting.
25. Create and manipulate DataFrames using Pandas. Perform the following:

    i) Access, filter, and modify data within a DataFrame.
    ii) statistical analysis and handle missing data.
    iii) Group data and export DataFrames to CSV files.
    iv) Visualize data using Matplotlib.

Learning Resources:

Textbooks:

1. "Automate the Boring Stuff with Python" by Al Sweigart, No Starch Press, 2nd Edition, 2019.
2. "Python Crash Course" by Eric Matthes, No Starch Press, 2nd Edition, 2019.
3. "Learning Python" by Mark Lutz, O'Reilly Media, 5th Edition, 2013.

Reference Books:

1. "Python Programming: An Introduction to Computer Science" by John Zelle, Franklin, Beedle & Associates, 3rd Edition, 2016.
2. "Python for Data Analysis" by Wes McKinney, O'Reilly Media, 2nd Edition, 2017.
3. "Fluent Python" by Luciano Ramalho, O'Reilly Media, 2nd Edition, 2022.

Online Resources:

- Official Python Documentation
- W3Schools Python Tutorial
- Coursera: Python for Everybody
- Udemy: Complete Python Bootcamp

- https://www.udemy.com/course/beginning-c-plus-plus-programming/

II – Year: I – Semester

Course Code: HSMD301	PRINCIPLES OF ECONOMICS	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the core micro and macroeconomic concepts, theories, models, principles, tools, and techniques
CO2	Understanding the role of market and prices in influencing key economic activities
CO3	Develop the skills to interpret, analyze the economic concepts and variables through diagrams, tables and graphs
CO4	Relate the key economic principles to real life situations, especially in the context of development challengeswhich would help students to make informed decisions
CO5	Understand the concept of calculation of National Income and its related macroeconomic variables and frameworks

Syllabus:

Unit I	Definition of Economics, Scope of Economics, Micro vs. Macroeconomics, Basic Economic problems of the economy, Production Possibility Curve of an Economy,	8 Lectures
Unit II	Consumers' Behaviour; Utility Analysis. Indifference curve analysis and consumers' equilibrium. Applications of IC Analysis; Laws of Supply and Demand. General market equilibrium, Elasticity of demand; Demand Estimation and Forecasting	10 Lectures
Unit III	Theory of production; Laws of Production, Optimal use of Factors of Production, Producer's Equilibrium, Cost concept and types of costs. Cost of production, cost and revenue functions	8 Lectures
Unit IV	Price and output determination and Producers' equilibrium under different market situations in the short-run and long-run.	8 Lectures
Unit V	National Income; Business Cycle; Inflation & Deflation	8 Lectures

Textbooks:

1. H. L. Ahuja, 'Macroeconomics: Theory and Policy.' (2021) S. Chand and Co.
2. D. N. Dwivedi, 'Microeconomics: Theory and Applications.' (2020) Vikas Publishing House
3. N. Gregory Mankiw and D. Bhattacharya, 'Principles of Economics.' (2019) Cengage Learning India
4. Ramesh Singh, 'Indian Economy.' (2023) McGraw Hill Education

Recommended Books:

1. Microeconomic Analysis – R. R. Barthwal, Wiley Eastern Ltd. New Delhi, 1991.
2. Principles of Microeconomics - D. D. Tewari & K. Singh, New Age International, New Delhi, 1996.
3. Microeconomics - Kourtsoyanis, ELBS, McMillan, London, 1985.
4. Principles of Economics - M L Seth and L N Agrawal, Educational Publication, Agra, 1995.
5. Economics – P. A. Samuelson & W. D. Nordhaus, Tata McGraw Hill Publications, New Delhi, 2002.

Web Resources:

1. https://nptel.ac.in/courses/
2. https://www.indiabudget.gov.in/economicsurvey/
3. https://www.khanacademy.org/economics-finance-domain
4. https://dbie.rbi.org.in/DBIE/dbie.rbi?site=home

II – Year: I – Semester

Course Code: HSMD302	ORGANIZATIONAL BEHAVIOUR	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the basic concepts of OB and how different moral values and organizational culture affect the functioning in the organization.
CO2	Develop personality, perception and modify behavior depending upon the environment.
CO3	Identify the processes used in developing communication and suitable leadership styles.
CO4	Analyze and compare different models used to explain individual behavior related to motivation (why) behind behavior and psychological well-being.
CO5	Explain group dynamics and demonstrate skills required for working in groups and teams.

Syllabus:

Unit I	Fundamentals of organizations-Nature of people and Organizations, Forces affecting organizational behaviour, Changing work force and employment relations, Impact of globalization and Information technology on organizational behavior, Organizational climate and culture	8 Lectures
Unit II	Individual dimensions in organizational behavior-Individual differences; Theories of Personality, Perception- Perceptual process and impression management. Learning-theories of learning and implications for management.	8 Lectures
Unit III	Communication- Concept, Process, Barriers and their remedies; Leadership-Theories and Styles. Implications for different stakeholders	9 Lectures
Unit IV	Theories and implications of Motivation, Workplace emotions: satisfaction, designing effective jobs, Job-rotation enrichment, enlargement and reengineering work process, job-related causes of stress, fatigue and its impact on productivity. Employee counselling and other psychological measures to improve productivity and mental health.	9 Lectures
Unit V	Groups and group dynamics, group behavior, group dynamics theories and group cohesiveness-group decision-making process, understanding work teams, team Vs groups, team development, Ingredients of effective teams, team life cycle, Interpersonal skills-Johari Window and transactional analysis	8 Lectures

Textbooks:

1. K. Aswathappa, 'Organizational Behavior.' (2018) Himalaya Publishing House
2. L. M. Prasad, 'Organizational Behavior: Text and Cases.' (2021) S. Chand and Co.
3. S. P. Robbins, Timothy A. Judge, N. Vohra, 'Organizational Behavior.' (2019) Pearson Education

Recommended Books:

1. Organizational Behaviour - Luthans, Fred, Mc Graw Hill, International Edition, 2013.
2. Organisational Behaviour – Rao, V.S.P, Excel Books, New Delhi, 2012.
3. Developing Managerial skills in Organizational Behaviour - Mainiero, Lisa A. and Tromley, Cheryl L., Prentice Hall India, New Delhi, 2009.
4. Organizations: structures, processes and outcomes - Hall Tolbert, PHI, New Delhi, 2010.
5. Behaviour in organizations: Understanding and managing the human side of work - Jerald Greenderg, Baron, PHI, 2008.

Web Resources:

1. https://www.brainscape.com/subjects/organizational-behavior
2. https://teambuilding.com/blog/organizational-behavior-books

II– Year: I – Semester

Course Code: HSAC301	ENGLISH FOR TECHNICAL WRITING	Credits 2-0-0: 2

Course Outcomes: At the end of the course, the student will be able to

CO1	Apply the principles of technical writing to produce clear, concise, and audience- appropriate documents.
CO2	Construct various types of technical documents using appropriate structures and formats.
CO3	Create and interpret visual representations of data for effective communication in technical writing.
CO4	Compose well-structured scientific papers adhering to standard conventions in their field.
CO5	Utilize digital tools and editing techniques to enhance the quality and efficiency of technical writing projects.

Syllabus:

Unit I	**Fundamentals of Technical Writing:** Principles of technical communication; Audience analysis and document planning; Technical writing style and tone.	6 Lectures
Unit II	**Technical Document Structures:** Report formats (formal reports, progress reports, feasibility studies); Technical manuals and user guides; Standard Operating Procedures (SOPs)	5 Lectures
Unit III	**Data Visualization and Description:** Creating and describing graphs, charts, and tables; Writing figure captions and legends; Interpreting and explaining statistical data.	5 Lectures
Unit IV	**Scientific Paper Writing:** Structure of scientific papers; Writing effective abstracts and introductions; Crafting methods, results, and discussion sections.	6 Lectures
Unit V	**Technical Editing and Digital Tools:** Proofreading and editing techniques for technical documents; Using reference management software; Leveraging digital tools for collaborative writing and version control.	6 Lectures

Recommended Books:

1. Mike Markel and Stuart Selber, '*Technical Communication,'* (2021), Macmillan
2. Alred, Brusaw, and Oliu, *'Handbook of Technical Writing,'* (2011), St. Martin's Press
3. Michael Alley, '*The Craft of Scientific Writing,'* (1998), Springer
4. Joshua Schimel, '*Writing Science: How to Write Papers that get Cited and Proposals that get Funded'* (2012), OUP USA
5. Carolyn Rude and Angela Eaton, '*Technical Editing'* (2010), Pearson

Web Resources:

1. https://developers.google.com/tech-writing
2. https://clickhelp.com/clickhelp-technical-writing-blog/
3. https://www.writethedocs.org/

II– Year: I – Semester

Course Code: HSAC302	ENGLISH FOR TECHNICAL WRITING	Credits 0-0-2: 1

Course Outcomes: At the end of the course, the student will be able to

CO1	Apply technical writing principles to produce clear, concise, and audience-appropriate content.
CO2	Create well-structured technical documents including reports, manuals, and SOPs.
CO3	Design effective data visualizations and write clear, informative captions and explanations.
CO4	Compose well-structured scientific papers
CO5	Utilize digital tools for efficient editing, reference management, and collaborative writing.

Syllabus:

1. **Technical Writing Style Exercises**
   Clarity and concision drills; Jargon translation activities; Audience analysis and adaptation exercises
2. **Technical Document Creation Workshop**
   Report formats (formal reports, progress reports, feasibility studies); Technical manuals and user guides; Standard Operating Procedures (SOPs)
3. **Data Visualization and Description Exercises**
   Creating and describing graphs, charts, and tables; Writing figure captions and legends; Interpreting and explaining statistical data.
4. **Scientific Paper Writing Practice**
   Structure of scientific papers; Writing effective abstracts and introductions; Crafting methods, results, and discussion sections
5. **Technical Editing and Digital Tools Practice**
   Proofreading and editing exercises; Using reference management software; Exploring digital tools for collaborative exercises

Recommended Books:

1. Mike Markel and Stuart Selber, '*Technical Communication,'* (2021), Macmillan
2. Alred, Brusaw, and Oliu, *'Handbook of Technical Writing,'* (2011), St. Martin's Press
3. Michael Alley, '*The Craft of Scientific Writing,'* (1998), Springer
4. Joshua Schimel, '*Writing Science: How to Write Papers that get Cited and Proposals that get Funded'* (2012), OUP USA
5. Carolyn Rude and Angela Eaton, '*Technical Editing'* (2010), Pearson

Web Resources:

1. https://developers.google.com/tech-writing
2. https://clickhelp.com/clickhelp-technical-writing-blog/
3. https://www.writethedocs.org/

II– Year: II – Semester

Course Code: PHCC401/ PHMC401	MATHEMATICAL PHYSICS I	Credits 3-1-0: 4

Course Objectives:

This course aims to introduce the Physics of Mathematical Physics I to the students.

Objectives are.

- To Study the basic concepts of Calculus.
- To Study the basic concepts of First and Second-Order differential equations.
- To Study the basic concepts of Vector Analysis.
- To study the basic concepts of Vector Integration.

Course Outcome: After completion of the course, students will be able to:

CO1	Draw and interpret graphs of various functions.
CO2	Solve first and second-order differential equations and apply these to physics problems.
CO3	Explain the concept of gradient of scalar field and divergence and curl of vector fields.
CO4	Perform line, surface and volume integration and to develop an understanding of apply Green's, Stokes' and Gauss's Theorems to compute these integrals.

Syllabus:

Unit I	**Calculus:** Recapitulate the concept of functions. Plot and interpret graphs of functions using the concepts of calculus. First Order Differential Equations: First order differential Equations: Variable separable, homogeneous, non-homogeneous, exact and inexact differential equations and Integrating Factors. Application to physics problems.	12 lectures
Unit II	**Second Order Differential Equations:** Homogeneous Equations with constant coefficients. Wronskian and general solution. Particular Integral with operator method, method of undetermined coefficients and method of variation of parameters. Cauchy-Euler differential equation and simultaneous differential equations of First and Second order.	14 lectures
Unit III	**Vector Analysis Vector Algebra:** Scalars and vectors, laws of vector algebra, scalar and vector product, triple scalar product, interpretation in terms of area and volume, triple cross product, product of four vectors. Scalar and vector fields. Vector Differentiation: Ordinary derivative of a vector, the vector differential operator. Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Laplacian operator. Vector identities.	15 Lectures
Unit IV	**Vector Integration:** Ordinary Integrals of Vectors. Double and Triple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Scalar and Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems, their verification (no rigorous proofs) and applications.	15 lectures

Learning Resources:

Text Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig, J. Wiley and Sons, 10th Edition 2023.
2. An introduction to ordinary differential equations, E. A. Coddington, Dover Publications Inc, 1989.
3. Vector Analysis: Schaum Outline Series, M. R Spiegel, McGraw Hill Education, 2nd Edition, 2009.
4. Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, Jones and Bartlett Learning, 5th Edition, 2012.
5. Mathematical Physics, A.K. Ghatak, IC Goyal and S.J. Chua, Laxmi Publications Private Limited, 1st Edition, 2016.

Reference Books:

1. Essential Mathematical Methods, K. F. Riley & M. P. Hobson, Cambridge Univ. Press, 1st Edition, 2011.
2. Differential Equations with Applications and Historical Notes, George F. Simmons, McGraw Hill, 2nd Edition, 2017.
3. Introduction to Vector Analysis, H.F. Davis and A. D. Snider, Wm. C. Brown Publishers; 6th edition 1991.

II – Year: II – Semester

Course Code: PHCC403	ANALOG ELECTRONICS	Credits 3-1-0: 4

Course Objectives:

This course aims to introduce the *Analog Electronics* to the students.

Objectives are.

- To Study the basic concepts of semiconductor devices and their applications.
- To study the basic concepts of Rectifier diodes, Zener diode, photodiode etc
- To emphasizes on understanding of amplifiers
- To Study the basic concepts of oscillators, operational amplifier and their applications.

Course Outcomes: After completion of the course, students will be able to:

CO1	Characterize and working of pn junction
CO2	Two terminal devices: Rectifier diodes, Zener diode, photodiode etc
CO3	NPN and PNP transistors: Characteristics of different configurations, biasing, stabilization and their applications.
CO4	CE and two stage RC coupled transistor amplifier using h-parameter model of the transistor.
CO5	Ideal and practical op-amps: Characteristics and applications.

Syllabus:

Unit I	**Semiconductor Diodes:** P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity.PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Derivation for Barrier Potential, Barrier Width and Current for abrupt Junction. Equation of continuity, Current Flow Mechanism in Forward and Reverse Biased Diode.	10 lectures
Unit 11	**Two-terminal Devices and their Applications:** (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, (2) Zener Diode and Voltage Regulation. Principle, structure and characteristics of (1) LED, (2) Photodiode and (3) Solar Cell, Qualitative idea of Schottky diode and Tunnel diode.	10 lectures
Unit III	**Bipolar Junction transistors:** n-p-n and p-n-p Transistors. I-V characteristics of CB and CE Configurations. Active, Cutoff and Saturation Regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow	11 lectures
Unit IV	**Amplifiers:** Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response.	12 lectures

Unit V	**Feedback in Amplifiers:** Positive and Negative Feedback. Effect of negative feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhuizen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.	13 lectures

Learning Resources:

Text Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, Tata Mc-Graw Hill, 2017.
2. Electronics: Fundamentals and Applications, J.D. Ryder, Prentice Hall, 5th Edition, 1975.
3. Op-Amps and Linear Integrated Circuit, R. A. Gayakwad, Pearson, 4th edition, 1999.
4. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, Oxford University Press, 6th Edition, 2014.
5. Semiconductor Devices: Physics and Technology, S.M. Sze, Wiley India, 2nd Ed., 2002.
6. Electronic Principles, A. Malvino, D.J. Bates, Tata Mc-Graw Hill 52 Education, 7th Edition, 2018.
7. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, Pearson India, 10th Edition, 2009.

Reference Books:

1. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, PHI, 6th Edition.,2009.
2. Learning Electronic Devices & circuits, S. Salivahanan & N. S. Kumar, Tata Mc-Graw Hill OP-Amps, 3rd Edition, 2012.
3. Microelectronic Circuits, M.H. Rashid, Cengage Learning, 2nd Edition, 2012.

II– Year: II – Semester

Course Code: PHCC405	CLASSICAL PHYSICS I	Credits 3-1-0: 4

Course Objectives:

The primary objective is to teach the students Classical Mechanics at a level more advanced than what they have learnt in B.Sc. This is a course which forms the basis of Physics of many areas of Physics.

Course Outcomes: After completion of the course, students will be able to:

CO1	Explain the concept of Lagrangian Formulation of Mechanics
CO2	Apply the concept of Lagrange's equations; gyroscopic forces; dissipative systems; Jacobi integral; gauge invariance etc.
CO3	Describe the concept of Central force; definition and characteristics etc.
CO4	Describe the concept of Canonical transformation, Poisson bracket etc.
CO5	Explain the concept of Rigid body motion, Central force problems (the Kepler problem and scattering).

Syllabus:

Unit I	Lagrangian Formulation of Mechanics: The variational principles and least action principles, Lagrangian equations of motion, constraints, Principle of virtual work and D'Alembert's principle, generalized coordinates, conjugate variables and phase space, symmetries and conservation laws.	10 Lectures
Unit II	Lagrange's equations; gyroscopic forces; dissipative systems; Jacobi integral; gauge invariance; generalized coordinates and momenta; integrals of motion; symmetries of space and time with conservation laws; invariance under Galilean transformations. Rotating frames; inertial forces; terrestrial and astronomical applications of Coriolis force.	15 Lectures
Unit III	Central force; definition and characteristics; Two-body problem; closure and stability of circular orbits; general analysis of orbits; Kepler's laws and equation; artificial satellites; Rutherford scattering. Principle of least action; derivation of equations of motion; variation and end points; Hamilton's principle and characteristic functions; Hamilton-Jacobi equation.	15 Lectures
Unit IV	Canonical transformation; generating functions; Properties; group property; examples; infinitesimal generators; Poisson bracket; Poisson theorems; angular momentum PBs; small oscillations; normal modes and coordinates.	10 Lectures
Unit V	Rigid body motion (inertia tensors, Euler angles, rotation matrices) Central force problems (the Kepler problem and scattering)	6 Lectures

Learning Resources:

Text Books:

1. Classical Mechanics, Goldstein, H., Pearson Education, 3rd edition, 2011.
2. Mechanics: Vol I (Course of Theoretical Physics S) Landau, L.D., Lifshitz, E.M., Butterworth-Heinemann, 3rd edition, 1982
3. Classical Mechanics, N C Rana, P S Joag, Tata McGraw-Hill, 2017.
4. Mechanics, A Sommerfeld, Academic Press, 1952.
5. Introduction to Dynamics, I Perceival, D Richards, Cambridge Univ. Press. 1982

II– Year: II – Semester

Course Code: PHCC402	GENERAL PHYSICS LABORATORY II	Credits 0-0-4: 2

Course Objectives:

This course aims to introduce the practical's related to thermal Physics and Electricity and Magnetism.

Course Outcomes: After completion of the course, students will be able to:

CO1	The practical knowledge of Thermodynamics, Electricity, and magnetism doing experiments: Engine, electric vibrations.
CO2	Apply and learn electric phenomena such as diode, and CRO and do experiments related to electric devices.

Complete any Eight practical's from the given experiments:

Sl. No.	Title of the experiments
1	Study of Linear Expansion Coefficient.
2	Study of Transverse Standing Waves on a String.
3	Study of simple harmonic motion.
4	Study of Longitudinal Standing Waves in a Sound Tube.
5	Study of Archimedes principle and density.
6	Uses of Newton's ring apparatus for obtaining interference fringes.
7	Study of series and parallel circuits using capacitor (voltage-current division rule)
8	Determination of frequency of AC by using a sonometer.
9	Study of digital multimeter for measuring (i) resistances, (ii) ac and dc voltages, (iii) DC Current, and (iv) checking electrical fuses.
10	Validation of Biot-Savart law

Learning Resources:

Text Books:

1. Advanced Practical Physics for students, H.T. Flint, B. L.Worsnop, Khosla Publishing House, 1971.
2. Advanced level Physics Practical, Michael Nelson, Jon M. Ogborn, Heinemann Educational Publishers, 4th Edition, reprinted 1985.
3. A Text Book of Practical Physics, I. Prakash, Ramakrishna, Kitab Mahal, 11th Edition, , 2011.
4. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, Vani Publication, 1985

II– Year: II – Semester

Course Code: MAMC401	ANALYTICAL GEOMETRY	Credits 4-0-0: 4

Course Objectives:

The primary course objectives of analytical geometry are to introduce students to the concept of using coordinate systems to represent geometric shapes, enabling them to translate geometric problems into algebraic equations and vice versa, focusing on concepts like lines, circles, conic sections, and their equations in both 2D and 3D space, while also developing problem-solving skills through applications of these concepts.

Course Outcomes: After completion of the course, students will be able to:

CO1	Learn the basic tools of two-dimensional coordinate system.
CO2	Learn Cartesian and Polar forms of conic sections and their properties.
CO3	Apply the concept of three-dimensional coordinate systems and three-dimensional shapes.
CO4	Learn the basic tools of sphere.
CO5	Learn the basic of cone and cylinders, its construction and equation.

Syllabus:

Unit I	Change of Axes: Transformation of coordinates, Translation of axes, Rotation of axes, Conic section; Parabola, hyperbola, and ellipse, Invariants. Pair of Straight lines: Homogeneous equations of second degree, Angle between a pair of lines, Bisectors of the angles between the pair of lines, Condition for the general equation of second degree to represent a pair of lines, removal of xy-terms and the first-degree terms, central conics, centre of a conic, pairs of parallel and perpendicular lines, points of intersection of a line and curve.	12 Lectures
Unit II	General conics: tangent, condition of tangency, equation of pair of tangents, pole and polar, reduction to standard forms, equation of the axes, and length of the axes, tangent and normal and properties, polar equation of a conic.	11 Lectures
Unit III	Introduction to three-dimensional geometry: Different forms of straight lines and planes, Skew lines, Coplanar lines, Angle between two planes, Shortest distance between two lines and equations of shortest distance. .	11 Lectures
Unit IV	Sphere: Plane section of a sphere, intersection of two spheres, sphere with a given diameter, Equation of a sphere through a given circle.	11 Lectures
Unit V	Cones and Cylinders: Definition, Equation of a cone with a conic as guiding curve, the right circular cone, its definition and equation. Definition and equation of cylinder and right circular cylinder.	11 Lectures

Learning Resources:

Text Books:

1. P. R. Vittal, *Analytic Geometry: 2D and 3D*, Pearson Education India; First edition, 2013.
2. R. J. T. Bell, *Coordinate Solid Geometry*, Macmillan, 1983.

Reference Books:

1. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
2. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.

Course Code: CYMC401	ENVIRONMENTAL SCIENCE	Credits 2–0–0: 2

Course Objectives:
The objective of this course is to develop awareness among students towards environment, natural resources, ecosystem and biodiversity and management of environmental pollutions.

Course Outcomes: After completion of the course student will be able to:

CO1	understand the basic concept of environmental science and natural resources.
CO2	know about the basic concept of ecosystem and biodiversity.
CO3	learn about environmental pollutions.
CO4	know the management of environmental pollutions.
CO5	learn about the social issues and the environment.

Syllabus:

Unit I	**Nature of Environmental studies and Natural resources** Definition, scope and importance of environmental science – Need for public awareness, Natural resources: Forest resources, Water resources, Energy resources, Mineral resources, Land resources and Food resources- The significance of alternative renewable energy sources in adverse environmental effects - Role of an individual in conservation of natural resources.	8 lectures
Unit II	**Ecosystems and Biodiversity** Concept of an ecosystem, Structure and function of an ecosystem, Energy flow in the ecosystem, Food chains, food webs and ecological pyramids & Ecological succession- Biodiversity - Definition, Value of biodiversity, Hot spots of biodiversity - Endangered and endemic species of India, Threats to biodiversity, Conservation of biodiversity: In-situ and Ex-situ conservation.	10 lectures
Unit III	**Environmental Pollution** Ecological and biochemical aspects of water pollution,Types, sources, consequences and control measures of water pollution, Air pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear pollution, Climate change, global warming, acid rain, Tropospheric chemistry of ozone, ozone layer depletion, Nuclear accidents and holocaust - Pollution by trace elements (Hg, As, F, Pb and Cd): Biochemical effects, toxicology, toxicity, control and treatment-Fireworks: current environmental issues-Role of an individual in prevention of pollution.	9 lectures
Unit IV	**Management of Environmental Pollution** Causes, effects, treatments methods and control measures of solid waste, municipal waste, hazardous waste, biomedical waste and E-waste- Waste minimization techniques & Cleaner Technology, Green Chemistry: Principles and its role in controlling environmental pollution, Disaster management: floods, earthquake, cyclone , landslides and Tsunami	8 lectures
Unit V	**Social Issues and the Environment** Water conservation: Methods of water conservation, rain water harvesting, Watershed Management (WSM) Resettlement and rehabilitation of people- Wasteland reclamation, Environmental Impact Assessment, Precautionary and Polluters pay Principle, Environment protection act: Air (prevention and control of pollution) act, Water (prevention and control of	10 lectures

	pollution) act, Forest (Conversation or Preservative) Act, 1980, Wildlife (Protection) Act Issues involved in enforcement of environmental legislation, Population explosion – Family Welfare Programs, Environment and human health - Human Rights - Women and Child Welfare.	

Learning Resources:

Text Books:

1. Environmental Science and Engineering, Anubha Kaushik and C. P. Kaushik, New Age International (P) Limited, Chennai, 2nd Edition, Reprint 2006.
2. Environmental Science: Working with the Earth, G.Tyler Miller, JR., Thomson- South Western, India First Edition, Delhi, 2007.
3. Environmental Science and Engineering, Deeksha Dave, Cengage Learning India, Pvt. Ltd., Delhi, 2010.
4. Environmental Engineering and Management, S.K.Dhameja, S.K.Kataria
5. & Sons, New Delhi, Reprint, 2009.
6. Introduction to Environmental Engineering and Science, Gilbert M. Masters, “Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.
7. Essentials of Ecology, C.Townsend, J. Harper and Michael Begon, Blackwell Science, 2003.
8. E.R. Nagarajan and A. Murugan, Environmental Science, Wiley Publishers, New Delhi, 2017

Reference Books:

1. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media,New Delhi,2nd Edition,2004.
2. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.
3. Wager K.D., Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
4. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.
5. Trivedi R.K. and P.K. Goel, Introduction to Air Pollution, Techno-Science Publications. Miller T.G. Jr., Environmental science, wadsworth Publishing Co. USA, 2nd edition 2004.
6. Trivedi R.K. and P.K. Goel, “An Introduction to Air Pollution”, BS publications, 2005.

Online Resources:

http://www.cseindia.org/
http://apesnature.homestead.com/lectures.html
http://www.uwgb.edu/dutchs/EnvSC102Notes.HTM
http://www.course-notes.org/Environmental_Science
http://jvarekamp.web.wesleyan.edu/newsyl.html
http://oso.tamucc.edu/~ianmacd/1401/classnotes.html

II– Year: II – Semester

Course Code: HSAC401	DIGITAL COMMUNICATION TOOLS	Credits 1-0-0: 1

Course Outcomes: At the end of the course, the student will be able to

CO1	Evaluate the impact of digital communication tools on scientific discourse and select appropriate tools for specific communication needs.
CO2	Compose professional emails and effectively utilize messaging platforms for scientific collaboration.
CO3	Design and maintain professional social media profiles and create engaging content for scientific outreach.
CO4	Demonstrate proficiency in using virtual collaboration tools and create compelling digital presentations.
CO5	Apply scientific writing tools to manage references, format documents, and navigate open-access publishing platforms.

Syllabus:

Unit I	**Introduction to Digital Communication:** Overview of digital communication in the modern world; Types of digital communication tools; Ethical considerations in digital communication.	4 lectures
Unit II	**Email and Messaging Platforms:** Email etiquette and best practices; Instant messaging tools for professional communication; Collaborative messaging platforms.	3 lectures
Unit III	**Social Media for Scientific Communication:** Leveraging social media for scientific outreach; Creating and managing professional profiles; Data visualisation tools for social media.	2 lectures
Unit IV	**Virtual Collaboration and Presentation Tools:** Cloud-based document collaborations; Virtual meeting platforms; Creating effective digital presentations	3 lectures
Unit V	**Scientific Writing and Publishing Tools:** Reference, Bibliography and Webliography management; LaTeX for scientific writing; Open-access publishing platforms; Professional and Technical Blogs	2 lectures

Recommended Books:

1. Song, Halsey, and Burress, '*The Hamster Revolution: How to Manage your Email before it Manages You,'* (2008), Berrett-Koehler Publishers
2. Gary Reynolds, *'Presentation Zen: Simple Ideas on Presentation Design and Delivery,'* (2011), New Riders
3. Stefan Kottwitz, '*Latex Beginner's Guide,'* (2011), Pakt Publishers Limited

Web Resources:

1. https://www.digitalcommunicationtools.com
2. https://www.nature.com/articles/d41586-019-00535-w
3. https://www.overleaf.com/learn

II– Year: II – Semester

Course Code: HSAC402	DIGITAL COMMUNICATION TOOLS	Credits 0-0-2: 1

Course Outcomes: At the end of the course, the student will be able to

CO1	Navigate and utilize various digital communication platforms effectively for professional purposes.
CO2	Manage emails efficiently and use messaging tools professionally in scientific contexts.
CO3	Create engaging science communication content for various social media platforms.
CO4	Collaborate effectively using virtual tools and deliver compelling digital presentations.
CO5	Apply scientific writing tools to manage references, format documents in LaTeX, and navigate open-access publishing platforms.

Syllabus:

1. **Navigating through Digital Communication Platforms**
   Social media platform comparison and usage; Professional networking site profile creation; Digital communication ethics case studies
2. **Email and Messaging Tools Practice**
   Email composition and organisation exercises; Instant messaging etiquette role-play; Collaborative messaging platform project
3. **Social Media for Scientific Communication Exercises**
   Science blog creation and management; Infographic design for social media; Social Media thread writing on scientific topics
4. **Virtual Collaboration and Presentation Tools Workshop**
   Google Docs collaborative writing exercise; Zoom/Webex meeting hosting and participation practice; Digital presentation creation and delivery exercises
5. **Scientific Writing and Publishing Tools Practice**
   Reference management; LaTeX document creation exercises.

Recommended Books:

1. Song, Halsey, and Burress, '*The Hamster Revolution: How to Manage your Email before it Manages You,'* (2008), Berrett-Koehler Publishers
2. Gary Reynolds, *'Presentation Zen: Simple Ideas on Presentation Design and Delivery,'* (2011), New Riders
3. Stefan Kottwitz, '*Latex Beginner's Guide,'* (2011), Pakt Publishers Limited

Web Resources:

1. https://www.digitalcommunicationtools.com
2. https://www.nature.com/articles/d41586-019-00535-w
3. https://www.overleaf.com/learn

II– Year: II – Semester

Course Code: HSAU401	INDIAN CONSTITUTION	Credits 2-0-0: 0

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the historical context and basic components of the Indian constitution.
CO2	Analyze the structure and functions of the Union government
CO3	Examine and understand the functioning of the state government and its functionaries
CO4	Evaluate the structure and responsibilities of local administrative bodies
CO5	Understand the process of conducting elections in India and the role of the constitutional bodies.

Syllabus:

Unit I	The Constitution: Introduction; The History of the Making of the Indian Constitution; Preamble and the Basic Structure, and its interpretation; Fundamental Rights and Duties and their interpretation; State Policy Principles.	5 Lectures
Unit II	Union Government; Structure of the Indian Union; President – Role and Power; Prime Minister and Council of Ministers; Lok Sabha and Rajya Sabha.	6 Lectures
Unit III	State Government; Governor – Role and Power; Chief Minister and Council of Ministers; State Secretariat.	6 Lectures
Unit IV	Local Administration; District Administration; Municipal Corporation; Zila Panchayat.	6 Lectures
Unit V	Election Commission; Role and Functioning; Chief Election Commissioner; State Election Commission.	5 Lectures

Textbooks:

1. D. D. Basu, 'Introduction to Constitution of India.' (2022) Lexis Nexis
2. M. Laxmikanth, 'Indian Polity.' (2023) McGraw Hill Education
3. M. P. Jain, 'Outlines of Indian Legal and Constitutional History.' (2022) Lexis Nexis

Recommended Books:

1. Ethics and Politics of the Indian Constitution, Rajeev Bhargava, Oxford University Press, New Delhi, 2008.
2. The Constitution of India B.L. Fadia, Sahitya Bhawan; New edition (2017)

Suggested Software/Learning Websites:

a. https://www.constitution.org/cons/india/const.html
b. http://www.legislative.gov.in/constitution-of-india
c. https://www.sci.gov.in/constitution
d. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/

II– Year: II – Semester

Course Code: PHEX201	LED LIGHT REPAIRING AND MAINTENANCE	Credits 0-0-4: 2

Course Objectives:

This is a course objective are.

- To use the knowledge of basics of electronics and LED to carry out work.
- Perform LED repair and assembly as per the recommended quality standards.
- Implement the soft skills that are required to carry out work efficiently.

Course Outcomes:

After completion of the course, students will be able to:

CO1	Explain basics of LED and semiconductor.
CO2	Apply the knowledge for the repair of LEDs.
CO3	Identify the importance of reduction electronic waste management and Intellectual Property Rights (IPR).

Course Content:

(Any 12 experiments + 3 Experimental Activities)

1. To identify the different LEDs in the circuit and measure its activities (ON/OFF).
2. To measure the Power and Energy of different LEDs.
3. To study how soldering and de-soldering of LED in done. (Hands on Training)
4. To check the voltage and current output at different sections of units of LED.
5. To check LEDs in series and parallel circuit. (Hands on Training)
6. To check the burnt out and damage LEDs in bulbs.
7. To perform repair and replacement of LEDs and other components.
8. To study an assembly of LED bulbs / Strips dismantle with different wattage.
9. To identify the operation of LED in the fiber optics.
10. To check and replace the burnt and damage LED strips
11. To demonstrate the process of soldering if loose, de-soldered wires and connections are found.
12. To demonstrate basic knowledge of assembly of products such as spot light, LED bulb and LED tube light. 13. To study the characteristics of three indicator LEDs that emit in the infrared, red and blue parts of the spectrum.
14. To investigate the relationship between the Threshold Voltage of an LED and the wavelength of light emitted from the LED.
15. To study and measure the P-I characteristics of light-emitting diode (LED) used in optical fiber communication as a light source.
16. To measure LED light output using a Photodiode.
17. To study the wavelength characteristics of LED for different 3 colors and measure it.
18. To study the properties of LED and how they can combine in the 7-segment display.

Additional Activities to be conducted related to subject (Any-3)

1. *Mini Projects with report.*
2. *Industrial /Research organization /Working organization /Field visit with report.*
3. *Any one computer-aided demonstrations.*
4. *Démonstrations – Any one demonstrations.*

Note: *Students have to perform 12 experiments and participate in additional three activities equivalent to 3 experiments with 12 experiments. Total laboratory work with additional activities should be 15 experiments.*

Learning Resources:

Text Books:

1. NSDC Skill Based Participant Handbook LED Light Repair Technician (E), Publisher Rachna Sagar Pvt. Ltd.
2. Vigyan Ashram, Design Manual (LED).

II– Year: II – Semester

Course Code: PHEX203	MAINTENANCE AND REPAIRING OF PHYSICS LABORATORY EQUIPMENT	Credits 0-0-4: 2

Course Objectives:

This is a course objective are.

- To use the knowledge of basics laboratory equipment's to carryout work
- Knowledge to create awareness of Lab Equipment
- Perform equipment repair and assembly as per the recommended quality standards 4. Implement the soft skills that are required to carry out work efficiently.
- To expose the students to the repairing of equipment.

Course Outcomes:

After completion of the course, students will be able to:

CO1	Identify Lab Equipment and Electronic Components.
CO2	Interpret the basic principles of physical instruments.
CO3	Apply the knowledge for the repair.
CO4	Identify the importance of reducing electronic waste management.

Course Content:

(Any 12 experiments + 3 Experimental Activities)

1. To identify the different equipment in used in the physics lab.
2. To study least count and measure the diameter of different sizes of thin wire using a screw gauge.
3. To study least count and measure the diameter of different size of rod using vernier calliper.
4. To study least count and how to measure the Current and Voltage using ammeter and voltmeter.
5. To study the DC and AC Voltage, Current, and Power using a multimeter.
6. To study the function/operation of resistance and measure the values of different resistance using color code and multimeter.
7. To study the function/operation of capacitor and measure the values of different capacitor using multimeter.
8. To measure current and voltage when resistance connected in series and parallel form.
9. To measure current and voltage when capacitor connected in series and parallel form.
10. To check and identify the fault in the circuit and how to repair it.
11. To study of CRO for the measurement of voltage and frequency.
12. To study the calibration of Spectrometer.
13. To study the function and operation of simple p-n junction and Zener diode.
14. To study the function and operation of IC. (IC 555, IC 741, IC 7400, etc.)
15. To study the simple pendulum to measure "g".
16. To study the telescope and measure the oscillation of the pendulum.
17. To study PCB and Breadboard for connections of simple electric components.
18. To study and measure of wavelength of LASER light.
19. To study and demonstration of various geometrical glasses.
20. To study the use of a stopwatch.
21. To study how to draw graphs using Excel.
22. To study the principle and operation of the Transformer.
23. To study an operation and how an electric fan is repaired.
24. To study an operation and how the power supply is repaired.

25. To study how spectrums are obtained using normal prism.
26. To study and repair mobile chargers.
27. To study function generator.

Additional Activities to be conducted related to subject (Any-3)

1. Mini Projects with report.
2. Industrial /Research organization /Working organization /Field visit with report.
3. Any one computer-aided demonstrations.
4. Démonstrations – Any one demonstrations.

Note: Students have to perform 12 experiments and participate in additional three activities equivalent to 3 experiments with 12 experiments. Total laboratory work with additional activities should be 15 experiments.

Learning Resources:

Text Books:

1. NSDC Skill Based Participant Handbook LED Light Repair Technician (E), Publisher Rachna Sagar Pvt Ltd.

*Students exiting the program after securing **80 credits** will be awarded a **UG Diploma** in the relevant **Discipline/Subject** provided they secure an additional **4 credits** in skill-based vocational courses offered during the first year or second-year summer term.*

III – Year: I – Semester

Course Code: PHCC501/ PHMC501	SOLID STATE PHYSICS I/ SOLID STATE PHYSICS	Credits 3-1-0: 4

Course Objectives:

This course aims to develop a deep understanding of the following properties of solids:

- Structural
- Electronic
- Magnetic
- Crystallography
- Bonding
- Lattice dynamics

Course Outcomes: After completion of the course, students will be able to:

CO1	Analyze the structure and symmetry of crystalline solids.
CO2	Explain bonding mechanisms in solids and calculate cohesive energy.
CO3	Apply free electron theory to explain electrical and thermal properties of metals.
CO4	Explain the concept of lattice vibrations and their contribution to specific heat.
CO5	Explore magnetic properties of materials and the phenomenon of superconductivity.

Syllabus:

Unit I	**Structure and Symmetry:** Crystalline vs amorphous solids, Miller indices, Bragg's law, Reciprocal lattice, Brillouin zones, NaCl, CsCl structures	12 lectures
Unit II	**Bonding in Solids:** Ionic, covalent, metallic, Van der Waals bonding, Lennard-Jones potential, and Madelung constant	6 lectures
Unit III	**Free Electron Theory of Metals:** Fermi-Dirac distribution, Density of states, Wiedemann-Franz law, Bloch theorem, and Kronig-Penney model.	10 lectures
Unit IV	**Lattice Vibrations:** Einstein and Debye models, phonons, Dispersion relations in solids, acoustic and optical modes.	12 lectures
Unit V	**Magnetic Properties and Superconductivity:** Diamagnetism, Para magnetism, ferromagnetism, hysteresis, Quantum mechanical treatment, Type I and Type II superconductors, and Meissner effect.	16 lectures

Learning Resources:

Textbooks:

1. Crystallography for Solid State Physics, A.R. Verma and O.N. Srivastava, New Age International Private Limited, Second edition, 1991
2. Introduction to Solids, Leonid V. Azaroff, McGraw Hill Education, New edition, 2017
3. Solid State Physics, C. Kittel, Wiley, Eighth edition, 2012
4. Solid State Physics, Ashcroft and Mermin, Brooks/Cole, New edition, 2021
5. Solid State Physics, A. J. Decker, Laxmi Publications, 2008

Reference Books:

1. Solid State Physics: An Introduction to Principles of Materials Science, H. Ibach and H. Luth, Springer-Verlag Berlin and Heidelberg GmbH & Co. K, 2nd edition, 1995
2. Principles of the Theory of Solids, J.M. Ziman, Cambridge University Press; 2nd edition, 1979

III – Year: I – Semester

Course Code: PHCC503	MATHEMATICAL PHYSICS II	Credits 3-1-0: 4

Course Objectives:

This course aims to equip students with advanced techniques in the Mathematical Physics.

Objectives are.

- To Study the basic concepts of Vector Calculus.
- To Study the basic concepts of Matrices.
- To Study the basic concepts of Differential equations.
- To study the basic concepts of Special functions.
- To Study the basic concepts of Fourier analysis.

Course Outcomes: After completion of the course, students will be able to:

CO1	Apply vector calculus in curvilinear coordinates for solving physical problems.
CO2	Work with matrices and tensors, including diagonalization and eigenvalue problems.
CO3	Solve first and second-order differential equations using methods such as Frobenius.
CO4	Utilize special functions like Bessel and Legendre in physics contexts.
CO5	Perform Fourier and Laplace transformations to analyze physical systems.

Syllabus:

Unit I	**Vectors and Curvilinear Coordinates:** Gradient, divergence, and curl in curvilinear systems, Laplacian in Cartesian, spherical, and cylindrical coordinates, Orthogonal curvilinear coordinates and metric tensors.	12 lectures
Unit II	**Matrices and Tensors:** Hermitian, orthogonal, and unitary matrices, Eigenvalue problems, Cayley-Hamilton theorem, Cartesian, covariant, and contravariant tensors, quotient law.	12 lectures
Unit III	**Differential Equations:** First and second-order equations with constant coefficients, Series solutions and Frobenius method, Bessel equations, Wronskian, and linear independence	11 lectures
Unit IV	**Special Functions:** Bessel, Legendre, Hermite, and Laguerre functions, Generating functions, orthonormality, Beta and Gamma functions	11 lectures
Unit V	**Fourier Analysis and Integral Transformations:** Fourier theorem, series, and integrals, Laplace transform and applications in physical systems	10 lectures

Learning Resources:

Textbooks:

1. Mathematical Methods for Physicists, George B. Arfken, Hans J. Weber and Frank E. Harris, Elsevier, Seventh edition, 2012
2. Mathematical Physics, A.K. Ghatak, L.C. Goyal, and S.J. Chua, Laxmi Publications Private Limited, First Edition, 2016
3. Mathematical Physics – P.K. Chattopadhyay, New Age International Private Limited, Third edition, 2022

4. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons Inc, 10th edition, 2010
5. Theory and Problems of Vector Analysis (Schaum's Outline Series), M.R. Spiegel, McGraw-Hill Education / Asia, SI metric ed edition, 1980

Reference Books:

1. Applied Mathematics for Engineers and Physicists, L.A. Pipes and L.R. Harvill, Dover Pubns, 3rd edition, 2014
2. Mathematical Physics – H.K. Dass and Dr. Rama Verma, S Chand Publishing, Eighth edition, 2019.

III – Year: I – Semester

Course Code: PHCC505	ELECTRODYNAMICS I	Credits 3-1-0: 4

Course Objectives:

This course provides an in-depth understanding of the following:

- Electrostatics
- Current electricity
- Magnetism
- Alternating current
- Electromagnetic wave propagation

It also covers applications of Maxwell's equations.

Course Outcomes: After completion of the course, students will be able to:

CO1	Apply Gauss's law to various charge distributions and solve Poisson's and Laplace's equations.
CO2	Define thermoelectric effects and use DC bridges for electrical measurements.
CO3	Analyze magnetic fields and their interactions with current-carrying conductors.
CO4	Analyze alternating current circuits and compute power, inductance, and mutual inductance.
CO5	Apply Maxwell's equations to describe electromagnetic wave propagation and understand waveguide properties.

Syllabus:

Unit I	**Electrostatics (10 lectures):** Gauss's law, applications, electric potential and field, Poisson's & Laplace's equation, Boundary conditions, capacitors, dielectric polarization, and Clausius-Mosotti equation.	10 lectures
Unit II	**Current Electricity:** Galvanometers, DC bridges, Kelvin's double bridge, Thermoelectric effects, LR, CR, and LCR circuits	10 lectures
Unit III	**Magnetism:** Biot-Savart's law, Ampere's circuital law, Gauss's theorem in magnetism, Magnetic materials: diamagnetism, paramagnetism, ferromagnetism.	10 lectures
Unit IV	**Alternating Current:** RMS values of AC current, LCR circuits in AC, Self-inductance, mutual inductance, power in AC circuits.	10 lectures
Unit V	**Electromagnetism and Wave Propagation:** Maxwell's equations, Poynting theorem, energy and momentum conservation, EM wave propagation, laws of reflection, transmission, waveguides.	16 lectures

Learning Resources:

Textbooks:

1. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited, 4th edition, 2015
2. Electricity and Magnetism, Edward M. Purcell and David J. Morin, Cambridge University Press, 3rd edition,2013
3. Electromagnetism - Vol. 1: Theory, Ashutosh Pramanik, Prentice Hall India Learning Private Limited, 2014

4. Classical Electrodynamics, J.D. Jackson, Wiley, 2020
5. Fundamentals Of Magnetism & Electricity, D.N. Vasudeva, S Chand & Company, 2011

Reference Books:

1. EM Waves and Fields, P. Lorrain and O. Corson, W. H. Freeman & Co Ltd, 3rd edition, 1987
2. Electricity and Magnetism, A. S. Mahajan and A.A. Rangwala, McGraw Hill Education, 2017

III – Year: I – Semester

Course Code: PHMC501	RADIATION PHYSICS	Credits 3-0-0: 3

Course Objectives:

This course provides an in-depth understanding of the following:

- Interaction of radiation with matter
- Radiation detectors
- Measurement of radiation exposure and dose
- Internal and external dosimetry

Course Outcomes: After completion of the course, students will be able to:

CO1	Explain the interaction of radiation with matters.
CO2	Apply the detectors to find the radiation.
CO3	Analyze how to measure the radiation exposure and dose.
CO4	Analyze the internal and external dosimetry.

Syllabus:

Unit I	**Interaction of radiation with matter**: Passage of heavy charged particles through matter: Energy loss by collision, maximum energy loss in a single collision, range energy relation, Bragg curve, Specific ionization, mean excitation energies, Bethe-Bloch formula collision stopping power, radiation stopping power. Interaction of neutrons: Neutron sources, General properties, energy classification, elastic and inelastic scattering, nuclear reaction, neutron activation and induced activity, radioisotope production, nuclear fission.	13 lectures
Unit II	**Radiation detectors:** Characteristics of organic and inorganic scintillation counters, Resolving time, Semiconductor devices - physics of semiconductors, diffused junction, surface barrier and ion-implanted detectors, Examples, Semiconductor spectrometer, Analysis of pulse height of spectra, superheated drop detectors. Neutron detectors: BF3 counters, fission chambers, activation methods, Neutron time of flight method. Preamplifier circuits, noise, linear pulse amplifier, pulse shaping, pulse stretching, operation amplifier, Pulse discriminators, coincidence and anti-coincidence circuits. Scalers, single and multichannel analyzer, charge sensitive amplifier. Principles of measurement (collimation shielding, geometry, calibration), Radiation survey instruments.	11 lectures
Unit III	**Measurement of radiation exposure and dose**: Particle flux and fluence, energy flux and fluence, cross section, linear and mass absorption coefficient, stopping power and LET. Exposures and its measurement, absorbed dose and its relation to exposure. Electronic equilibrium, Bragg-Gray principle and air wall chamber, Kerma, Kerma rate constant. Biological effectiveness, Equivalent dose, effective dose, Committed equivalent dose, Ambient and directional equivalent dose. Tissue equivalence.	11 lectures
Unit IV	**Internal and external dosimetry:** Biological half-life, effective half-life, selectivity of organs, beta particle dosimetry. Calculation of integral dose due to internal deposition, specific effective energy, annual limit on intake, derived air concentration. Dosimeters: Primary and secondary dosimeters. Pocket dosimeters, films, TLDs. Chemical and calorimetric devices.	11 lectures

Learning Resources:

Textbooks:

1. Radiation Detection and Measurement, G. F. Knoll, John Wiley & Sons Inc, 4th edition, 2010
2. Nuclear Radiation Detectors, S. S. Kapoor and V. S. Ramamurthy, New Age International Private Limited, Second edition, 2022
3. Introduction to Health Physics, Herman Cember, Pergamon Pr, Revised, Enlarged, Subsequent edition, 1983
4. Radiation Dosimetry, Attix F H et al, Vol. I, II and III Academic Press, NY, 1968

Reference Books:

1. Source book on Atomic Energy, Glasstone S, Krieger Publishing Company, 3rd edition, 2012
2. Fundamentals of Radiation Dosimetry, Greening J R, Bristol, Adam Hilger, Medical Physics Hand Book 6, 1981
3. Health Physics, Morgan K Z and Turner J E, Wiley, NY, 1978
4. Thermoluminescence and TL Dosimetry, Horowitx Y S, Boca Raton (eds.), Vol. I, II and III, CRC Press, 1984
5. Radioactivity and its Measurements, Mann W B, Et al, Pergamon Oxford, 1980
6. Radionuclide Decay Scheme and Dose Estimation, Dillman L T, et al, Society of Nuclear Medicine, NY, MIRD Pamphlet No. 10, 1975
7. Radiation Protection Standards, Taylor L S, CRC Press, Cleveland, Ohio, 1971
8. Radiation Protection in Hospitals Medical Sciences Series, Richard F. Mould, Adam Hilger Ltd, Bristol and Boston, 1985
9. The Dosimetry of ionising radiation, Kenneth R Kase, Bjarngard B E and Attix F H, Vol I & II, Academic Press, 1985 & 1987
10. Radiation Protection, Ronald L. Kathren, Adam Hilger Ltd. International Publishers Services, 1985
11. Environmental Radioactivity, Merril Eisenbud, Academic Press, Orlando, Third Edition 1987
12. Atoms, Radiation & Radiation Protection, James E Turner, WILEY.VCH, Third completely revised and enlarged edition, 2023

III – Year: I – Semester

Course Code: CYMC507	GREEN CHEMISTRY	Credits 3-0-0: 3

Course Objectives:

This course introduces students to the utilization of green chemistry from industrial perspective and provides exposure to methods by which environmental problems are evaluated and designing of sustainable solutions.

Course Outcomes: After completion of the course student will be able to:

CO1	Know about basics of green chemistry.
CO2	Describe twelve principles of green chemistry with suitable examples.
CO3	describe and evaluate chemical products and processes from environmental perspective.
CO4	define and propose sustainable solutions.
CO5	critically assess the methods for waste reduction and recycling.

Syllabus:

Unit I	**Introduction to Green Chemistry** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.	10 lectures
Unit II	**Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry. Explanations of principle with special emphasis on - Designing green synthesis processes: Prevention of Waste/ by-products; maximize the incorporation of the materials used in the process into the final products (Atom Economy) with reference to rearrangement, addition, substitution and elimination reactions; Prevention/ minimization of hazardous/ toxic products; Designing safer chemicals; Use of safer solvents and auxiliaries (e.g. separating agent) - green solvents (supercritical CO2, water, ionic liquids),solventless processes, immobilized solvents.	8 lectures
Unit III	**Examples of Green Synthesis/ Reactions and some real world cases-I** Green Synthesis of the following compounds: adipic acid, catechol, methyl methacrylate, urethane, disodium iminodiacetate (alternative to Strecker synthesis), paracetamol, furfural. Microwave assisted reactions: Applications to reactions (i) in water: Hofmann Elimination, hydrolysis (of benzyl chloride, methyl benzoate to benzoic acid), Oxidation (of toluene, alcohols); (ii) reactions in organic solvents: Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: Applications to esterification, saponification, Simmons-Smith Reaction (Ultrasonic alternative to Iodine).	10 lectures
Unit IV	**Examples of Green Synthesis/ Reactions and some real world cases-II** Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments; Designing of Environmentally safe marine antifoulant; Right fit pigment: synthetic azopigments to replace toxic organic and inorganic pigments; Synthesis of a compostable and widely applicable plastic (poly lactic acid) from corn; Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting	10 lectures
Unit V	**Future Trends in Green Chemistry**	**7** lectures

	Oxidizing and reducing reagents and catalysts; multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Green chemistry in sustainable development (Bio-diesel, bio-ethanol and biogas).	

Learning Resources:

Text Books:

1. Anastas P.T. & Warner J.K.: Green Chemistry- Theory and Practical, Oxford University Press (2000).
2. Ahluwalia V.K. & Kidwai M.: New Trends in Green Chemistry, Anamalaya Publishers, New Delhi (2004).
3. Kumar V., An Introduction to Green Chemistry, Vishal Publishing Co., (2015).
4. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
5. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).

Reference Books:

1. Matlack A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
2. Das Asim K. and Das Mahua, Environment Chemistry with Green Chemistry, Booksand Allied (P) Ltd. (2010)
3. Manahan S.E. (2005) Environmental Chemistry, CRC Press.
4. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole.

Online Resources:

https://swayam.gov.in/explorer

III – Year: II – Semester

Course Code: PHCC601	ATOMIC AND MOLECULAR PHYSICS I	Credits 3-1-0: 4

Course Objectives:

This course aims to explore advanced concepts in atomic and molecular physics, including:

- Atomic models
- Electron spin and quantum numbers
- Atomic and molecular spectra
- Laser physics

Course Outcomes:

After completion of the course, students will be able to:

CO1	Explain and analyze the development of atomic models, including Bohr and Sommerfeld models, and the experimental foundations of electron spin.
CO2	Describe the behavior of single and multi-electron atoms, including spin-orbit coupling, spectral line intensities, and effects like Zeeman and Paschen-Back.
CO3	Analyze molecular spectra by understanding rotational, vibrational, and electronic transitions and molecular energy levels.
CO4	Explain the principles of laser operation, including population inversion, rate equations, and the characteristics of laser light.
CO5	Understand quantum numbers and atomic orbitals, including the Pauli exclusion principle and the significance of various quantum numbers in atomic structure.

Syllabus:

Unit I	**Atomic Models and Fundamental Concepts:** Bohr and Sommerfeld models, Impact of finite nuclear mass on Rydberg constant, Electron spin, Franck-Hertz, and Stern-Gerlach experiments	12 lectures
Unit II	**Single and Multi-Valence Electron Atoms:** Magnetic dipole moment, spin-orbit coupling, Vector atom model, LS and JJ coupling, Spectral line intensity, Zeeman and Paschen-Back effects.	12 lectures
Unit III	**Molecular Spectra:** Rotational, vibrational, and electronic spectra, Overview of molecular energy levels and transitions.	10 lectures
Unit IV	**Laser Physics:** Einstein coefficients, stimulated emission, Population inversion, rate equations, properties of laser light, Types of lasers: Ruby, He-Ne, Nd lasers, Semiconductor laser.	14 lectures
Unit V	**Quantum Numbers and Atomic Orbitals:** Quantum numbers: Principal, angular, magnetic, and spin, atomic orbitals and the Pauli exclusion principle.	8 lectures

Learning Resources:

Textbooks:

1. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, Robert Eisberg, Robert Resnick, Wiley, Second edition, 2006

2. Introduction to Atomic Spectra, H.E. White, MCGRAWHILL EXCLUSIVE (CBS), 2019
3. Principles of Lasers, Orazio Svelto, Springer-Verlag New York Inc., 5th ed. 2010 edition, 2009
4. Optics, P.K. Srivastava, CBS PUBLISHERS AND DISTRIBUTORS PVT LTD, First Edition, 2011
5. Atom, Laser & Spectroscopy, S.N. Thakur and D.K. Rai, Prentice Hall India Learning Private Limited, 2nd edition, 2013

Reference Books:

1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw-Hill Inc. US, 1962
2. Atoms, Molecules, and Photons, Wolfgang Demtröder, Springer, 3rd ed. 2018 edition, 2019

III – Year: II – Semester

Course Code: PHCC603	NUCLEAR PHYSICS	Credits 3-1-0: 4

Course Objectives:

This course introduces key concepts in nuclear physics, including:

- Nuclear forces and stability
- Nuclear models and reactions
- Accelerators and detectors
- Particle physics and cosmic rays

Course Outcomes:

After completion of the course, students will be able to:

CO1	Explain the nature of nuclear forces, nuclear stability, and radioactive decay processes like alpha, beta, and gamma decay.
CO2	Analyze nuclear models such as the liquid drop model and the shell model and apply the Bethe-Weizsäcker mass formula to problems in nuclear stability and decay.
CO3	Evaluate nuclear reactions including fission and fusion processes and understand their applications in thermonuclear reactions and nuclear reactors.
CO4	Explain the principles and workings of particle accelerators such as Van de Graaff, Cyclotron, and Synchrotron, as well as detectors like Geiger-Mueller counters.
CO5	Outline the basics of particle physics, including leptons, baryons, mesons, quarks, and cosmic ray phenomena.

Syllabus:

Unit I	**Nuclear Forces and Stability of Nuclei:** Nucleon-nucleon forces, nuclear stability, Alpha, beta, gamma decay, and selection rules.	13 lectures
Unit II	**Nuclear Models:** Liquid drop, shell models, Bethe-Weizsäcker mass formula, applications to fission and alpha decay.	13 lectures
Unit III	**Nuclear Reactions:** Fission and fusion processes, Thermonuclear reactions, nuclear reactors, and Q-value of reactions.	10 lectures
Unit IV	**Accelerators and Detectors:** Van de Graaff, Cyclotron, Synchrotron, linear accelerators, Geiger-Mueller counters, ionization chambers, and scintillation detectors.	10 lectures
Unit V	**Particle Physics and Cosmic Rays:** Leptons, baryons, mesons, conservation laws, Quarks, color charge, and cosmic ray composition.	10 lectures

Learning Resources:

Textbooks:

1. Introductory Nuclear Physics, S.S.M. Wong, Prentice Hall India Learning Private Limited, 1996
2. Nuclear Physics, V. Devanathan, Alpha Science Intl Ltd, 2nd edition, 2011
3. Concepts of Nuclear Physics, B.L. Cohen, McGraw Hill Higher Education, 1st edition, 1974
4. Fundamentals of Nuclear Physics, B.B. Srivastava, Rastogi Publications, 1st edition, 2018
5. Introduction to Elementary Particles, D.J. Griffiths, Wiley-VCH, 2nd edition, 2008

Reference Books:

1. Introduction to Nuclear Physics, H.A. Enge, Addison Wesley Publishing Company, 1966
2. Introduction to High Energy Physics, D.H. Perkins, Cambridge University Press, 4th edition, 2000

III – Year: II – Semester

Course Code: PHCC605	DIGITAL ELECTRONICS	Credits 3-1-0: 4

Course Objectives:

This course introduces foundational concepts in digital electronics, focusing on:

- Number systems and codes
- Logic gates and Boolean algebra
- Combinational and sequential logic circuits
- Programmable logic devices

Course Outcomes: After completion of the course, students will be able to:

CO1	Explain various number systems, perform conversions between bases, and carry out arithmetic operations in binary, octal, and hexadecimal systems.
CO2	Simplify Boolean expressions using Boolean algebra, and design digital circuits using logic gates.
CO3	Compare different digital logic families (TTL and CMOS) based on their characteristics such as noise margin, fan-in, and fan-out.
CO4	Design and analyze combinational logic circuits using methods like Karnaugh maps, and implement logic functions using multiplexers, encoders, and decoders.
CO5	Design sequential logic circuits using flip-flops, counters, and shift registers, and understand the basics of programmable logic devices such as ROM, PLA, PAL, and FPGA.

Syllabus:

Unit I	**Number Systems and Codes:** Decimal, Binary, Hexadecimal, and Octal number systems, Base conversions, Binary, octal, and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), Representation of signed and unsigned numbers, Binary Coded Decimal (BCD) code.	12 lectures
Unit II	**Logic Gates and Boolean Algebra:** Introduction to Boolean Algebra and Boolean operators, Truth tables of OR, AND, NOT gates, XOR, XNOR, and universal gates (NOR, NAND), Simplification of Boolean expressions using Karnaugh maps, Standard representation of logic functions (SOP and POS).	12 lectures
Unit III	**Digital Logic Families:** Fan-in, fan-out, noise margin, power dissipation, Speed-power product, figure of merit, TTL and CMOS families and their comparison.	8 lectures
Unit IV	**Combinational Logic Analysis and Design:** Multiplexers, Demultiplexers, Encoders, Decoders, Binary Adder and Subtractor, Karnaugh map minimization techniques, Implementing logic functions with multiplexers.	12 lectures
Unit V	**Sequential Logic and Programmable Devices:** Flip-flops-SR, JK, T, D flip-flops, Clocked and edge-triggered flip-flops, Counters (synchronous, asynchronous, and modulo-N), Shift registers, ROM, PLA, PAL, CPLD, FPGA basics.	12 lectures

Learning Resources:

Textbooks:

1. Digital Design, M. Morris Mano, Pearson Education, Sixth edition, 2018
2. Digital Fundamentals, Thomas L. Floyd, Pearson Education Limited, 11th edition, 2015

3. Digital Electronics: Theory and Practice, W.H. Gothmann, Prentice Hall India Learning Private Limited, 2nd edition, 1982
4. Digital Principles, R.L. Tokheim, McGraw Hill, 3rd edition, 1993
5. Verilog HDL Primer, J. Bhasker, Star Galaxy Pub, 3rd edition, 2005

Reference Books:

1. Digital Design and Synthesis with Verilog HDL, Samir Palnitkar, Pearson India, 2nd edition, 2003
2. Digital Principles and Applications, A.P. Malvino, McGraw Hill Education, Eighth edition, 2014

III – Year: II – Semester

Course Code: PHCC606	ELECTRONICS LABORATORY	Credits 0-0-4: 2

Course Objectives:

This course aims to introduce the practical's related to Digital Electronics.

Course Outcomes: After completion of the course, students will be able to:

CO1	Perform experiments based on logic gates
CO2	Simplify Boolean expressions using Boolean algebra, and design digital circuits using logic gates.
CO3	*Draw the characteristics of a transistor in CE and CB configuration*
CO4	Design and analyze combinational logic circuits
CO5	Design sequential logic circuits using flip-flops

Syllabus:

Students must complete any Eight practical's from the given experiments:

Sl. No.	Title of the experiments
1	To verify and design AND, OR, NOT, and XOR gates using NAND gates.
2	To convert a Boolean expression into logic gate circuit and assemble it using logic gate ICs.
3	Design a half and full adder.
4	Design a half and full subtractor.
5	Design a seven-segment display driver.
6	Design a 4 x 1 multiplexer using gates.
7	To build a flip- flop circuits using elementary gates. (RS, clocked RS, D-type).
8	Design a counter using d/t/jk flip-flop.
9	Design a shift register and study serial and parallel shifting of data.
10	To design and study of a Regulated Power Supply using diodes.
11	To draw the characteristics of a transistor in CE and CB configuration
12	To draw the characteristics of a Zener Diode and to study its use as a voltage regulator

Learning Resources:

Text Books:

1. Digital Systems: Principles and Applications, Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, Pearson, 10th edition, 2006
2. Digital Design, M. Morris Mano and Michael D. Ciletti, Pearson Education, Sixth edition, 2018
3. Fundamentals of Digital Circuits, A. Anand Kumar, PHI, 4th edition, 2016
4. Digital Logic and Computer Design, M. Morris Mano, Masood Books UP, 2018

*Students exiting the program after securing **120 credits** will be awarded **UG Degree** in the relevant Discipline/**Subject**.*

III – Year: II – Semester

Course Code: ECMC501/ ECPC501	ELECTROMAGNETIC FIELD THEORY	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the coordinates systems, vector calculus and apply it in electromagnetic problem
CO2	Apply the principles electrostatics to solve electrostatic problems
CO3	Apply the principles of magnetostatics to solve magnetostatics problems
CO4	Understand the time varying field and apply it to solve electromagnetic problems
CO5	Analyze wave propagation in various media, and understand phenomena such as wave polarization, reflection, and energy flow through the Poynting vector.

Syllabus:

Unit 1	Review of vector algebra, Rectangular, Cylindrical, Spherical Coordinate systems and transformation, Vector Calculus- Gradient, Divergence and curl, Green's and Stroke theorems.	8 lectures
Unit 2	Electrostatics, Coulomb's law, Gauss's law and applications, Electric potential, Poisson's and Laplace equations, Method of images. Electrostatic fields in matter, Dielectrics and dielectric polarization, Capacitors with dielectric substrates, Electric Boundary Conditions.	10 lectures
Unit 3	Magnetostatics, Biot-Savart's Law, Ampere Circuits Law, Applications of Ampere's Law, Maxwell Equations of static fields, Magnetic Scalar and Vector Potentials, Magnetic Force- charge particle, current elements, Magnetic field in material space, Magnetization, Magnetic Boundary Conditions, Inductor, Inductances, Magnetic Energy,	10 lectures
Unit 4	Time-varying Fields, Faraday's Law, Displacement current, Maxwell Equations, Time Varying Harmonic Fields.	7 lectures
Unit 5	Electromagnetic waves, General wave Equations, waves in lossy dielectrics, plane waves in lossless dielctrics, free space, good conductors, Wave polarization, Poyinting vector and reflection of waves, Reflection of Waves.	7 lectures

Learning Resources:

Text Books:

1. Elements of Electromagnetics, 4th Edition – M. N. O. Sadiku, Oxford.

Electromagnetic waves and radiating systems, 2nd edition, E. Jordan and K. Balmin, Prentice Hall of India, New Delhi, 2001.

Reference Books:

1. Engineering Electromagnetics, W. H. Hayt and J. A. Buck, 7th edition, Tata McGraw Hill.
2. Advanced Engineering Electromagnetics, C. A. Balanis, John Willy and Sons, New York, 2001.

III – Year: II – Semester

Course Code: MAMC601	VECTOR CALCULUS	Credits 3-0-0: 3

Course Objectives:

The primary objective of a vector calculus course is to introduce students to the fundamental concepts of vectors in three-dimensional space, including operations like dot product and cross product, and to develop skills in calculating derivatives and integrals of vector functions, while also exploring important theorems like the divergence theorem, Green's theorem, and Stokes' theorem, with a focus on applying these concepts to solve problems in physics and engineering fields

Course Outcomes: After completion of the course, students will be able to:

CO1	Learn the derivatives and partial derivatives of vector valued functions of 3 variables.
CO2	Define the gradient, divergence, curl operators and see their applications.
CO3	Learn the concept of vector integration and use to evaluate integrals of fractions defined over curves and surfaces.
CO4	Use Green's Theorem, Stoke's Theorem and Gauss Divergence theorem and apply them to transform one type of integral to another so as to reduce complexity in computing.
CO5	Learn the derivatives and partial derivatives of vector valued functions of two variables

Syllabus:

Unit I	**Vector Differentiation:** Vector Differentiation- Scalar and Vector Fields-Scalar Fields-Vector Fields. Vector Calculus-Limits and Continuity of vector Functions-Ordinary Derivatives-Partial Derivatives-Directional derivatives	8 lectures
Unit II	Vector Differential Operator-Gradient-Invariance of the Gradient (Statement Only), gradient of a vector Function and Gradient in Curvilinear coordinates. Divergence –Invariance of the Divergence (Statement Only), Divergence in Curvilinear coordinates. Curl-Invariance of the Curl (Statement Only), Curl in Curvilinear coordinates	10 lectures
Unit III	**Vector Integration**: Vector Integration-Definition of basic concepts, Ordinary Integrals, Line Integral, Surface Integrals, volume Integral.	8 lectures
Unit IV	**Vector Calculus:** Scalar triple product, vector triple product, ordinary and partial differentiation of a vector function, derivative of sum, dot product and cross product of two vectors,gradient, divergence, curl and their applications.	8 lectures
Unit V	Integral Theorems-Green's Theorem in the plane, Gauss Divergence Theorem, Stoke's Theorem.	8 lectures

Learning Resources:

Textbooks:

1. Murray R. Spiegel and Seymour Lipschutz, Vector Analysis, Schaum's Outlines Second Edition, 2009

2. M.R. Spiegel: Vector Analysis, Schaum's Outline Series, McGraw Hill, 1959

Reference Books:

1. P.C. Matthew’s, Vector Calculus, Springer Verlag London Limited, 1998

IV – Year: I – Semester

Course Code: PHCC701	MATHEMATICAL AND COMPUTATIONAL METHODS IN PHYSICS	Credits 3-1-0: 4

Course Objectives:

This course aims to learn to solve physics problems using mathematical and computational methods.

- To Study the basic concepts of Curvilinear coordinates.
- To Study the basic concepts of Linear spaces and operators
- To study the basic concepts of Algorithms and Flowcharts.
- To study the basic concepts of Scientific Programming

Course Outcomes:

After completion of the course, students will be able to:

CO1	Explain the basic concept of coordinate systems, gradient, curl, divergence, etc.
CO2	Interpret the basics of vector spaces, operators, matrix representation, etc.
CO3	Illustrate the use of flowcharts, algorithms, etc.
CO4	Identify the basics of the application of scientific Programming to solve problems.

Syllabus:

Unit I	Numerical Analysis: Methods for determination of zeroes of linear and non-linear algebraic equations and transcendental equations, solutions of simultaneous linear equations, Iterative method, Matrix inversion.	10 lectures
Unit II	Linear fitting and interpolation: Interpolation with equally spaced and unevenly spaced points, curve fitting, polynomial, least square and cubic spline fitting. Linear spaces and operators.	10 lectures
Unit III	Numerical differentiation and integration: Newton-cotes formulae, Error estimates, Gauss 'method. Numerical solution of ordinary differential equation: Euler and Runge Kutta methods. Algorithms and Flowcharts:	9 lectures
Unit IV	Random variate: Monte-Carlo evaluation of integrals and error analysis, methods of importance sampling, Random Walk, rejection Method, Metropolis algorithm. Scientific Programming:	9 lectures
Unit V	Programming: Elements of Computer programming with C ++.	18 lectures

Learning Resources:

Text Books:

1. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, 1st edition 2005.
2. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, Cambridge University Press, 3rd edition, 2006.
3. Numerical Methods for Mathematics, Science and Engineering, J.H. Mathews, Pearson Education US, 2nd edition 1993.
4. Computer programming in Fortran 90 and 95, V. Rajaraman, Prentice-Hall of India, 1997. A Textbook of Applied Electronics, R. S. Sedha, S.Chand & Co. 3rd edition 2008
5. Mathematical Physics, Partha Goswami, Cengage Learning, 1st edition, 2012.

Reference Books:

1. Advanced Engineering Mathematics, D.G. Zill and W. S. Wright, Jones and Bartlett Learning, 5th edition,2012.
2. Numerical Recipes: The Art of Scientific Computing, William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, Cambridge University Press, 3rd edition 2007.

IV – Year: I – Semester

Course Code: PHCC703	QUANTUM MECHANICS I	Credits 3-1-0: 4

Course Objectives: This course aims to provide insight into concepts that go beyond the realm of classical mechanics. The course comprises:

- Overview of physics beyond classical mechanics and formalism of quantum mechanics.
- Discuss the fundamental concept of quantum mechanics.
- Use of mathematical tools to solve quantum problems.
- Application of quantum concept in harmonic oscillator, electromagnetic field, etc.
- Gives an idea of the degeneracy of many particle systems, symmetric and unsymmetric wave functions.

Course Outcomes: After completion of the course, students will be able to:

CO1	Understanding the fundamentals of quantum mechanics, properties, and their physical significance
CO2	To conceptualize the postulate of quantum mechanics, which involves the formalism of wave equations and their application in one-dimensional problems
CO3	Usage of mathematical operators to solve quantum problems.
CO4	Solve different problems related to the dynamics of subatomic particles.
CO5	Formulate new approximation methods for solving quantum mechanical problems.

Syllabus:

Unit I	**Introduction And Overview of Quantum Mechanics:** Brief introduction to origins of quantum Physics, Wave packets, Dirac notation, Operators and their eigenvalues and eigenfunctions, orthonormality, completeness and closure, generalized uncertainty principle, Unitary transformations, change of basis, Matrix Representation of operators, Continuous basis, position and momentum representation and their connection Parity operator.	12 lectures
Unit II	**Fundamental Concepts of Quantum Mechanics:** Basic postulates of quantum mechanics, Time evolution of system's state, Schrodinger, Heisenberg and interaction pictures, Density operator (Pure state and mixed state density operators), Discrete and continuous spectra in 1-D, Solution of 1-D harmonic oscillator using algebraic method	11 lectures
Unit III	**Angular Momentum:** Orbital, Spin and total angular momentum operators, Pauli spin matrices, their Commutation relations, Eigenvalues and eigenfunctions of L_2 and L_z, Angular momentum as generator of rotation, Addition of angular momenta, Clebsch-Gordon coefficients, L-S coupling.	11 lectures
Unit IV	**Pictures of representations:** Matrix theory of harmonic oscillator, Derivation of Hamiltonian of atomic electron in an em-field, Equation of election in uniform magnetic field.	10 lectures
Unit V	**Identical Particles:** Many particle systems, Systems of identical particles, Exchange degeneracy, Summarization postulate, construction of symmetric and anti-symmetric wave functions from unsymmetrized functions, The Pauli exclusion principle, Introduction to second quantization, Creation and annihilation operators for Fermions and Bosons, Fock states.	12 lectures

Learning Resources:

Text Books and Reference Books :

1. " Principles of Quantum Mechanics, R. Shankar, Springer, 2nd edition 2011.
2. Quantum Mechanics: Concepts and Applications, Nouredine Zettili, Wiley india Pvt. Ltd, 2nd edition, 2016
3. Quantum Mechanics: A Modern Development, Leslie E. Ballentine, Wspc, 1st edition 1998.
4. Introduction to Quantum Mechanics, David J. Griffiths, Cambridge University Press, 2nd edition, 2016

Quantum Mechanics, Cohen-Tannoudji, Diu, and Laloë, Wiley VCH, 1st edition 1997

IV – Year: I – Semester

Course Code: PHCC705	CLASSICAL PHYSICS II	Credits 3-1-0: 4

Course Objectives**:** This course aims to provide insight into Newtonian approaches to solving various physical phenomena, fundamentals of all physical sciences, and subsequently relatively modern and challenging topics like the mechanics of a system of particles at an advanced level.

- This structured approach ensures a thorough understanding of classical mechanics, preparing students for advanced topics in physics and engineering.
- To understand Hamilton's equations and canonical transformations, including generating functions, Legendre transformations, Routh's procedure, and the formalism of Poisson brackets, while exploring their applications in deriving invariants, the Jacobi identity, angular momentum relations, and Liouville's theorem.
- To explore Hamilton-Jacobi theory by analyzing the Hamilton-Jacobi equation, separation of variables, action-angle variables, and applying the formalism to problems such as harmonic oscillation and the Kepler problem, while drawing analogies between the Hamilton-Jacobi equation and the Schrödinger equation
- To examine the dynamics of rigid bodies by studying kinematics, Euler angles, the equations of motion, angular momentum, kinetic energy, the inertia tensor, principal axis transformation, and Euler's equations of motion.
- To analyze small oscillations through principal axis transformation and vibration frequencies, while also exploring the principles of special relativity, including Lorentz transformations, Minkowski space, four-vector formalism, and the metric tensor.

Course Outcomes: The outcome of this course enriches students to correlate with:

CO1	Deal with fundamentals of Newtonian mechanics, principle of work done in equilibrium state, formulation of Lagrangian and Hamiltonian and its deduction.
CO2	Understanding of generating function as a function of generalized coordinates, discussion on the dynamic of the system in cyclic or canonical condition and mathematical method to analyses canonical transformation.
CO3	Introduction to the Hamilton-Jacobi method to define system dynamics in a new coordinate system and its applications.
CO4	The concept of reduced mass to deal with many body problems and kinematics to solve problems in rigid body dynamics.
CO5	Analyze classical problems, such as the harmonic oscillator problem, using advanced mathematical approaches.

Syllabus:

Unit I	**Introductory To Newtonian Mechanics (Lagrangian And Hamiltonian):** Coordinate systems, Generalized coordinates, Degree of freedom, Constraints, Principal of Virtual Work, D'Alembert's principal and its applications, Lagrange's equation and its applications, virial theorem, Calculus of variations: Hamilton's principle, Lagrange's equations from Hamilton's principle, Method of Lagrange's multipliers for non-holonomic systems, cyclic coordinates, conservation theorems and symmetry principles, Noether's theorem	12 lectures
Unit II	**Hamilton's Equations and Canonical Transformations:** Generating function, Legendre transformation, Hamilton equations of motion, Routh's procedure, Canonical transformation and its examples, Lagrange, Poisson, and other canonical invariants, Infinitesimal canonical theorem in Poisson bracket formalism, Jacobi identity, Angular momentum Poisson bracket relations, Liouville's theorem.	12 lectures
Unit III	**Hamilton-Jacobi Theory:** The Hamilton-Jacobi equation, Separation of variable in Hamilton-Jacobi equation; Acton-angle variables one degree of freedom. Applications of H-J formalism: Harmonic oscillation, Kepler's problem, analogy between Hamilton – Jacobi equation and Schrödinger equation.	10 lectures
Unit IV	**Rigid Body Dynamics:** The kinematics of rigid body motion: the Euler angles, Euler's theorem on the motion of a rigid body, the rigid body equations of motion: angular momentum and kinetic energy of motion about a point, the inertia tensor and the moment of inertia, the principal axis transformation, the Euler equations of motion.	10 lectures
Unit V	**Small oscillations and Special Theory of Relativity:** Formulation of the problem, principal axis transformation, frequencies of free vibrations and normal coordinators, forced vibrations and the effect of dissipative forces. Lorentz Transformations. Minkowski space, Four-vector formalism, metric tensor.	12 lectures

Learning Resources:

Text Books and Reference Books :

1. Classical Mechanics, Herbert Goldstein, Charles Poole, and John Safko, Pearson Education, 3rd edition, 2011.
2. Mechanics, L.D. Landau and E.M. Lifshitz, Butterworth-Heinemann, 3rd edition 1998.
3. Classical Mechanics, David Morin, Cambridge University Press, 1st edition, 2008.
4. An Introduction to Mechanics, Daniel Kleppner and Robert Kolenkow, McGraw Hill Education, 1st edition 2017.
5. Classical Mechanics, John R. Taylor, Cup, 2008.

IV – Year: I – Semester

Course Code: PHCC702	GENERAL PHYSICS LABORATORY III	Credits 0-0-4: 2

Course Objectives:

This course introduces the practical's related to Basic Physics Principles and their applications.

Course Outcomes (CO): After completion of the course student will be able to:

CO1	Learn the practical knowledge of mechanics doing experiments
CO2	Learn optical phenomena such as diffraction, refraction, and dispersion
CO3	Perform experiments related to optical devices: Prism, grating, and rectangular slabs

Syllabus:

Complete any seven practicals from the given experiments:

Sl. No.	Title of the experiments
1	*To measure the magnetic field for circular conductor loops.*
2	*To verify the existence of discrete atomic energy levels and to evaluate the quantum of energy transfer from electron beam to atoms by Frank Hertz experiment.*
3	*To find the value of Planks constant (h) using a photo cell.*
4	*To determine the electronic charge by using rectifier equation in case point contact Germanium rectifier.*
5	*To analyze waves (Square, Triangular, clipped sine wave) using Fourier analysis kit.*
6	*Determine Boltzmann constant by P–N junction diode and hence find the value of of LED.*
7	*Determination of stopping potential of the material of photo cell & determination of maximum kinetic energy of the photoelectron*
8	*Study the elastic and plastic extension of material wires.*

Learning Resources:

Text Books:

1. Engineering Practical Physics, S.Panigrahi and B. Mallick, Cengage learning, 2015.
2. B. Sc. Practical Physics, C.L. Arora, S. Chand Publishing, 2010.
3. B. Sc. Practical Physics, by H. Singh, P. S. Hemne, S. Chand Publishing, 2022.

Online Resources:

https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham

IV – Year: I – Semester

Course Code: PHMC701	RESEARCH METHODOLOGY	Credits 3-0-0: 3

Course Objectives:

This course aims to learn different methods to formulate a research work.

- To Study the basic definition of the research problem.
- To Study the basic concepts of research design and ethics.
- To study the basic concepts of data analysis.
- To study the basic use of computer applications.

Course Outcomes:

After completion of the course, students will be able to:

CO1	Analyze the basics of research formulation.
CO2	Explain the basics of research formulation, and research ethics.
CO3	Define the basic concept of error analysis.
CO4	Identify the basic role of computer applications in the area of research.

Syllabus:

Unit I	**Definition of the problem**: identifying and formulating the problem, techniques involved in solving the problem: (a) exact analytical solutions of equations involved, (b) numerically solving equations, (c) simulating the problem on a computer, Monte Carlo or molecular dynamics approach, (d) experimental observations and theoretical modelling.	10 lectures
Unit II	**Research design and ethics:** review of research literature, purpose and use of literature review, locating relevant information, uses of library and electronic databases, identification of gaps in research, formulation of research problem, definition of research objective, preparation and presentation of literature review, theoretical models and frame work, scientific ethics, copyrights and plagiarism.	10 lectures
Unit III	**Analyzing data:** errors and analysis of errors, introductory probability and stochastic processes, descriptive statistics and correlations.	8 lectures
Unit IV	**Using computers in research:** Handling different operating systems, (a)literature survey using web, handling search engines, (b) computer usage for collecting/analyzing data, simulations using Fortran/ C++ /Mathematica/MATLAB/Molden, (c) preparation of research articles, thesis and presentation, research papers: using word processing software-MS Word/Latex/others, drawing graphs and diagrams-Origin/Statistica/Excel/others, seminar presentations-Power point or oral and poster presentations.	14 lectures

Learning Resources:

Text Books:

1. How to Write and Publish, R. A. Day and B. Gastel, Greenwood Press, 7th edition, 2011.
2. Probability and Statistics for Engineers and Scientists, S. Ross, Academic Press, 2009.
3. Research Methodology: Methods and Techniques, C. R. Kothari, New Age International Publishers, Fourth edition, 2019.
4. Data Reduction and Error Analysis for Physical Sciences, P.R. Bevington and D.K. Robinson, McGraw-Hill Education, 3rd edition, 2002

IV – Year: I – Semester

Course Code: ECMC701/ ECPC701	ANTENNA ENGINEERING	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to

CO1	Gain knowledge of Antenna and radiation concept.
CO2	Analyse various dipole antennas and understand the impact of perfect electric conductor on antennas.
CO3	Understand and design array antenna, Yai-Uda, Microstrip antenna etc.
CO4	Understand the basic concept and advantages of smart antennas, including fixed weight and adaptive beamforming techniques.
CO5	Understand the basic operation of different radar systems.

Syllabus:

Unit I	Radiation Mechanisms, Field regions, Antenna parameters and Magnetic vector potential and radiated fields relations	8 lectures
Unit II	Infinitesimal dipoles, Half wavelength Dipoles Monopoles, Antenna Bove perfect electric conductor.	10 lectures
Unit III	Antenna arrays, Linear array-endfire, broadside array, Broadband antennas, Frequency independent antennas – Spiral antennas, log periodic antennas. Aperture antennas, Horn antennas, Microstrip antennas and its analysis.	8 lectures
Unit IV	Basic Concepts of Smart Antennas: Concept and benefits of Smart antennas, Fixed weight beamforming basics, Adaptive beamforming.	8 lectures
Unit V	Radar fundamentals, Range equation, Different types of radar.	8 lectures

Learning Resources:

Text Books:

1. Antenna theory: Analysis and design, C.A Balanis, 3rd Ed., John Wiley & Sons., 2005.
2. Antennas, J.D. Kraus, McGraw Hill International, New York, 1988.
3. Skolnik, Merrill I, Introduction to Radar Systems, 3rd ed. New York, McGraw-hill, 2002.

Reference Books:

1. R. E. Collin, “Antennas and Radio Wave Propagation”, McGraw Hill., 1985.
2. F. B Gross, “Smart Antennas for Wireless Communications”, McGraw-Hill., 2005.

Online Resources:

1. https://archive.nptel.ac.in/courses/108/101/108101092/
2. Introduction to Antenna Theory - RAHAE102 | Udemy

IV – Year: II – Semester

Course Code: PHCC801	LASERS TECHNOLOGY	Credits 3-0-0: 3

Course Objectives: - This course aims to provide insight into fundamentals of concept of laser, different types of lasers, and its application in various fields which include:

- Basic structure and working principle of laser
- Understanding and basic properties of laser
- It offers the capability of elementary problem-solving in laser optics
- Relating theoretical predictions and measurement of results
- Application of quantum concepts in harmonic oscillators, electromagnetic fields, etc.

Course Outcomes: The outcome of this course enriches student to correlate with:

CO1	Identify the fundamental concepts of absorption and emission of light, laser properties, and study of different types of lasers.
CO2	Identify the factors involve in enhancing the performance of the laser.
CO3	Analyze and solve simple problems related to lasers
CO4	Formulate new methods to study laser and its classification
CO5	Demonstrate knowledge of laser and its applications

Syllabus:

Unit I	**Fundamental of Laser:** Quantum behavior of light, development of laser, concept: energy levels, population levels; Absorption and emission of light, Einstein relations. Condition of stimulated emission and light amplification, Idea of population Inversion, pumping schemes, classification of lasers, Components of a laser. Two-level and three-level Laser rate equations.	10 lectures
Unit II	**Mode:** Optical Gain, Line Broadening Mechanism, Bandwidth, Modes of a laser with emphasis on single mode operation, properties of modes, optimization of output power. Intensity, directionality, monochromaticity, polarization and speckles.	9 lectures
Unit III	**Laser Amplifiers:** Output control of lasers, Selection of narrow frequency range, Selection of TEM Modes. And single longitudinal modes. Idea of generating high power pulse.	8 lectures
Unit IV	**Q-Switching:** Concept of Q-factor, Q-switching for obtaining giant pulses, different methods of Q-switching. Cavity dumping, mode locking techniques frequency conversion using non- linear crystals, Idea of tunable Lasers.	8 lectures
Unit V	**Application:** Applications of lasers in: Civil, Mechanical, Electrical, Electronics, Laboratory studies, Medical Science, Military applications, automobiles, Aeronautics and space science.	7 lectures

Learning Resources:

Text Books and Reference Books :

1. Laser Fundamentals, William T. Silfvast, Cambridge University Press, 2nd edition, 2008.
2. Lasers: Principles, Types, and Applications, K. Thyagarajan, Laxmi Publications, Second edition, 2019.
3. Optical Fiber Communications, Gerd Keiser, McGraw Hill Education, Fifth edition, 2017.
4. Laser Physics, Peter W. Milonni and Joseph H. Eberly, Wiley, 1st edition, 2010.

IV – Year: II – Semester

Course Code: PHCC803	ENERGY STUDIES	Credits 3-0-0: 3

Course Objectives: - The course will enable students to approach energy issues in a sophisticated and scientific fashion and basic concept of energy.

- To understand Energy and its Uses.
- To understand Sources of Energy
- Study the flow of energy
- To understand the concept of system and synthesis.

Course Outcomes: The outcome of this course enriches student to correlate with:

CO1	Identify the fundamental concepts of Units and scales of energy use, Mechanical energy and transport, Heat energy: Conversion between heat and mechanical energy, Electromagnetic energy, etc.
CO2	To attain knowledge of the basics of Fundamental forces in the universe.
CO3	To acquire more knowledge of the flow of energy by understanding the basics of solar radiation etc.
CO4	Gain knowledge on the concept of nuclear radiation, climate change, energy storage and conversion.

Syllabus:

Unit I	**Energy and its Uses:** Units and scales of energy use, Mechanical energy and transport, Heat energy: Conversion between heat and mechanical energy, Electromagnetic energy: Storage, conversion, transmission and radiation, Intro to the quantum, energy quantization, Energy in chemical systems and processes, flow of CO_2, Entropy and temperature, Heat engines, Phase change energy conversion, refrigeration and heat pumps, Internal combustion engines,	13 lectures
Unit II	**Sources of Nuclear Energy:** Fundamental forces in the universe, Quantum mechanics relevant for nuclear physics, Nuclear forces, energy scales and structure, nuclear binding energy systematics, reactions and decays, nuclear fusion and fission, nuclear fission reactor design, safety, operation and fuel cycles.	10 lectures
Unit III	**Nuclear Energy management:** Nuclear radiation, fuel cycles, waste and proliferation, Climate change, Energy storage, Energy conservation.	7 lectures
Unit IV	**Renewable Energy Sources:** Solar radiation, Absorption and thermal utilization, Solar-thermal electricity, Photovoltaics (PV), Advanced PV, overview, Fluid dynamics and power in the wind, available resources, viscosity, types of fluid flow, Wind turbine dynamics and design, wind farms Geothermal power and ocean thermal energy conversion, Tidal/wave/hydro power, Bio-mass Energy.	12 lectures

Learning Resources:

Text Books:

1. Climate Change and Sustainable Transportation, A. S. Khati and P. G. Dastidar, The Energy and Resources Institute, TERI, 2019.
2. Energy Studies, D.William Shepherd and W. Shepherd, Imperial college press, 2nd edition, 2004.
3. Concepts of Modern Physics, A Beiser, McGraw Hill, 6th edition, 2003.
4. Introduction to Quantum Mechanics, David J. Griffiths, Cambridge University Press, 2nd edition, 2016.

IV – Year: II – Semester

Course Code: PHMC805	MODERN PHYSICS	Credits 2-0-0: 2

Course Objectives: This course aims to provide a brief insight into the bridge between the classical and modern approaches to various physical phenomena and diverse perspectives of advanced methods.

- Discuss on postulate of matter wave duality.
- Idea of uncertainty in measurement.
- Quantum behavior of a particle in indefinite rigid box.
- Structure of atom and interaction prevalent within.

Course Outcomes: Outcome of this course enrich student to correlate with:

CO1	Study of investigation and evidence of wave-particle dualism of photon.
CO2	Understanding the behavior of quantum particle and rising of uncertainty of measurement, versatility of Schrodinger equation to define the wave behavior accurately, and basic postulate of wave behavior of light.
CO3	Generalized theory and mathematical approaches to understanding the quantization of energy state of particle in infinite rigid potential box and mechanism involve in the production of highly monochromic beam.
CO4	Concept involves interaction of electron-electron, proton-electron, etc. and its method to determine the interaction within atom.

Syllabus:

Unit I	**Postulate of Matter-Wave Duality:** Planck's quantum, Blackbody Radiation, Photo-electric effect, and Compton scattering. De Broglie wavelength, Davisson-Germer experiment. Wave description of particles by wave packets, Group and Phase velocities and the relation between them, Double-slit experiment, Probability, Wave amplitude, and wave functions.	8 lectures
Unit II	**Principle of Uncertainty:** Position measurement- gamma-ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle, Derivation from Wave Packets impossibility of a particle following a trajectory; Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation; Momentum and Energy operators; stationary states; physical interpretation of a wave function, Physical Acceptability of Wave Functions, normalization; Probability and probability current densities in one dimension.	8 lectures
Unit III	**One Dimensional Infinitely Rigid Box**: energy Eigen values, Eigen functions and their normalization; Quantum dot as an example; Quantum mechanical scattering and tunneling in one dimension across a step potential & across a rectangular potential barrier. Lasers: Metastable states, Spontaneous, and Stimulated emissions, Optical Pumping and Population Inversion.	6 lectures
Unit IV	**Structure of Atom:** Size of the atom, Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Modern Spectroscopic techniques (NMR, ESR, Raman Spectroscopy etc.)	6 lectures

Learning Resources:

Text Books:

1. Modern Physics, Kenneth S. Krane, John Wiley & Sons, 3rd edition, 2012.
2. Modern Physics for Scientists and Engineers, Stephen T. Thornton and Andrew Re, Brooks/Cole, 5th edition, 2020.
3. Introduction to Modern Physics, Richard Wolfson, Pearson, 3rd edition, 1999.
4. Concepts of Modern Physics, Arthur Beiser, Medtech science, 2024.
5. Modern Physics, Paul A. Tipler and Ralph A. Llewellyn, W. H. Freeman, 5th Edition, 2007.

Reference Books:

1. Modern Physics for Scientists and Engineers, Thornton, Stephen T., and Rex, Andrew, Cengage Learning, 2009.

IV – Year: II – Semester

Course Code: PHCC807	ELECTRODYNAMICS II	Credits 3-1-0: 4

Course Objectives:

- Introduce electrostatic principles, focusing on solving Poisson's and Laplace's equations, boundary value problems, and forces on dielectrics.
- Teach the fundamentals of electrostatics, magnetostatics, and Maxwell's equations for understanding wave propagation in different media.
- Explore plane electromagnetic waves, polarization, wave reflection/refraction, and wave propagation in conductors and dielectrics.
- Study the radiation from oscillating sources, electric dipole fields, and their applications to radio wave transmission.
- Examine radiation emitted by accelerating charges, focusing on Lienard-Wiechert potentials and power radiated by moving charges.

Course Outcomes: The outcome of this course enriches students to correlate with:

CO1	Understand the solutions to Poisson's and Laplace's equations, apply boundary conditions, and analyze forces in dielectric materials.
CO2	Apply Gauss's law, Ampere's law and Maxwell's equations to describe electrostatic and magnetostatic phenomena and electromagnetic wave propagation.
CO3	Analyze plane wave propagation, polarization, and Fresnel equations, with applications to waveguides and resonant cavities.
CO4	Understand radiation from dipoles and oscillating sources, applying it to fields like radio wave communication.
CO5	Apply the Lienard-Wiechert potentials and Larmor's formula to describe radiation from accelerating charges and compute radiated power.

Syllabus:

Unit I	**Electrostatics and Boundary value problems:** Poisson's and Laplace's equation in cartesian, spherical coordinate system and its solution, uniqueness theorem, method of images, separation of variables, multipole expansion, polarization, field of a polarized object, electric displacement, boundary conditions for D and E, dielectric constant, boundary value problems, energy, forces on dielectrics	13 lectures
Unit II	**Electrostatics, Magnetostatics and Electrodynamics:** Gauss's law, Boundary value problems, multipoles, dielectrics, Biot and Savart law, Ampere's law, Faraday's law, Displacement current, Maxwell's equations, Wave propagation in Conductors and Dielectrics	13 lectures

Unit III	**Plane Electromagnetic Waves and Wave Propagation:** Plane Waves in Non-conducting Medium Linear and Circular Polarization, Stokes Parameter, Reflection and Refraction of Electromagnetic Waves at a Plane Interface between Dielectrics, Fresnel Equation, Group Velocity Dispersion (GVD), Kramers-Kronig Relations. **Waveguides and Resonant Cavities:** Field sat the surface of and within a Conductor; Cylindrical Cavities and Wave Guides, Resonant Cavities, Power losses in a Cavity and Q of a Cavity.	14 lectures
Unit IV	**Simple Radiating Systems and Diffraction:** Fields of Radiation of localized oscillating Source, Electric Dipole fields and radiation and its application to radio waves.	9 lectures
Unit V	**Radiation by moving Charges:** Lienard-Wiechertz Potentials and Fields for a Point Charge, Total power Radiated by an Accelerating charge, Larmor's formula.	7 lectures

Learning Resources:

Text Books and Reference Books :

1. Principles of Quantum Mechanics, R. Shankar, Springer, 2nd edition, 1994.
2. Quantum Mechanics: Concepts and Applications, Nouredine Zettili, Wiley india Pvt. Ltd, 2nd edition 2016
3. Quantum Mechanics: A Modern Development, Leslie E. Ballentine, World Scientific Publishing Co Pte Ltd, 1998
4. Introduction to Quantum Mechanics, David J. Griffiths, Cambridge University Press, 3rd edition, 2018.
5. Quantum Mechanics, Cohen-Tannoudji, Diu, and Laloë, Wiley-VCH, 2nd edition, 2019.

IV – Year: II – Semester

Course Code: PHCC809	QUANTUM MECHANICS II	Credits 3-1-0: 4

Course Objectives: The aim of this course is to provide insight into variational principles, Quantum scattering and relativistic Quantum Mechanics of sub-atomic particles.

- Overview of physics beyond classical mechanics and formalism of quantum mechanics.
- Discuss the fundamental concept of quantum mechanics.
- Use of mathematical tools to solve quantum problems.
- Application of quantum concept in harmonic oscillator, electromagnetic field, etc.
- Gives an idea of the degeneracy of many particle systems, symmetric and unsymmetric wave functions.

Course Outcomes : Outcome of this course enrich student to correlate with:

CO1	Identify the fundamental concepts of approximations in quantum mechanics
CO2	Solve and explain different problems related to the dynamics of subatomic particles.
CO3	Comprehensive knowledge of scattering theory and systematic analyses of the effect through different methods.
CO4	Formulate new methods to solve relativistic quantum mechanical problems
CO5	Contribution and approach of Dirac formalism in solving different quantum problems.

Syllabus:

Unit I	**Approximation methods for stationary systems:** Time independent perturbation theory, Perturbation of non-degenerate states: first and second order perturbation, Perturbation of a harmonic oscillator, Perturbation of degenerate states, removal of degeneracy, Zeeman and Stark effects, Variational and WKB methods.	12 lectures
Unit II	**Approximation methods for non-stationary systems:** Schrodinger, Heisenberg and interaction pictures, Equations of Motion, Constant and harmonic perturbation, Discrete and continuous case, transition probability, Fermi golden rule, Adiabatic and sudden approximations.	12 lectures
Unit III	**Scattering Theory:** Scattering of a wave packet, The differential and total Cross section, The Born approximation, Partial waves and phase shifts, The Lippmann Schwinger equation, Definition and properties of S-matrix, T-matrix, Optical theorem	12 lectures
Unit IV	**Relativistic Quantum Mechanics:** Klein-Gordon, Dirac equations and properties of Dirac matrices, Lorentz and CPT invariance of Dirac equation, Non-relativistic reduction of the Dirac equation, Central forces and the hydrogen atom.	12 lectures
Unit V	**Solution to Dirac Equation:** Free particle solution, Hydrogen atom in Dirac's theory, Dirac electron in constant magnetic field, Foldy-Wouthuysen transformation, Hole theory.	6 lectures

Learning Resources:

Text Books:

1. Classical Electrodynamics ,John David Jackson, wily,3rd edition,2007
2. Introduction to Electrodynamics ,David J. Griffiths, Pearson Education India Learning Pvt.Ltd,4td edition,2005
3. Electrodynamics: A Modern Approach ,David H. Frisch and John C. McLennan
4. The Classical Theory of Fields, L.D. Landau and E.M. Lifshitz, Butterworth-Heinemann,4th edition,1980
5. Electromagnetic Fields, John A. Stratton**,** Wiley-IEEE Press,1st edition,2007

Reference Books:

1. Classical Electrodynamics , Jackson, John David, Wiley, 1999.
2. Introduction to Electrodynamics, Griffiths, David J. Pearson, 2013.
3. The Classical Theory of Fields. Landau, L.D. and Lifshitz, E.M. Pergamon Press, 1975.

IV – Year: II – Semester

Course Code: PHMC811	STATISTICAL MECHANICS	Credits 3-1-0: 4

Course Objectives**:**

- Introduce key concepts of thermodynamics, including entropy, phase space, and energy distribution in classical systems.
- Teach the formulation and applications of microcanonical, canonical, and grand canonical ensembles and their relation to partition functions.
- Explore blackbody radiation and the quantum corrections to classical radiation theories like Rayleigh-Jeans.
- Introduce quantum statistics through Bose-Einstein and Fermi-Dirac distributions and quantum mechanical ensemble theory.
- Apply quantum statistical mechanics to systems such as ideal Bose and Fermi gases, Bose-Einstein condensation, and electron gas in metals.

Course Outcomes: The outcome of this course enriches students to correlate with:

CO1	Explain thermodynamic laws, equilibrium, and the statistical interpretation of entropy and energy distribution.
CO2	Master ensemble theory and partition functions to derive thermodynamic quantities for different systems.
CO3	Explain key laws of blackbody radiation, resolving classical failures with Planck's quantum theory.
CO4	Differentiate between classical and quantum statistical distributions, applying them to quantum systems like particles in a box.
CO5	Analyze quantum gases and related phenomena, such as Bose-Einstein condensation, Pauli Para magnetism, and electron behavior in metals.

Syllabus:

Unit I	**Statistical Basis of Thermodynamics:** Quasistatic and non-quasi static processes, laws of thermodynamics, entropy of a probability distribution, random walks - Langevin' Theory of Brownian Motion, entropy, phase space, Liouville's theorem postulates of statistical mechanics, system in thermodynamic equilibrium, law of equipartition of energy and its applications, classical ideal gas, Gibb's paradox.	13 lectures
Unit II	**Ensemble Theory:** Microcanonical, canonical and grand canonical ensembles and partition functions. Maxwell's Boltzmann's distribution, Gibb's formulation for canonical and grand canonical ensembles, partition function, their thermodynamic properties	10 lectures
Unit III	**Theory of Radiation:** Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jeans Law. Ultraviolet Catastrophe. Planck's Quantum Theory of Black body radiation, Experimental verification and deduction of Planck's law of Radiation,	12 lectures

Unit IV	**Quantum Statistics:** Drawbacks of M B distribution, Bose-Einstein's and Fermi-Dirac distribution, symmetric and antisymmetric particles, non-degenerate, weakly degenerate and strongly degenerate, Quantum mechanical ensemble theory, Density Matrix, Statistics of various ensembles, examples: Free particle in a box, harmonic Oscillator, Theory of Simple Gases: Ideal gas in different quantum mechanical ensembles.	12 lectures
Unit V	**Application of Quantum Statistics:** Ideal Bose Gas: Thermodynamics, Bose-Einstein Condensation, Blackbody Radiation, Phonons, Ideal Fermi Gas: Thermodynamics, Pauli Para magnetism, Landau diamagnetism, Electron gas in metals.	9 lectures

Learning Resources:

Text Books and Reference Books:

1. Statistical Mechanics R.K. Pathria, Paul D. Beale., Academic Press Inc, 3rd Edition,2011.
2. Statistical Mechanics, Franz Mandl, Wiley India Pvt Ltd, 2nd Edition,2014.
3. Introduction to Modern Statistical Mechanics, David Chandler, Oxford Univ Press, 1987.
4. Statistical Mechanics: Theory and Applications, B. K. Agarwal,M. Ganesh, New Age International Private Limited, 2020.

*Students for a 4-year **UG Degree (Honors)** need to complete additional **(3, 3, 2) Credits** major/minor courses in place of **MOOC** courses or need to complete additional **(4, 4, 4) Credits** major courses in place of Project.*