

चौधरी चरण सिंह विश्वविद्यालय, मेरठ
Chaudhary Charan Singh University, Meerut



NAAC A++ Accredited

Syllabus of the Subject: Physics (University Campus only)

B.Sc. Honors/ Honors with Research in Physics
(A Four-Year Degree Program with Multiple Exits and Entries)
(National Education Policy-2020)

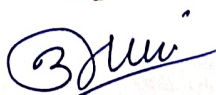
**(As per guidelines of U.P. Government and UGC according to
National Education Policy-2020 w.e.f. the session 2025-2026)**

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FOREWORD

The syllabus for the undergraduate Physics program is developed in compliance with the suggestions of the UGC Undergraduate Curriculum Framework 2025. The preface, definitions and acronyms, characteristics, and significant components of UGCF are included in this document, as stated in UGCF 2025. In line with worldwide trends and advancements in higher education, UGCF 2025 clearly incorporates the aims and underlying philosophy of National Education Policy (NEP) 2020 into its qualities. The salient features, such as holistic development, academic flexibility, rootedness, life-long learning, multidisciplinary education, multilingualism, intra- and inter-university mobility, apprenticeship, research, innovation, entrepreneurship, social outreach, and so on, aim to enrich the learning experience, creativity, innovation, and skill development of our country's youth.

Drafting Committee

PREFACE

The Undergraduate Curriculum Framework-2025 aligns with the National Education Policy (NEP) 2020, emphasizing the historical perspective, philosophical foundation, and current realities of higher education. It aims to synchronize these cornerstones and shapes the future of higher education.

Chaudhary Charan Singh University, Meerut a leading institution of teaching, learning, and research in higher education, acknowledged nationally and globally, has promoted the pursuit of excellence in all spheres of education as part of its commitment to national development. As a state university mandated to lead the way in expanding the horizons of human resource development through higher education expansion, it has always placed a high value on constructive and meaningful innovation as a regular feature of undergraduate curriculum development.

The design of undergraduate curricular framework reflects the ample strive of keeping pace with the emerging trends in higher education in the new millennium globally and its critical importance in enriching the youth of our nation. It is well equipped with the prevailing priorities of skill development through innovative and practical oriented teaching-learning.

To achieve the noble goal, precisely stated in the National Education Policy 2020, the university has attempted to investigate the possibility of further restructuring and refinement of its undergraduate curriculum framework in accordance with the objective and underlying philosophy of the NEP 2020 to capture the imagination of our nation's youth by depicting the contemporary realities of our demographic advantage globally.

The outcome of this extensive exercise carried out by the university is the Undergraduate Curriculum Framework-2025 (UGCF-2025), which not only emphasizes the core concepts of the NEP - 2020 but also goes on to create a teaching-learning framework at the undergraduate level to attract young minds to research, innovation, apprenticeship, social outreach, entrepreneurship, and similar such areas of human knowledge and effort while imbibing the truly charged academic environment of the university and its cons.

The Department's Courses Committee develops the content of several sets of first-year courses (Semester I and Semester II) after an extensive research. The topic working group's contributions were collated, and the current document was developed.

1.UGCF-2025: DEFINITIONS AND ABBREVIATIONS

- **Academic Credit:** An academic credit is a unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
- **Courses of Study:** Courses of the study indicate pursuance of study in a particular discipline.

Every discipline shall offer four categories of courses of study, viz. Discipline Specific Core (DSC) courses, Discipline Specific Electives (DSEs), Skill Enhancement Courses (SECs) and Generic Electives (GEs). Besides these four courses, a student will select Ability Enhancement Courses (AECs) and Value-Added Courses (VACs) from the respective pool of courses offered by the University.

- **Discipline Specific Core (DSC):** Discipline Specific Core is a course of study, which should be pursued by a student as a mandatory requirement of his/her program of study. In Bachelor of Science (Hons.) Physics program, DSCs are the core credit courses of Physics which will be appropriately graded and arranged across the semesters of study, being undertaken by the student, with multiple exit options as per NEP 2020. A student will study four DSC courses each in Semesters I to VI; and one DSC course each in semesters VII and VIII.
- **Discipline Specific Elective (DSE):** The Discipline Specific Electives (DSEs) are a pool of credit courses of Physics from which a student will choose to study based on his/ her interest. A student of Bachelor of Science (Hons.) Physics, gets an option of choosing one DSE of Physics in each of the semesters III to VI, while the student has an option of choosing a maximum of three DSE courses of Physics in semesters VII and VIII.
- **Generic Elective (GE):** Generic Electives is a pool of courses offered by various disciplines of study (excluding the GEs offered by the parent discipline) which is meant to provide multidisciplinary or interdisciplinary education to students. In case a student opts for DSEs beyond his/her discipline specific course(s) of study, such DSEs shall be treated as GEs for that student. In semesters I, II, V and VI, a student has to compulsorily study one GE course from a pool of courses offered by the institution. However, in semesters III and IV a student has an option of choosing between a DSE course in Physics and a GE course of another discipline. Similarly, in semester VII and VIII a student can exercise an option of choosing a maximum of two GE courses out of a combination of three DSE and GE courses.
- Ability Enhancement course (AEC), Skill Enhancement Course (SEC) and Value Addition Course (VAC):
- These three courses are a pool of courses offered by all the Departments in groups of odd and even semesters from which a student can choose. A student who desires to make Academic Project/ Entrepreneurship as Minor has to pick the appropriate combination of courses of GE, SEC, VAC, and Internship/Apprenticeship/Project/Community Outreach which shall be offered in the form of various modules.
- AEC courses are the courses based upon the content that leads to knowledge enhancement through various areas of study. They are Language, Literature and Environmental Science and Sustainable Development, which are mandatory for all disciplines. Every student has to study "Environmental Science and Sustainable Development" courses I and II of two credits each in the first year (I / II semester) and the second year (III/ IV semester), respectively. The AEC pool consists of credit courses in languages listed in the Eighth Schedule of the Constitution of India, as updated from time to time.

- SECs are skill-based courses in all disciplines and are aimed at providing hands-on training, competencies, proficiency and skills to students. SEC courses may be chosen from a pool of courses designed to provide skill-based instructions. Some of these courses may be offered to students of Physics while the rest can be open to students of all other disciplines.
- A student will study one Skill Enhancement Course of 2 credits each (following 1T+ 1P/0T+2P credit system) in all the semesters from I to VI. It is to be noted that in the semesters III, IV, V and VI; students can choose either one SEC paper or can join any Internship/Apprenticeship/Project (following two credit system).
- VACs are common pool of courses offered by different disciplines and aimed towards personality building, embedding ethical, cultural and constitutional values; promote critical thinking, Indian knowledge systems, scientific temperament, communication skills, creative writing, presentation skills, sports and physical education and team work which will help in all round development of students.

2. FEATURES OF UGCF 2025

The Undergraduate Curriculum Framework 2025 (UGCF 2025) is meant to bring about systematic change in the higher education system in the University and align it with the NEP 2020. The objectives of the NEP 2020 have been reflected in the following features of UGCF-2025.

a) Holistic Development

Holistic development of the students shall be nurtured through imparting life skills in initial years. The life skill courses shall include courses on 'Environment and Sustainable Development Studies', 'Communication Skills', 'Ethics and Culture', 'Science and Society', 'Computational Skills', 'IT and Data Analytics', and similar such skills which shall make the students better equipped to deal with the life's challenges.

b) Academic Flexibility

Flexibility to the students to determine their learning trajectories and pursuance of programs of study has been well ingrained in the UGCF. The framework allows students to opt for one, two, or more discipline(s) of study as a core discipline(s) depending on his/her choice. He/she has been provided the option of focusing on studying allied courses of his/her selected discipline(s) (DSEs) or diversifying in other areas of study of other disciplines. Students have also been provided with the flexibility to study SECs or opt for Internships or Apprenticeship or Projects or Research or Community Outreach at an appropriate stage. In the fourth year, students are provided flexibility to opt for writing a dissertation (on major, minor, or combination of the two) or opt for Academic projects or Entrepreneurship depending upon their choice and their future outlook, post completion of their formal education.

c) Multiple Exits/Re-entry/Academic Bank of Credit (ABC)/Academic Outreach

Considering the diversity of Indian society and the diverse backgrounds of its students, multiple

exits and re-entry opportunities have been provided at various stages of the undergraduate program to accommodate their needs and enable them to complete their studies based on their life priorities. The earning and accumulation of credits in the Academic Bank of Credit (ABC), and the flexibility to redeem the requisite credit for the award of appropriate Certificate/Diploma/Degree, as per the norms laid down by the UGC and the University, shall be made available to the students to provide the opportunity for lifelong learning as well as academic outreach beyond the superstructure of the program of study in another University/Institution at the national/ international level depending upon individual choice of the student(s).

d) Multidisciplinary Education

UGCF has included interdisciplinary education by integrating the requirement to choose at least four optional papers from any other discipline (s) other than the one chosen as the scoring discipline (s). In reality, a student pursuing a single-core discipline course may achieve a minor in a subject other than the core if he or she receives at least 28 credits in that area. The framework does not preserve or encourage hierarchies across fields of study/disciplines, as well as silos between distinct areas of learning. As long as a student meets the prerequisites for a course of study, he or she can study it. Modules or study systems will be substantially broken down to assist students in selecting the track/academic pathways that will lead to the desired end.

e) Multilingualism

One of the significant hallmarks of the framework is a provision of pursuing multilingualism while studying any other discipline as core subject(s), which has no bearing with any language and linguistics. The first and second semesters of the curriculum give students the option to study languages that are enshrined in the eighth schedule of the Indian Constitution, allowing them to grow holistically, including the potential to achieve competency in a language other than their home tongue

f) Research and Innovation

The framework provides a mandatory program on research methodologies as one of the discipline specific elective (DSE) course sat the VI and VII semester for students who opt for writing dissertation on major/minor discipline at VII and VIII semesters. Further, provision for internship/apprenticeship/project/community outreach right from the III semester up to VI semester provides ample opportunity to the students to explore areas of knowledge/activity beyond the four walls of the classroom and reach out to the world outside without any dilution of the academic feature of the course of study, he/she is pursuing. This also acts a precursor for the students to take up academic project or entrepreneurship at a later stage in VII and VIII semester. Such an initiative will help in skill development and laying a strong foundation for research and thus contribute towards overall national development through the development of skilled manpower and innovation.

g) Intra-and Inter-University Mobility

Student mobility inside and between universities is another essential component that has been incorporated into the system. A student, by virtue of such mobility, will be able to make lateral movement within the University as well as from the University to any other Institution and vice-versa. Such a feature provides a student full choice in terms of education pursuit, with a focus on

higher education, and enables him/her to attain his/her life goals as he/she perceives them.

Based on the aforementioned features of UGCF2025, the University expects maximum involvement of the student fraternity in utilizing the benefits of such a flexible yet rigorous curriculum framework at the undergraduate level and reaping the benefits of it through enrichment of their skills in their area of interest which will eventually help them in gaining employment, entrepreneurship, start-ups and various other ways of a dignified life and living as a global citizen with comparable skills and innovative ideas befitting to the contemporary global demands. The university expects the youthful nation to reap the maximum benefits out of the UGCF – 2025 in developing skilled manpower to harness the youthful energy at one hand and expand the permeation of the skilled workforce globally, taking the demographic advantage on the other hand.

Bachelor of Science (Honours) Physics

Or

**Bachelor of Science (Honours) Physics with Research/ Academic Projects/
Entrepreneurship**

Or

**Bachelor of Science (Honours) Physics with Research (Major) and Discipline-2
(Minor)**

3. INTRODUCTION TO UNDERGRADUATE DEGREE COURSE IN PHYSICS

According to the UGCF 2025 guidelines, the undergraduate degree course in Physics consists of six/eight semesters spread over three/four academic years. The teaching-learning process is student-centered, and it includes both theoretical and practical components. It provides curriculum flexibility while ensuring that the student has a solid foundation in the topic and obtains in-depth understanding. Aside from the DSCs, students can choose courses from the curriculum, which includes DSEs, GEs, SECs, AECs, and VACs. As a result, the curricular structure emphasizes interdisciplinary approaches and adherence to new methods. Furthermore, it provides a student with maximum flexibility in pursuing his or her studies at the undergraduate level, including the ability to eventually design the degree with multiple exit options based on the student's needs and aspirations in terms of his or her life goals, without compromising teaching and learning, both qualitatively and quantitatively. This will fit the

4. PROGRAM DURATION AND EXIT OPTIONS

The minimum credit to be earned by a student per semester is 18 credits and the maximum is 26 credits. However, students are advised to earn 22 credits per 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. However, the mandatory numbers of credits which have to be secured for the purpose of award of Undergraduate Certificate/Undergraduate Diploma/Appropriate Bachelor's Degree in Physics are listed in Table1.



Table1: QUALIFICATION TYPE AND CREDIT REQUIREMENTS

S. No.	Type of Award	Stage of Exit	Mandatory Credits to be Secured for the Award
1	Undergraduate Certificate in Physics	After successful completion of Semester II	44
2	Undergraduate Diploma in Physics	After successful completion of Semester IV	88
3	Bachelor of Science Physics (Honours)	After successful completion of Semester VI	132
4	Bachelor of Science Physics (Honours With Research/Academic Projects/Entrepreneurship)	After successful completion of Semester VIII	176
5	Bachelor of Science Physics (Honours) with Research in Physics (Major) and Discipline - 2(Minor)	After successful completion of Semester VIII with minimum 28 GE credits in Discipline-2(Minor)	176

Major Discipline (Physics)

A student pursuing four-year undergraduate program in Physics (Core course) shall be awarded B.Sc. Honours degree with Major in Physics on completion of VIII Semester, if he/she secures in Physics at least 50% of the total credits i.e., at least 88 credits in Physics out of the total of 176 credits. He/she shall study 20 DSCs and at least 2 DSEs of Physics in eight semesters.

Minor Discipline (Discipline -2)

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

5. PROGRAM OBJECTIVES

The undergraduate degree course in Physics aims to provide:

- In-depth knowledge in physics through understanding of key physical concepts, principles, theories and their manifestations.
- Competence and skill in solving both theoretical and applied physics problems.
- A conducive learning environment to ensure cognitive development of students.
- Exposure to the latest advances in physics, allied disciplines and research.
- Critical and analytical thinking, scientific reasoning, problem-solving skills, communication skills and teamwork.
- Moral and ethical awareness, leadership qualities, innovation and life-long learning.
- Multi-cultural competence and multilingualism.
- Knowledge and skills to undertake higher studies/research in physics and related interdisciplinary areas thereby enabling students' employment/entrepreneurship.
- Sufficient subject matter competence and enable students to prepare for various competitive examinations such as IIT-JAM, GATE, GRE, UGC-CSIR NET/JRF and

6. PROGRAM OUTCOMES

The learning outcomes of the undergraduate degree course in physics are as follows:

- **(a) In-depth disciplinary knowledge:** The student will acquire comprehensive knowledge and understanding of the fundamental concepts, theoretical principles and processes in the main and allied branches of physics. The core papers will provide in-depth understanding of the subject. A wide choice of elective courses offered to the student will provide specialized understanding rooted in the core and interdisciplinary areas.
- **(b) Hands-on/Laboratory Skills:** Comprehensive hands-on/laboratory exercises will impart analytical, computational and instrumentation skills. The students will be able to demonstrate mature skills for the collation, evaluation, analysis and presentation of information, ideas, concepts as well as quantitative and/or qualitative data.
- **(c) Research skills:** The course provides an opportunity to students to hone their research and innovation skills through internship/apprenticeship/project/community outreach/dissertation/Academic Project/Entrepreneurship. It will enable the students to demonstrate mature skills in literature survey, information management skills, data analysis and research ethics.
- **(d) Role of Physics:** The students will develop awareness and appreciation for the significant role played by physics in current societal and global issues. They will be able to address and contribute to such issues through the skills and knowledge acquired during the program. They will be able identify/mobilize appropriate resources required for a project, and managing a project through to completion, while observing responsible and ethical scientific conduct, safety and laboratory hygiene regulations and practices.
- **(e) Communication and IT Skills:** Various DSCs, DSEs, SECs, GEs and AECs have been designed to enhance student's ability to write methodical, logical and precise reports. The courses will, in addition, guide the student to communicate effectively through oral/poster presentations, writing laboratory/project reports and dissertations. Several IT based papers in DSCs, DSEs, SECs and AECs will enable students to develop expertise in general and subject specific computational skills.
- **(f) Critical and Lateral Thinking:** The program will develop the ability to apply the underlying concepts and principles of physics and allied fields beyond the classrooms to real life applications, innovation and creativity. A student will be able to distinguish between relevant and irrelevant facts and information, discriminate between objective and biased information, apply logic to arrive at definitive conclusions, find out if conclusions are based upon sufficient evidence, derive correct quantitative results, make rational evaluations, and arrive at qualitative judgments according to established rules.



7. PROGRAM STRUCTURE

Semester	Level of Course	Discipline Specific Core Course (DSC) Cr-3	Discipline Specific Elective Course (DSE)	Generic Elective Course (GE) Cr 4	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC) Cr.2	Value Addition Course (VAC) Cr.2	Dissertation/ Seminar	Total Credits
First Year									
I	Foundation or Introductory Level	DSC-1 (Mathematical physics I) DSC-2 (Mechanics and Relativity) DSC -3 (Waves and oscillations) DSC -4 (Experiment based on DSC-(1+2+3))		GE-1 Mathematics-I	(Pool of Courses) AEC I - Cr.2	(Pool of Courses) SEC 1: MATLAB for Beginners SEC 2: Physics of Sun SEC 3: Introduction to Physics of Devices	(Pool of Courses) VAC 1: Renewable energy VAC 2: Digital literacy VAC 3: Internet of things VAC 4: Basics of Quantum technology VAC 5: Introduction to Nano-Science and technology VAC 6: Ancient Indian science and technology VAC 7: Intellectual property of rights VAC 8: Earth atmosphere climate change and remediation		22
II		DSC 5- (Mathematical physics II) DSC-6 (Electricity and magnetism) DSC -7 (Electrical circuit analysis) DSC -8		GE -2 Mathematics - II	(Pool of Courses) AEC I - Cr.2	(Pool of Courses) SEC 4: Introductory Vacuum Science & Technology SEC 5: Fundamentals of Electronic Instrumentation SEC 6:			22

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	(Experiment based DSC- (5+6+7))				Learning Gaussian			
Credits I+II	24		8	4	4	4		44

Second Year

III	DSC 9: Mathematical Physics III DSC 10: Thermal Physics DSC 11: Light and Matter DSC 12: Experiment Lab. based on mathematical physics, thermal physics, and light-matter		GE 3: Chemistry of Food Nutrients GE 4: Real Analysis					
IV	DSC 13: Modern Physics DSC 14: Solid State Physics DSC 15: Analog Electronics DSC 16: Experiment Lab. based on Modern physics, solid state and analog electronics		GE 5: Chemistry and Environment GE 6: Numerical Methods		SEC7: Energy Storage Devices			
Credits III+IV	24		16		4			44

Third Year

V	DSC 17: Atomic, Molecular and Nuclear Physics	DSE 1: Semiconductor Physics DSE 2:					Seminar	
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		DSC 18: Quantum Mechanics I	Basic Plasma Physics						
		DSC 19: Digital Electronics	DSE 3: Particle and Detector Physics						
		DSC 20: Experiment Lab. based on atomic physics, Quantum mechanics and Digital electronics							
VI		DSC 21: Statistical Mechanics	DSE 4: Fundam entals of Magnet ism					Dissertation	
		DSC 22: Electromagnet ic Theory	DSE 5: Electric al Material s						
		DSC 23: Modelling and Statistical Analysis in Physics	DSE 6: Fundam entals of Optoele ctronics						
		DSC 24: Experiment Lab.							
Credits V+VI		24	8					12	44
*(VIAPCW)	VIAPCW of 4 credits. Note: 1. VIAPCW of 4 credits is mandatory but it may be done in either first or second or third year of Graduation Program. 2. For exit with Certificate VIAPCW of 4 credits after first year is mandatory.								
Total Credits After One-Year									44+4* (mandato ry for Certificat e)
Exit-1 and Re-entry: Undergraduate Certificate in Major Discipline after securing 44 credits in two semesters (one year) of a UG (Honors/ Honors with Research) program with single major and in addition 4 credits in a Vocational Course/ Internship/ Apprenticeship/ Project/ Community Outreach/ Workshop (VIAPCW)*. With these credits a student may take re-entry in the second Year.									

8. TEACHING-LEARNING PROCESS

9. ASSESSMENT METHODS

10. SCHEME OF EXAMINATION



11. SYLLABUS FOR UNDERGRADUATE PROGRAM IN PHYSICS FOR FIRST YEAR B.SC. HONORS PROGRAM

11.1 Discipline Specific Core (DSC) Courses

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: First	Semester: First
Course Code: MJCC1	Course Type: DSC 1
Core : Compulsory	Course Title: Mathematical Physics - I
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment : 25 Marks	External Assessment : 75 Marks

Course Objectives:

- The significance of course is on applications in solving problems in physics.
- The objective of the course is to equip the student with the mathematical techniques that are required for understanding theoretical treatment in different Physics subjects being taught.
- The skills developed during the course will prepare students not only for doing fundamental and applied research but also for a wide variety of careers.

Course Outcomes:

After completing this course, student will be able to,

- Draw and interpret graphs of various elementary functions and their combinations.
- Understand the vector quantities as entities with Cartesian components which satisfy
- Concept of Tensors and apply to physics problems
- Appropriate rules of transformation under rotation of the axes.
- Solve first and second order differential equations and apply to solve the physics problems.
- Understand the functions of more than one variable and concept of partial derivatives.
- Understand the concept of scalar field, vector field and gradient of scalar fields.

Unit	Topics	No. of Hours
I	Functions: Elementary functions, plotting and interpretation of elementary functions: power functions, exponential functions, logarithmic functions, trigonometric functions, inverse trigonometric functions and their sums, differences, products, quotients, and compositions and their combinations. Taylor's series expansion for elementary functions. Multi-Variable Functions: Functions of more than one variable, partial derivatives, chain rule for partial derivatives. Scalar-valued functions over the plane and the space. Vector function of a scalar variable:	15

	Curves and Paths. Scalar and vector fields, concept of directional derivative, the vector differential operator, gradient of a scalar field and its geometrical interpretation.	
II	Vector Algebra: Coordinate rotation, reflection and inversion for defining scalars, vectors, pseudo-scalars and pseudo-vectors. Component form in 2D and 3D. Geometrical and physical interpretation of addition, subtraction of vectors. Position, separation and displacement vectors. Transformation of Cartesian components of vectors under rotation of the axes. Operations with vectors, product of vectors: scalar and vector product of two, three and four vectors in index notation, Reciprocal vectors. Invariance of scalar product under rotation transformation.	15
III	Introduction to Tensors: Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. contravariant, covariant & mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew-symmetric tensors. Examples of tensors in physics. Dirac Delta Functions: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. Application of Dirac Delta Functions.	15

Essential/ Recommended Readings:

1. Vector Analysis and Cartesian Tensors, D.E. Bourne and P.C. Kendall, 3Ed., 2017, CRC Press.
2. A.W. Joshi, "Matrices and Tensors in Physics", New Age International Private Limited, 1995, 3e
3. Vector Analysis, Murray Spiegel, 2Ed., 2017, Schaum's outlines series.
4. Introduction to Vector Analysis, Davis and Snider, 6 Ed., 1990, McGrawHill.
5. Differential Equations, R. Bronson and G.B. Costa, Schaum's outline series.
6. Mathematical Physics, A.K. Ghatak, I.C. Goyal and S.J. Chua, Laxmi Publications Private Limited (2017)
7. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
8. Differential Equations, George F. Simmons, 2007, McGrawHill.
9. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
10. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
11. Probability and Statistics, Murray R Spiegel, John J Schiller and R Alu Srinivasan, 2018, McGraw Hill Education Private Limited.
12. Essential Mathematical Methods, K.F. Riley and M.P. Hobson, 2011, Cambridge Univ. Press.
13. John E. Freund's Mathematical Statistics with Applications, I. Miller and M. Miller, 7th Ed., 2003, Pearson Education, Asia.
14. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 7Ed., 2013, Elsevier.
15. The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008,

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: First	Semester: First
Course Code: MJCC2	Course Type: DSE 2
Core : Compulsory	Course Title: Mechanics & Relativity
Credits (in hours per week):3	3L-0T-0P
Internal Assessment : 25 Marks	External Assessment : 75 Marks

Course Objectives:

- This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts.
- It begins with Newton's Laws of Motion and ends with the Special Theory of Relativity.
- The students will learn the collisions in the centre of mass frame, rotational motion and central forces.
- They will be able to apply the concepts learnt to several real world problems.
- In the laboratory part of the course, the students will learn to use various instruments, estimate the error for every experiment performed and report the result of experiment along with the uncertainty in the result up to correct significant figures.

Course outcomes: Upon completion of this course, students will be able to.

- Learn fundamentals of Newton's laws of motion.
- Understand translational and rotational dynamics of a system of particles.
- Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
- Understand Einstein's postulates of special relativity.
- Apply Lorentz transformations to describe simultaneity, time dilation and length contraction.
- Use various instruments for measurements and perform experiments related to rotational dynamics, elastic properties, fluid dynamics, acceleration due to gravity, collisions, etc.

Unit	Topics	No.of Hours
I	Dynamics of a system of particles: Inertial and Non-inertial frames, Newton's Laws of Motion and their invariance under Galilean transformations. Momentum of variable mass system: motion of rocket. Dynamics of a system of particles, principle of conservation of momentum. Work and Kinetic Energy Theorem. Conservative forces and examples (Gravitational and electrostatic), non-conservative forces and examples (velocity dependent forces e.g. frictional force, magnetic	15

	force). Potential Energy. Energy diagram. Stable, unstable and neutral equilibrium. Force as gradient of the potential energy.	
II	Dynamics of a Rigid Body: Translational and rotational motion, Angular velocity, angular momentum and acceleration, Torque, Principle of conservation of angular momentum, kinetic energy in rotational motion, Moment inertia of body, calculation of moment of inertia of symmetric rigid bodies (rectangular, cylindrical and spherical), theorems on moment of inertia. The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Non-inertial frames and fictitious forces. Uniformly rotating frame. Centrifugal force, Coriolis force and its applications. Central Force Motion: Central forces, Law of conservation of angular momentum for central forces, Two-body problem and its reduction to equivalent one-body problem and its solution. Effective potential energy, stability of orbits for central potentials of the form kr^n for $n = 2$ and -1 using energy diagram. Kepler's laws for planetary motion, Solution of Kepler's problem, orbit for artificial satellites.	20
III	Relativity: Concept of space and time, Galilean Transformation, Postulates of special theory of relativity, Lorentz transformation, length contraction, time dilation, simultaneity, velocity addition, relativity of mass, Equivalence of mass and energy, Conservation of relativistic energy, Concept of zero rest mass.	10

Recommended Readings:

1. An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
2. Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et.al., 2017, McGraw Hill Education.
3. Theory and Problems of Theoretical Mechanics, Murray R. Spiegel, 1977, McGraw Hill Education.
4. Classical Mechanics by Peter Dourmashkin, 2013, John Wiley and Sons.
5. Introduction to Classical Mechanics With Problems and Solutions, David Morin, 2008, Cambridge University Press.
6. Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
7. Introduction to Special Relativity, Robert Resnick, 2007, Wiley.
8. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e
9. Feynman Lectures, Vol.1, R.P. Feynman, R.B. Leighton, M.Sands, 2008, Pearson Education.
10. University Physics, H. D. Young, R.A. Freedman, 14/e, 2015, Pearson Education.
11. Classical Mechanics, H. Goldstein, C. P. Poole, J. L. Safko, 3/e, 2002, Pearson Education.
12. Newtonian Mechanics, A. P. French, 2017, Viva Books.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: First	Semester: First
Course Code: MJCC3	Course Type: DSE 3
Core : Compulsory	Course Title: Waves and Oscillations
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment : 25 Marks	External Assessment : 75 Marks

Course Objectives:

- This course reviews the concepts of waves and oscillations learnt at school from a more advanced perspective and goes on to build new concepts.
- It begins with explaining ideas of free oscillations and superposition of harmonic motion leading to physics of damped and forced oscillations.
- The course will also introduce students to coupled oscillators, normal modes of oscillations and free vibrations of stretched strings.
- Concurrently, in the laboratory component of the course students will perform experiments that expose them to different aspects of real oscillatory systems.

Course Outcomes:

On successful completion of this course, the students will have the skill and knowledge to,

- Study of travelling and standing waves, stretched strings
- Understand simple harmonic motion
- Understand superposition of waves
- Understand superposition of two perpendicular harmonic oscillations
- Study about free, damped and forced oscillations
- Understand coupled oscillators and normal modes of oscillation

Unit	Topics	No.of Hours
I	Wave Motion & Simple Harmonic Motion: Periodic and harmonic motions, Harmonic oscillators, Simple harmonic motion (SHM), Differential equation of SHM, its solution and characteristics, energy transformation in simple harmonic motion, linearity and superposition principle, rotating vector representation of simple harmonic oscillation, motion of simple and compound pendulum, loaded spring. Principle of superposition of waves, Beats, Superposition of two perpendicular harmonic oscillations: Graphical and Analytical Methods, stationary waves, phase and group velocity. Composition of simple harmonic motion, Lissajous Figures.	20
II	Damped & Forced Oscillations: Introduction of damping, damped harmonic oscillator, dead beat motion, critically damped system, lightly damped system: relaxation time, logarithmic decrement, quality factor Q. Forced Oscillations: Equation of motion, complete solution, steady state solution, resonance, sharpness of resonance, power dissipation,	15

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	and quality factor.	
III	Coupled Oscillations: Normal coordinates and normal modes, degrees of freedom, 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.	10

Essential/ Recommended Readings:

1. Vibrations and Waves by A.P. French. (CBS Pub. And Dist.,1987)
2. The Physics of Waves and Oscillations by N.K. Bajaj (Tata McGraw-Hill,1988)
3. Fundamentals of Waves and Oscillations By K. UnoIngard (CambridgeUniversityPress,1988)
4. An Introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow(McGraw-Hill,1973)
5. Waves: Berkeley Physics Course by Franks Crawford (TataMcGrawHill,2007).
6. Classical Mechanics by Peter Dourmashkin, John Wiley and Sons
7. [https://phys.libretexts.org/Bookshelves/Classical_Mechanics/classical_Mechanics_\(Dourmashkin\)](https://phys.libretexts.org/Bookshelves/Classical_Mechanics/classical_Mechanics_(Dourmashkin))

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: First	Semester: First
Course Code: MJCC4	Course Type: DSC 4
Core : Compulsory	Course Title: Experimental Lab-I
Credits (in hours per week): 6	0L-0T-6P
Internal Assessment : 25 Marks	External Assessment: 75 Marks
Course Objectives: • To understand and minimize random errors in measurements. • To determine moments of inertia of regular and irregular bodies. • To measure modulus of rigidity using dynamical methods. • To determine Young's modulus and Poisson's ratio of materials.	
Course outcomes: By the end of the course, students will be able to: • Analyze measurement errors and uncertainties. • Determine moment of inertia using experimental setups. • Evaluate modulus of rigidity via dynamical methods. • Calculate Young's modulus and Poisson's ratio. • Measure viscosity using capillary and flow-based techniques.	

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Unit	Topics	No. of Hours
Section-A	Mathematical Physics Based Experiments: Basic Elements of Python: The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability and formatting in the print statement. Control Structures: Conditional operations, if, if-else, if-elif-else, while and for Loops, indentation, break and continue, List comprehension. Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules. Recommended List of Programs (At least two) (a) Make a python function that takes a number N as input and returns the value of factorial of N and compare with the output of math. Factorial() method. Use this function to print the number of ways a set of m red and n blue balls can be arranged. (b) Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions. (c) Generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion. References: 1) Documentation at the Python homepage (https://docs.python.org/3/) 2) Tutorials (https://docs.python.org/3/tutorial/)	30
Section-B	Mechanics based Experiments: - To study the random errors in observations. It is advisable to keep observables of the order of least count of the instruments. - To determine the moment of inertia of a flywheel - To determine the moment of inertia of an irregular body by inertia table - To determine the modulus of rigidity by dynamical method (sphere/disc/Maxwell's needle) - To determine Coefficient of Viscosity of water by Capillary Rise Method. - To determine the Young's Modulus by bending of beam - To determine Poisson's ratio of rubber-by-rubber tubing. - To determine Coefficient of viscosity of water by	30

	Poiseuille's method. - To determine the coefficients of sliding and rolling friction experienced by a trolley on an inclined plane (virtual lab). - To verify the law of conservation of linear momentum in collisions on air track (virtual lab). - To verify the momentum and kinetic energy conservation using collision balls (virtual lab). Link for virtual lab Activities: https://phet.colorado.edu/en/simulations/collision-lab - Amrita Virtual Mechanics Lab: https://vlab.amrita.edu/?sub=1&brch=74	
Section-C	Wave Oscillations based Experiments: - Understand the applications of CRO by measuring voltage and time period of a periodic waveform using CRO - Study the superposition of two simple harmonic oscillations using CRO: Study of Lissajous figures - To determine the acceleration due to gravity by bar pendulum. - To study normal modes and beats in coupled pendulums or coupled springs. - To determine the frequency of AC mains by Sonometer. - To study the Spiral Spring Experiment (virtual lab). References (For Laboratory Work): Suggested additional Activities: - Virtual lab collision experiments on two dimensional elastic and inelastic collisions for example available on; https://archive.cnx.org/specials/2c7acb3c-2fbd-11e5-b2d9-e7f92291703c/collision-lab/#sim-advanced-sim https://phet.colorado.edu/en/simulations/collision-lab - Amrita Virtual Mechanics Lab: https://vlab.amrita.edu/?sub=1&brch=74	10
Recommended Readings: - Advanced Practical Physics for students, B.L. Flint and H.T.Worshnop, 1971, Asia Publishing House. - Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd. - Practical Physics, G.L. Squires, 2015, 4/e, Cambridge University Press.		

4. A Text Book of Practical Physics, Vol I, Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5. An introduction to Error Analysis: The study of uncertainties in Physical Measurements, J. R. Taylor, 1997, University Science Books

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: First	Semester: Second
Course Code: MJCC5	Course Type: DSC 5
Core : Compulsory	Course Title: Mathematical Physics - II
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment : 25 Marks	External Assessment : 75 Marks

Course Objectives:

- The emphasis of course is on applications in solving problems of interest to physicists.
- The course will also expose students to fundamental computational physics skills enabling them to solve a wide range of physics problems.
- The skills developed during course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

Course Outcomes:

After completing this course, student will be able to,

- Understand the concept of divergence and curl of vector fields.
- Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's
- Theorems to compute these integrals.
- The students will be also enabled to apply these to physics problems.
- Use curvilinear coordinates to problems with spherical and cylindrical symmetries.
- Students will learn Beta and Gamma Functions and their applications.
- Represent a periodic function by a sum of harmonics using Fourier series.

Unit	Topics	No. of Hours
I	Vector Calculus: Divergence and curl of a vector field and their physical interpretation. Gradient, Divergence and Curl and their significance. Laplacian operator. Vector identities, Integrals of vector-valued functions of single scalar variable. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of vector fields. Flux of a vector field.	15

	Gauss divergence theorem, Green's and Stokes' Theorems (no proofs) and their applications to solve the problems based on these theorems.	
II	Orthogonal Curvilinear Coordinates: Orthogonal curvilinear coordinates. Vector fields and vector algebra in curvilinear coordinates, Scale factors, Differential of an arc length. Geometrical Significance of scale factors. Differential Operator, Gradient, Divergence and Curl in curvilinear coordinates. Laplacian Operator, Derivation of Gradient, Divergence, Curl, Arc length, and Laplacian in Spherical and Cylindrical Coordinate Systems. Transformation of cylindrical polar co-ordinates into unit vectors, Conversion of spherical polar co-ordinates into unit vectors, Relation between cylindrical and spherical co-ordinates. Beta and Gamma Functions: Euler's Integrals, Gamma functions, properties of Gamma Function, Another forms of Gamma Function, Beta Functions, properties of Beta Function, Another form of Beta Function. Relation between Beta and Gamma Functions. Other Transformations. Expression of integrals in terms of Gamma and Beta Functions, Error Function (Probability Integral).	15
III	Fourier Series: Periodic functions, orthogonality of sine and cosine functions, Convergence of Fourier series and Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series, Expansion of functions with arbitrary period, Even and odd functions and their Fourier expansions (Fourier Cosine Series and Fourier Sine Series). Parseval's Identity. Application, summing of infinite series.	15

Essential/ Recommended Readings:

1. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
2. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5th Ed., 2012, Jones and Bartlett Learning.
3. Mathematical Physics by H.K. Das
4. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
5. Essential Mathematical Methods, K.F. Riley and M.P. Hobson, 2011, Cambridge Univ. Press.
6. Vector Analysis and Cartesian Tensors, D. E. Bourne and P. C. Kendall, 3rd Ed., 2017, CRC Press.
7. Vector Analysis, Murray Spiegel, 2nd Ed., 2017, Schaum's outline series.
8. Fourier analysis: With Application to Boundary Value Problems, Murray Spiegel, 2017, McGraw Hill Education.
9. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 7th Ed., 2013, Elsevier.
10. Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4th Ed., 2017, Cambridge University Press.
11. The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing.

shing House.

12. Introduction to Vector Analysis, Davis and Snider, 6Ed., 1990, McGrawHill.

13. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: First	Semester: Second
Course Code: MJCC6	Course Type: DSC 6
Core : Compulsory	Course Title: Electricity and Magnetism
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment : 25 Marks	External Assessment : 75 Marks

Course Objectives:

- Electricity and Magnetism govern much of the world around us – begin with the most fundamental processes in nature to cutting edge electronic devices.
- The student will acquire the knowledge and understanding of; Electric Potential, Boundary conditions, Maxwell's equations, various techniques of solving Laplace's equation, Electric field and Magnetic fields in matter.
- The course swathe static and dynamic electric and magnetic fields due to continuous charge and current distributions respectively.

Course outcomes:

After completing this course, student will be able to;

- Apply Coulomb's law to line, surface, and volume distributions of charges.
- Apply Gauss's law of electrostatics to distribution of charges
- Understand the concept of electric potential, Laplace's equations and uniqueness theorems.
- Solve boundary value problems using method of images
- Understand the effects of electric polarization and concepts of bound charges in dielectric materials
- Understand and calculate the vector potential and magnetic field of arbitrary current distribution
- Understand the concept of bound currents magnetic materials

Unit	Topics	No. of Hours
I	Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge. Differential and integral forms of Gauss's Law. Applications of Gauss Law to a point charge, infinite line charge, infinite sheet of charge, uniformly charged sphere. Curl of electric	15

	field, electric field vector as negative gradient of scalar potential. Boundary Value Problems in Electrostatics: Formulation of Laplace's and Poisson equations. The first and second uniqueness theorems. General Procedure for Solving Poisson's or Laplace's Equation.	
II	Electric Field in Matter: Polarization in matter, Bound charges and their physical interpretation. Field inside a dielectric, Displacement vector D, Gauss' Law in the presence of dielectrics, Boundary conditions for D, Linear dielectrics, Electric susceptibility and Dielectric constant, idea of complex dielectric constant due to varying electric field.	10
III	Magnetic Field: Divergence and curl of magnetic field B, Magnetic field due to arbitrary current distribution using Biot-Savart law, Ampere's law, Integral and differential forms of Ampere's Law, Magnetic scalar and vector potentials, Coulomb gauge and possibility of making vector potential divergence less, Vector potential due to line, surface and volume currents. Magnetic Properties of Matter: Magnetization in materials. Classification of magnetic materials. Magnetization vector. Bound currents, Magnetic intensity. Differential and integral form of Ampere's Law in the presence of magnetized materials. Magnetic susceptibility and permeability. Electrodynamics: Faraday's Law, Lenz's Law, inductance, electromotive force, Ohm's law, energy stored in a magnetic Field.	20

Recommended Readings:

1. Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings
2. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
3. Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn. 1981, McGraw-Hill.
4. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
5. Electricity and Magnetism, J. H. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: First	Semester: Second
CourseCode: MJCC7	Course Type: DSC 7
Core : Compulsory	Course Title: Electrical Circuit Analysis
Credits (In hours per week): 3	3L-0T-0P
Internal Assessment : 25 Marks	External Assessment : 75 Marks

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Course Objectives:

- This course covers the basic circuit concepts in a systematic manner which is suitable for analysis and design. It aims at study and analysis of electric circuits using network theorems and two-port parameters.
- This course intends to impart basic knowledge of electrical quantities such as current, voltage, power and analysis techniques of electrical circuits.
- To make the student familiar with the basic theory of self and mutual inductance, its application and in problem solving, understand concept of transients in electrical circuits (CR, LR, LCR) and resonance.
- Provide working knowledge for the analysis of AC circuits, mutually coupled LR circuits (transformers) and AC Bridges.

Course Outcomes:

After completing this course, student will be able to,

- On the completion of the course the student will be able to,
- Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and their difference
- Solve complex electric circuits using network theorems.
- Discuss resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.
- Evaluate the performance of two port networks.

Unit	Topics	No.of Hours
I	Circuit Analysis: Concept of constant voltage source and constant current source, Conversion of voltage source into current source. DC Transient Analysis: Charging and discharging with initial charge in RC circuit, RL circuit with initial current, time constant, RL and RC Circuits with source	15
II	AC Circuit Analysis: Sinusoidal voltage and current, Definitions of instantaneous, peak to peak, root mean square and average values, form factor and peak factor (for half-rectified and full-rectified sinusoidal wave, rectangular wave and triangular wave), voltage-current relationship in resistor, inductor and capacitor, phasor, complex impedance, power in AC circuits, sinusoidal circuit analysis for RL, RC and RLC Circuits, resonance in series and parallel RLC Circuits (Frequency Response, Bandwidth, Quality Factor), selectivity, application of resonant circuits.	15
III	Network Theorems: Principal of duality, Superposition theorem, Thevenin theorem, Norton theorem. Their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits, Reciprocity Theorem, Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission Parameters, Impedance matching.	15

Essential/ Recommended Readings:

1. Essentials of Circuit Analysis, Robert L. Boylestad, Pearson Education (2004)
2. Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, TataMcGraw-Hill (2005)

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3. Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics	
Year: First	Semester: Second	
CourseCode: MJCC8	Course Type: DSC 8	
Core : Compulsory	Course Title: Experimental Lab-II	
Credits (in hours per week): 6	0L-0T-6P	
Internal Assessment : 25 Marks	External Assessment : 75 Marks	
Course Objectives: • To study magnetic field variations in coils and measure inductance. • To measure resistances using bridge methods and galvanometers. • To determine mutual and self-inductance of coils. • To verify fundamental network theorems in electrical circuits. • To analyze transient and steady-state response of RC, RL, and LCR circuits. • To study resonance and frequency response in AC circuits.		
Course outcomes: By the end of the course, students will be able to: • Analyze magnetic fields and measure inductance using coils and bridges. • Accurately determine low and high resistances using standard techniques. • Evaluate self and mutual inductance in coil systems. • Verify and apply Norton's, Thevenin's, Superposition, and Maximum Power Transfer theorems. • Measure and interpret the time constant in RC and RL circuits. • Analyze resonance, quality factor, and bandwidth in LCR circuits. • Interpret frequency response characteristics in AC circuits.		
Unit	Topics	No.of Hours
Section-A	List of experiments based on Electricity and Magnetism: 1. Variation of magnetic field along axis of Helmholtz coil 2. Measurement of current and charge sensitivity of ballistic galvanometer 3. Measurement of low resistance by Kelvin's double bridge method 4. Determination of a high resistance by leakage method using ballistic galvanometer	45

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	- Measurement of field strength and its variation in a solenoid (determine dB/dx) - Determination of an unknown low resistance by Carey Foster's Bridge - Measurement of self-inductance of a coil by Anderson's Bridge. - Measurement of self-inductance of a coil by Owen's Bridge. - To determine the mutual inductance of two coils by the Absolute method.	
Section-B	List of experiments based on Electrical Circuit Analysis; - Verification of Norton's theorem. - Verification of Thevenin's Theorem. - Verification of Superposition Theorem. - Verification of Maximum Power Transfer Theorem. - Determination of time constant of RC and RL circuit - Study of frequency response of RC circuit - Study of frequency response of a series and parallel LCR Circuit and determination of its resonant frequency, impedance at resonance, quality factor and bandwidth. - To study the characteristics of a series RC Circuit. - To study the response curve of a Series LCR circuit and determine its resonant frequency, impedance at resonance, quality factor and bandwidth	45

Recommended Readings:

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing
- A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning
- Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press.
- A Textbook of Electrical Technology, B. L. Thareja, A.K. Thareja, Volume II, S. Chand.
- Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)
- Electrical Circuits, K. A. Smith and R. E. Alley, 2014, Cambridge University Press.
- Electrical Circuit Analysis, K. Mahadevan and C. Chitran, 2nd Edition, 2018, PHI learning Pvt. Ltd.

SECOND YEAR B.SC. HONORS PROGRAM

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Third
Course Code: MJCC9	Course Type: DSC 9
Core: Compulsory	Course Title: Mathematical Physics - III
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Develop a solid understanding of complex numbers, complex functions, and their graphical and analytical properties.
- Apply conditions for analyticity and differentiability of complex functions using the Cauchy-Riemann equations.
- Analyse and classify singularities and evaluate complex integrals using Cauchy's theorems.
- Apply the Residue Theorem for evaluating integrals and solving real-valued integrals via contour methods.
- Understand and compute Fourier Transforms and apply them to problems in signal processing and wave equations.
- Understand and apply Laplace Transforms to solve ordinary and partial differential equations, including physical problems.
- Grasp the concept and applications of the Dirac delta function and its integral transforms.

Course Outcomes:

After completing this course, students will be able to:

- After completing this course, students will be able to:
- Apply Cauchy-Riemann conditions and identify analytic functions.
- Evaluate complex integrals using residue theorem.
- Use Fourier transforms to solve physical and mathematical problems.
- Apply Laplace transforms to solve ordinary differential equations.
- Interpret and utilize the Dirac delta function in transforms.
- Integrate complex analysis and transform techniques in physical contexts.

Unit	Topics	No.of Hours
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I	Complex Analysis: Algebra of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem. Powers and roots of Complex Numbers. Functions of Complex Variables including elementary and trigonometric. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Integration of Complex Functions.	15
II	Fourier Integrals Transforms: Fourier Transforms: Fourier Integral theorem (Statement only). Fourier Transform. Fourier sine and cosine transform, Examples. Fourier transform of single pulse, trigonometric, exponential and Gaussian functions. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem.	15
III	Laplace Transforms and Dirac delta function: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Periodic Functions. Convolution Theorem. Inverse LT. Shifting Properties, Derivatives and Integrals of Inverse LTs, Definition and properties of Dirac delta function, Representation of Dirac delta function as a Fourier Integral. Laplace and Fourier Transform of Dirac delta function. Applications of LT.	15

Essential/ Recommended Readings:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
3. Complex Variables, A. S. Fokas & M. J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
4. Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
5. Complex Variables and Applications, J. W. Brown & R. V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
6. Mathematical Physics by H. K. Das

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Third
CourseCode: MJCC10	Course Type: DSC 10
Core: Compulsory	Course Title: Thermal Physics
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the basic principles of thermodynamics, including concepts of temperature, internal energy, work, and heat.
- Analyze the implications of the First and Second Laws of Thermodynamics in various physical processes.
- Comprehend the concept of entropy and its significance in determining the direction of thermodynamic processes.
- Apply thermodynamic potentials and Maxwell's relations to evaluate equilibrium and stability.
- Understand radiation laws and energy distribution using Planck's theory of blackbody radiation.
- Learn kinetic theory concepts such as velocity distributions, degrees of freedom, and specific heats of gases.

Course Outcomes:

After completing this course, students will be able to:

- Explain the Zeroth and First Law of Thermodynamics and apply them to thermodynamic processes.
- Analyse heat engines, refrigerators, and efficiency using the Second Law.
- Define and calculate entropy changes in various thermodynamic processes.
- Use thermodynamic potentials and Maxwell relations to assess equilibrium and process feasibility.
- Understand blackbody radiation and derive laws from Planck's theory.
- Apply kinetic theory to describe molecular motion and thermodynamic properties of gases.

Unit	Topics	No. of Hours
I	Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_p and C_v , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2 nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.	15

II	Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot’s Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. Thermodynamic Potentials: Thermodynamical potentials, Maxwell’s relations, conditions for feasibility of a process and equilibrium of a system. Clausius-Clapeyron equation, Joule-Thompson effect.	15
III	Theory of Radiation: Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck’s law, deduction of Wien’s distribution law, Rayleigh-Jeans law, Stefan-Boltzmann law and Wien’s displacement law from Planck’s law. Kinetic Theory of Gases: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.	15

Essential/ Recommended Readings:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B. N. Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
5. Heat Thermodynamics & Statistical Physics, Brij Lal and Subramaniam, 1st Edn., 2008, S. Chand.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Third
Course Code: MJCC11	Course Type: DSC 11
Core: Compulsory	Course Title: Light and Matter
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the wave-particle duality of light and matter with examples from classical and quantum experiments.
- Analyse interference and diffraction phenomena using the wave theory of light.

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- Understand single-photon and matter-wave experiments that support quantum behavior.
- Apply theoretical principles to the study of radiation-matter interactions, refractive properties, and polarization.
- Develop conceptual understanding of optical anisotropy, nonlinear optics, and basic laser physics.

Course Outcomes:

After completing this course, students will be able to:

- Describe wave-particle duality of light and matter using key experiments and concepts.
- Analyze interference phenomena in thin films, Newton's rings, and photon/electron double-slit setups.
- Differentiate between Fresnel and Fraunhofer diffraction and apply to practical optics problems.
- Explain interaction of electromagnetic waves with matter using refraction, absorption, and polarization principles.
- Understand optical anisotropy, nonlinear optical effects, and basics of laser operation.

Unit	Topics	No. of Hours
I	Duality of Light and matter: Light as an EM wave - Hertz's experiments; Particle characteristics by photoelectric effect and Compton effect (concepts only) and wave characteristics by interference and diffraction. Wave properties of particles: de Broglie hypothesis, wavelength of matter waves; particle wave complementarity: Velocity of de Broglie wave and need of a wave packet; Group and phase velocities and relation between them; equivalence of group and particle velocity, dispersion of wave groups.	10
II	Interference: Division of amplitude and wave-front. Two-slit interference experiment with photons: Young's double slit experiment. Lloyd's mirror. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringe). Newton's Rings: Measurement of wavelength and refractive index. Single photon interference. Two-slit interference experiment with electrons. Diffraction: Fraunhofer diffraction: Single slit, double slit, diffraction grating, resolving power of grating. Fresnel diffraction: Fresnel's assumptions, Fresnel's half-period zones for plane wave, explanation of rectilinear propagation of light, theory of a zone plate: multiple foci of a zone plate, Fresnel diffraction at straight edge, a slit and a wire by Fresnel half period zones. Diffraction of photons (e.g. X-rays, gamma rays etc.) and particles by matter, experimental study of matter waves: Davisson-Germer experiment.	20
III	Radiation Matter Interaction and Propagation into Matter: Index of refraction, Snell's laws, limit angle, complex refractive index, electronic polarizability. Optical anisotropy, ellipsoid of indices.	15

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Anisotropy induced by stress or electromagnetic fields. EM wave as a collection of photons. Interaction of an EM wave with dielectric or conductive materials. Light absorption, luminescence, fluorescence, phosphorescence. Non-linear optics: non-linear electric susceptibility, non-linear refractive index. The laser, types of laser sources.

Essential/ Recommended Readings:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Modern Physics by R. A. Serway, C. J. Moses and C. A. Moyer, Thomson Brooks Cole, 2012.
3. Modern Physics for Scientists and Engineers by S. T. Thornton and A. Rex, 4th Edn., Cengage Learning, 2013.
4. Optics, Ajoy Ghatak, McGraw-Hill Education, New Delhi, 7th Edn.
5. Fundamentals of Optics, F. A. Jenkins and H. E. White, 1981, McGraw-Hill. 10
6. Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.
7. A Textbook of Optics N. Subrahmanyam, Brij Lal, M. N. Avadhanulu, S. Chand & Co Ltd.
8. Introduction to Optics I - Interaction of Light with Matter, Ksenia Dolgaleva, (2021), Morgan and Claypool.
9. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
10. Modern Physics, G. Kaur and G. R. Pickrell, 2014, McGraw Hill.
11. Schaum's Outline of Beginning Physics II Waves, electromagnetism, Optics and Modern Physics, Alvin Halpern, Erich Erlbach, McGraw Hill.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Third
CourseCode: MJCC12	Course Type: DSC 12
Core: Compulsory	Course Title: Experimental Laboratory-III
Credits (I n hours per week): 6	0L-0T-6P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Implement programming-based visualization and computation using complex numbers.
- Understand fundamental thermodynamic measurements and constants like mechanical equivalent of heat and thermal conductivity.
- Perform classical optical experiments involving interference, diffraction, and dispersion.
- Determine material properties such as refractive index, dispersive power, and temperature coefficients.

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- Use modern tools (Python/Scilab/C++) for simulation and analysis of physical phenomena.
- Apply principles of error analysis, data plotting, and scientific reporting.

Course Outcomes:

After completing this lab course, students will be able to:

- Perform basic operations and visualizations with complex numbers using programming tools.
- Determine physical constants like the mechanical equivalent of heat and thermal conductivity using standard techniques.
- Measure the refractive index, wavelength, and dispersive properties using prism and grating-based optical setups.
- Analyse interference patterns to calculate wavelength and thickness of thin films.
- Understand and implement optical resolution concepts using Newton's rings and diffraction gratings.
- Integrate computational techniques with experimental physics for modelling and analysis.

Unit	Topics	No. of Hours
I	1. Handling of Complex Numbers: Syntax for creating complex numbers in Python/C++/Scilab, accessing real and imaginary parts, calculating the modulus and conjugate of a complex number, complex number arithmetic, plotting of complex numbers as ordered pairs of real numbers in a plane, conversion from Cartesian to polar representation. Recommended List of Programs: a) Determine the nth roots of a complex number and represent it in Cartesian and polar form. b) Transformation of complex numbers as 2-D vectors e.g. translation, scaling, rotation, reflection. c) Visualization of mappings of some elementary complex functions $w = f(z)$ from z-plane to w-plane. 2. To determine Mechanical Equivalent of Heat, J, by Callender and Barn's constant flow method. 3. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus. 4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's disc method. 5. To determine the Temperature Coefficient of Resistance of a given coil. (Virtual Lab) 6. Determination of refractive index of material of prism using Sodium (Na) light. (Virtual Lab) 7. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source. (Virtual Lab) 8. To determine wavelength of sodium light using Newton's Rings. (Virtual Lab) 9. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. 10. To determine wavelength of (i) Na source and (ii) spectral lines of Hg source using plane diffraction grating. (Virtual Lab) 11. To determine dispersive power of a plane diffraction grating using mercury lamp.	90

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	12. To determine resolving power of a plane diffraction grating using sodium lamp.	
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Essential/ Recommended Readings:

1. Documentation at the Python home page (<https://docs.python.org/3/>) and the tutorials there (<https://docs.python.org/3/tutorial/>).
2. Schaum's Outline of Programming with C++, J. Hubbard, 2000, McGraw-Hill Education.
3. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
4. A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal.
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edn., reprinted 1985, Heinemann Educational Publishers.
6. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.
7. B.Sc. Practical Physics, Geeta Sanon, R. Chand & Co.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Fourth
CourseCode: MJCC13	Course Type: DSC 13
Core: Compulsory	Course Title: Modern Physics
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the historical and quantum mechanical development of atomic structure and electron configurations.
- Analyze rotational, vibrational, and Raman spectra in diatomic molecules.
- Understand and interpret wave-particle duality and quantum mechanical descriptions of particles.
- Derive and apply the Heisenberg uncertainty principle in various physical contexts.
- Analyse quantum systems using the Schrödinger equation and calculate observables using operator methods.
- Solve basic quantum mechanical potential problems, including bound states and tunnelling phenomena.
- Describe the structure of atomic nuclei, nuclear forces, and models explaining stability and binding energy.

Course Outcomes:

After completing this course, students will be able to:

- Explain atomic structure using Bohr, Sommerfeld models and quantum numbers.
- Interpret spectra based on rotational and vibrational transitions in molecules.
- Explain wave-particle duality and apply the uncertainty principle to physical systems.
- Interpret the Schrödinger equation, wavefunctions, and probability densities.
- Analyse quantum tunnelling and bound states in one-dimensional potential systems.
- Apply quantum mechanics concepts to real phenomena like the double-slit experiment and radioactive decay.

Unit	Topics	No. of Hours
I	Quantum Physics: Wave description of particles by wave packets. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to carrier particles and range of an interaction.	12
II	Schrodinger Equation, operators, quantum step and barrier: Postulates of Quantum mechanics; Momentum and Energy operators; Schrodinger equation for non-relativistic particles; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current density. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions	15
III	Atomic Structure: Bohr's model, Bohr's correspondence principle, Wilson - Sommerfeld's quantization rules, energy level & spectra, Stern-Gerlach experiment for electron spin, Revision of quantum numbers, Pauli exclusion principle, electron configuration, Hund's rule. Molecular Spectroscopy: Types of molecular energy states, pure rotational spectra: rigid rotator, non-rigid rotator, vibrational-rotational spectra for diatomic molecules: harmonic oscillator, anharmonic oscillator, vibrating rotator, role of symmetry, Raman spectra.	18

Essential/ Recommended Readings:

1. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, by Robert Eisberg & Robert Resnick, Wiley India, 2nd Edition
2. Introduction to Atomic Spectra, by H. E. White, McGraw Hill.
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, Tata McGraw Hill, Fourth Edition (2017)
4. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
5. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
6. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
7. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
8. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
9. Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd

- Edn, Tata McGraw-Hill Publishing Co. Ltd.
10. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Fourth
CourseCode: MJCC14	Course Type: DSC 14
Core: Compulsory	Course Title: Solid State Physics
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the various types of atomic bonding and how they influence the structure and properties of solids.
- Explore the crystallographic structure of solids using lattice concepts, symmetry elements, and Miller indices.
- Analyse X-ray diffraction techniques and the significance of Brillouin zones and reciprocal lattices.
- Understand the fundamentals of lattice dynamics and phonons in monoatomic and diatomic chains.
- Explore the electrical and thermal behavior of metals using classical and quantum models.
- Learn the band theory of solids and apply it to understand conduction in metals and semiconductors.
- Describe and distinguish between different magnetic and dielectric behaviours in materials.
- Understand the principles and applications of superconductivity, including Type I/II, BCS theory, and modern devices like SQUIDs and Josephson junctions.

Course Outcomes:

After completing this course, students will be able to:

- Explain the types of bonding and crystal structures in solids.
- Analyse crystal geometry using unit cells, Miller indices, and Bragg's law.
- Understand lattice vibrations and the concept of phonons in solids.
- Apply free electron and band theory to study electrical properties of materials.
- Describe magnetic and dielectric behavior of materials and their applications.
- Understand the basic principles and applications of superconductivity.

Unit	Topics	No.of Hours
I	Bonding in solids and Crystals: Ionic bonding, covalent bonding, metallic bonding, Hydrogen bonding and Van der Waals bonding. Crystal structure: periodicity in crystals, lattice points and space lattice, translational, rotational and reflection symmetry elements. Lattice with a basis and crystal structure, unit cells and lattice parameters, Bravais lattices (in 2D and 3D) and crystal systems SC, BCC and FCC lattices, conventional and primitive unit cell, Wigner Seitz unit cell, amorphous and crystalline materials. Planes, Miller Indices, directions, density of atoms in different planes, interplanar spacing. Concept of reciprocal lattice, Brillouin zones (2 D lattice). Atomic Packing: Packing of spheres in 2D and 3D, hexagonal close packing, packing fraction of SC, FCC, and BCC. Point defects and line defects and their consequences on the crystal properties. X-rays: Bragg's law and Laue Condition, single crystal method and powder diffraction method.	15
II	Elementary Lattice Dynamics: Lattice vibrations and phonons: linear monoatomic and diatomic chains, acoustic and optical phonons, qualitative description of the phonon spectrum in solids. Electrical properties of metals: Free electron theory of metals (Drude model), its success and drawbacks, concept of relaxation time, collision time and mean free path, electrical conductivity, mobility and Ohm's law, thermal conductivity of metals, Wiedemann-Franz law. Band Theory: The Kronig-Penney model (Qualitative idea), Band Gap, direct and indirect bandgap, concept of effective mass, Hall Effect (Metal and Semiconductor).	15
III	Magnetic and Dielectric Properties of Solids: Dia-, para-, and ferromagnetism. Langevin and Weiss theories. Hysteresis and domain structure. Curie and Curie-Weiss laws Magnetic susceptibility and permeability. soft and hard material and their applications (discussion only). Dielectric polarization, permittivity, types of polarization, Ferroelectrics and piezoelectrics (basics). Superconductivity: Introduction to superconductivity, Meissner effect, Type I and Type II superconductors, London equations, BCS theory (qualitative), Critical temperature, magnetic field, and current. Applications: SQUIDS, maglev, Josephson junctions.	15
Essential/ Recommended Readings: 1. Solid State Physics, M. A. Wahab, 2015, 3rd Ed, Narosa Publications. 2. Solid State Physics, S. O. Pillai, New Age International Publishers 3. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd. 4. Elements of Solid State Physics, J. P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India. 5. Solid State Physics, A. J. Dekker, 2008, Macmillan Education. 6. Elementary Solid State Physics, Ali Omar, Pearson Publication.		

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Fourth
CourseCode: MJCC15	Course Type: DSC 15
Core: Compulsory	Course Title: Analog Electronics
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the electrical behaviour and physics of semiconductor devices, including diodes, transistors, and LEDs.
- Analyze the characteristics and applications of two-terminal devices, including rectifiers, photodiodes, and solar cells.
- Explain the operation of bipolar junction transistors in various regions and configurations.
- Design and analyze amplifier circuits, including biasing, gain calculations, and frequency response.
- Understand the principles of feedback and oscillator circuits, including RC phase shift and Colpitts oscillators.
- Learn the characteristics and practical applications of operational amplifiers, including inverting and non-inverting configurations.

Course Outcomes:

After completing this course, students will be able to:

- Explain the working of p-n junction diodes and their I-V characteristics.
- Analyze rectifier circuits, Zener diodes, LEDs, photodiodes, and solar cells.
- Understand the operation and characteristics of BJTs in various configurations.
- Design and evaluate transistor-based amplifiers and biasing circuits.
- Analyze multistage and feedback amplifiers for stability and frequency response.
- Explain the principles and design of sinusoidal oscillators and operational amplifiers.

Unit	Topics	No. of Hours
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. 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)	15

	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.	
II	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. Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. 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.	15
III	Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. Feedback in Amplifiers: Positive and Negative Feedback. Effect of negative feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. Operational Amplifiers: Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.	15

Essential/ Recommended Readings:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronic Devices and Circuit Theory by Louis Nashelsky and Robert Boylestad, Pearson Publication.
3. Electronic Devices: Conventional Current Version, 10e, by Thomas L. Floyd, Pearson Publication.
4. Electronic Principles by Albert Paul Malvino, McGraw Hill Publication.
5. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
6. Solid State Electronic Devices, B.G. Streetman & S. K. Banerjee, 6th Edn., 2009, PHI Learning.
7. Electronic Devices & circuits, S. Salivahanan & N.S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
8. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
9. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Second	Semester: Fourth
Course Code: MJCC16	Course Type: DSC 16
Core: Compulsory	Course Title: Experimental Laboratory-IV
Credits (in hours per week): 6	0L-0T-6P

Internal Assessment: 25 Marks	External Assessment: 75 Marks
Course Objectives: - Experimentally investigate semiconductor properties, including bandgap, Hall coefficient, and transistor characteristics. - Explore magnetic and dielectric properties of materials using BH curves and paramagnetic susceptibility methods. - Study quantum effects through classic experiments like the Franck-Hertz experiment. - Design, analyse, and test analog electronic circuits including amplifiers, oscillators, and operational amplifier applications. - Understand basic principles of digital-to-analog conversion. - Develop skills in circuit design, data acquisition, error analysis, and scientific reporting.	

Course Outcomes:

After completing this lab course, students will be able to:

- Determine semiconductor bandgap and Hall coefficient using standard techniques.
- Analyse magnetic and paramagnetic properties using hysteresis and susceptibility measurements.
- Study characteristics and applications of Zener diodes and BJTs.
- Design and test transistor amplifiers and oscillator circuits.
- Construct and evaluate OP-AMP-based analog circuits.
- Develop and test a basic digital-to-analog converter (DAC) system.

Unit	Topics	No. of Hours
I	- To determine the bandgap of a semiconductor using four probe method (Virtual Lab) - Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method) (Virtual Lab) - To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis. (Virtual Lab) - To determine the Hall coefficient of a semiconductor sample. (Virtual Lab) - To calculate the discrete energy levels using Franck-Hertz Experiment. (Virtual Lab) - To study the V-I characteristics of a Zener diode and its use as voltage regulator (Virtual Lab) - To study the characteristics of a Bipolar Junction Transistor in CE configuration. - To study the various biasing configurations of BJT for normal class A operation. - To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias. - To study the frequency response of voltage gain of a two stage RC-coupled transistor amplifier. - To design a phase shift oscillator of given specifications using	90

BJT.

12. To design a digital to analog converter (DAC) of given specifications.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. (a) To design inverting amplifier using Op-amp (741,351) & study its frequency response
(b) To design non-inverting amplifier using Op-amp (741,351) & study frequency response

Essential/ Recommended Readings:

1. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. B.Sc. Practical Physics, Geeta Sanon, R. Chand & Co.
4. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, McGraw Hill.
5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
6. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
7. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

THIRD YEAR B.SC. HONORS PROGRAM

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Fifth
Course Code: MJCC17	Course Type: DSC 17
Core: Compulsory	Course Title: Nuclear Physics
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the processes of radioactive decay, conservation laws, and mechanisms of fission and fusion.
- Relate quantum principles to modern nuclear phenomena, including neutrino discovery and energy generation.
- Describe the structure and properties of atomic nuclei, including experimental determination of nuclear parameters.

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- Interpret the binding energy trends and nuclear stability using mass number relationships and N/Z ratio.
- Understand the processes and quantitative features of radioactive decay, including alpha, beta, and gamma decays.
- Explore the theoretical models of decay processes, including Gamow theory, decay chains, and internal conversion.

Course Outcomes:

After completing this course, students will be able to:

- Describe nuclear properties and analyze binding energy trends.
- Understand the nature of radioactive decay and associated processes.
- Apply theoretical models to α , β , and γ decay mechanisms and spectroscopy.
- Relate atomic and nuclear structure to observed physical phenomena.
- Describe the structure and properties of atomic nuclei using theoretical models.
- Understand and explain nuclear decay processes and energy release in fission and fusion.

Unit	Topics	No. of Hours
I	Nuclear Structure & radioactivity: Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy; stability of the nucleus; Law of radioactive decay; Mean life and half-life; spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion- mass deficit, Fission- nature of fragments and emission of neutrons.	18
II	General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, matter density (experimental determination of each), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments.	10
III	Radioactivity decay: Decay rate and equilibrium (Secular and Transient) (a) Alpha decay: basics of α -decay processes, theory of α -emission, Gamow factor, Geiger Nuttall law, α -decay spectroscopy, decay Chains. (b) β -decay: energy kinematics for β -decay, β -spectrum, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics, internal conversion.	17

Essential/ Recommended Readings:

1. Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.
2. Concepts of Nuclear Physics by Bernard L Cohen, Tata McGraw Hill Publication, 1974.
3. Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008
4. Introduction to elementary particles by David J Griffiths, Wiley, 2008.

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5. Nuclear Physics by D. C. Tayal
6. Nuclear Physics by B. N. Srivastava

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Fifth
Course Code: MJCC18	Course Type: DSC 18
Core: Compulsory	Course Title: Basic Quantum Mechanics
Credits (in hours per week): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the conceptual foundations of quantum mechanics through the formulation of the time-dependent and time-independent Schrödinger equations.
- Interpret and analyse wave functions and probability densities to describe physical systems, ensuring conditions of normalization and physical acceptability are satisfied.
- Apply operator formalism for observables such as position, momentum, and energy, and compute expectation values and commutators.
- Solve quantum mechanical problems involving one-dimensional bound states, including infinite square wells and harmonic oscillators, and interpret their energy quantization.
- Apply quantum theory to hydrogen-like atoms, utilizing spherical coordinates and quantum numbers to analyse wavefunctions and orbital structures.

Course Outcomes:

After completing this course, students will be able to:

- Interpret the physical meaning of the wave function and apply the Schrödinger equation.
- Calculate probability densities, expectation values, and commutators of operators.
- Solve the time-independent Schrödinger equation for basic potential systems.
- Analyse bound states and quantum harmonic oscillator using appropriate wavefunctions.
- Apply quantum mechanics to hydrogen-like atoms and interpret atomic orbitals.
- Understand the role of quantization, uncertainty, and superposition in quantum systems.

Unit	Topics	No. of Hours
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I	Basics of Quantum Mechanics: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. Spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction	15
II	Time independent Schrodinger equation: Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier. Application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions	18
III	Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions; shapes of the probability densities for ground and first excited states; Orbital angular momentum quantum numbers l and m ; s, p, d shells.	12

Essential/ Recommended Readings:

1. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
5. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
6. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Fifth
CourseCode: MJCC19	CourseType: DSC 19
Core: Compulsory	Course Title: Digital Electronics
Credits (inhoursperweek): 3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

CourseObjectives:

- Understand the significance of binary systems in digital electronics.
- Convert between number systems and analyze logic operations using digital gates.
- Understand and construct basic logic gates, using diodes and transistors.

(Signature)

- Design logic circuits from truth tables using Sum of Products (SOP) and Karnaugh Map techniques.
- Understand and apply data processing circuits such as multiplexers, demultiplexers, encoders, and decoders.
- Design arithmetic circuits, including half and full adders/subtractors.
- Analyze the behaviour of flip-flops under various triggering and preset/clear conditions.
- Explore the use of IC 555 timer in astable, monostable, and bistable configurations.
- Construct and understand shift registers and counters.

Course Outcomes:

After completing this course, students will be able to:

- Differentiate between analog and digital systems and perform number system conversions.
- Design and simplify logic circuits using Boolean algebra and Karnaugh maps.
- Construct combinational circuits including adders, subtractors, encoders, and decoders.
- Explain and implement flip-flops, multivibrators, and sequential logic elements.
- Analyze and design shift registers and counters using logic ICs.
- Apply IC 555 for multivibrator applications in timing and waveform generation.

Unit	Topics	No. of Hours
I	Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	15
II	Arithmetic, data processing and sequential circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.	15
III	Multivibrators, shift registers and counters: IC 555: block diagram and applications: Astable, Monostable and Bistable multivibrators. Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.	15

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Essential/ Recommended Readings:

1. Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
7. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Fifth
Course Code: MJCC20	Course Type: DSC 20
Core: Compulsory	Course Title: Experimental Lab-V
Credits (in hours per week): 6	0L-0T-6P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Conduct advanced experiments in atomic and quantum physics including Zeeman effect and electron spin resonance.
- Understand and demonstrate the tunnelling effect using tunnel diodes.
- Build and test digital logic circuits, including gates, arithmetic units, and sequential logic systems.
- Design and implement multivibrators using IC 555 timer.
- Develop practical experience with combinational and sequential logic design and optimization.

Course Outcomes:

After completing this lab course, students will be able to:

- Demonstrate ESR and Zeeman effect experimentally.
- Analyze the I-V characteristics of a tunnel diode and implement transistor-based logic gates.
- Design and verify combinational and sequential logic circuits using logic gate ICs.
- Implement counters, shift registers, and multivibrators using flip-flops and 555 Timer.
- Apply digital logic and microprocessor programming to solve computational and control problems.

Unit	Topics	No.of Hours
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I

1. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
2. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
3. To show the tunneling effect in tunnel diode using I-V characteristics.
4. To design a switch (NOT gate) using a transistor.
5. To verify and design AND, OR, NOT and XOR gates using NAND gates.
6. To design a combinational logic system for a specified Truth Table.
7. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
8. To minimize a given logic circuit.
9. Half Adder, Full Adder and 4-bit binary Adder.
10. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
11. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
12. To build JK Master-slave flip-flop using Flip-Flop ICs
13. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
14. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
15. To design an astable multivibrator of given specifications using 555 Timer
16. To design a monostable multivibrator of given specifications using 555 Timer.

90

Essential/ Recommended Readings:

1. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
2. B.Sc. Practical Physics, Geeta Sanon, R. Chand & Co.
3. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
4. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
5. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
6. Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Sixth
Course Code: MJCC21	Course Type: DSC 21
Core: Compulsory	Course Title: Statistical Mechanics

Credits (in hours per week):3	3L-0T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand and distinguish between macrostates and microstates in statistical systems.
- Derive and interpret the Maxwell-Boltzmann distribution, classical entropy expressions, and related thermodynamic functions.
- Analyse the properties of thermal radiation and blackbody spectra using classical and quantum models.
- Apply quantum statistics to bosonic and fermionic systems and understand phenomena such as Bose-Einstein condensation and electron degeneracy pressure.
- Explore real-world applications including specific heats of solids, white dwarf stars, and photon/electron gases.

Course Outcomes:

After completing this course, students will be able to:

- Distinguish between macrostates and microstates and apply classical statistical concepts.
- Derive and use Maxwell-Boltzmann distribution and related thermodynamic quantities.
- Explain blackbody radiation and derive key radiation laws using classical and quantum theories.
- Apply Bose-Einstein statistics to systems like photon gas and Bose-Einstein condensates.
- Use Fermi-Dirac statistics to study electron gas and white dwarf stars.
- Analyse thermodynamic behavior of gases and radiation using different statistics models.

Unit	Topics	No.of Hours
I	Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.	15
II	Classical 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-Jean's Law. Ultraviolet Catastrophe. Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.	20

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III	Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.	10
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Essential/ Recommended Readings:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Sixth
Course Code: MJCC22	Course Type: DSC 22
Core: Compulsory	Course Title: Electromagnetic Theory
Credits (in hours per week): 3	3L-0T-3P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Formulate and apply Maxwell's equations in free space and media.
- Understand EM wave propagation in vacuum, dielectrics, conductors, and plasma.
- Analyze the interaction of EM waves at boundaries, including reflection, refraction, and polarization.
- Describe different states of polarization and propagation of EM waves in anisotropic media.
- Interpret the physical meaning of quantities like Poynting vector, wave impedance, and energy density.
- Use Maxwell's theory to explain optical effects like double refraction, total internal reflection, and Brewster's law.

Course Outcomes:

After completing this course, students will be able to:

- Apply Maxwell's equations to derive wave equations and understand energy flow in EM fields.
- Analyze EM wave propagation in vacuum, dielectrics, conductors, and plasma.

- Solve boundary-value problems involving reflection, refraction, and transmission of EM waves.
- Interpret polarization states and wave behavior in anisotropic and birefringent media.
- Use Poynting theorem to evaluate energy and momentum in electromagnetic systems.
- Explain practical applications of polarized light and wave interaction with materials.

Unit	Topics	No. of Hours
I	Maxwell Equations: Displacement Current. Maxwell's equations. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density.	12
II	EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth. EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence).	20
III	Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Analysis of Polarized Light.	13

Essential/ Recommended Readings:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
3. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
4. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
5. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
6. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Program: **B.Sc. (Honors/ Honors with Research)**

Subject: **Physics**

Year: Third	Semester: Sixth
Course Code: MJCC23	Course Type: DSC 23
Core: Compulsory	Course Title: Modelling and Statistical Analysis in Physics
Credits (in hours per week): 3	3L-0T-3P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the fundamentals of random variables, probability distributions, and statistical estimation.
- Analyze and compute properties of univariate and multivariate distributions including joint, marginal, and conditional forms.
- Use statistical tools such as mean, variance, moments, and covariance matrices, and apply eigen decomposition to understand bivariate random variables.
- Grasp the concept of estimation (point and interval) and understand the implications of the Central Limit Theorem.
- Understand the foundations of Bayesian probability.
- Apply Bayes' Theorem to compute posterior distributions from given priors and likelihoods.

Course Outcomes:

After completing this course, students will be able to:

- Distinguish between discrete and continuous probability distributions and compute associated statistics.
- Analyze multivariate distributions using covariance, correlation, and eigen decomposition.
- Apply estimation methods and understand the Central Limit Theorem.
- Use Bayes' theorem for probability updating and parameter inference.
- Model and interpret Bayesian linear and logistic regression outcomes.
- Perform Bayesian model comparison using conjugate priors and Bayes factors.

Unit	Topics	No.of Hours
I	Random variables: discrete and continuous Probability Distributions; Bivariate and multivariate random variables, Joint Distribution Functions (with examples from Binomial, Poisson and Normal); Mean, variance and moments of a random vector, covariance and correlation matrix, eigen decomposition of the covariance matrix (bivariate problem). Cumulative Distribution Function and Quantiles. Point Estimation, Interval estimation, Central Limit Theorem (statement, consequences and limitations).	18
II	Bayesian Statistics: Conditional probability and Bayes Theorem, Prior and Posterior probability distributions, examples of Bayes theorem in everyday life. Bayesian parameter estimation. Normal, Poisson and	17

	Binomial distributions, their conjugate priors and properties; Bayes factors and model selection.	
III	Bayesian Regression: Introduction to Bayesian Linear Regression. Bayesian logistic regression and its applications; Bayesian parameter estimation for regression models; Posterior distribution of model parameters and the posterior predictive distributions.	10

Essential/ Recommended Readings:

1. Schaum's Outline Series of Probability and Statistics, M. R. Spiegel, J. J. Schiler and R. A. Srinivasan, 2012, McGraw Hill Education
2. Schaum's Outline Series of Theory and Problems of Probability, Random Variables, and Random Processes, H. Hsu, 2019, McGraw Hill Education
3. Bayesian Logical Data Analysis for the Physical Sciences: A Comparative Approach with Mathematica Support, P. Gregory, 2010, Cambridge University Press
4. Linear Regression: An Introduction to Statistical Models, P. Martin, 2021, Sage Publications Ltd.
5. Data Analysis: A Bayesian Tutorial, D. S. Sivia and J. Skilling, 2006, Oxford University Press
6. Data Reduction and Error analysis for the Physical Sciences, P. R. Bevington and D. K. Robinson, 2002, McGraw-Hill Education.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Sixth
Course Code: MJCC24	Course Type: DSC 24
Core: Compulsory	Course Title: Experimental Laboratory-VI
Credits (in hours per week): 6	0L-0T-6P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Apply computational methods (C/C++/Scilab) to simulate and analyze models from statistical mechanics.
- Conduct optical and electromagnetic experiments, analyze wave properties, polarization, radiation laws, and constants.
- Understand and verify physical laws through visualization, programming, and hands-on experimentation.
- Connect theoretical models to real-world systems like blackbody radiation, specific heat, and EM wave interactions.

Course Outcomes:

After completing this lab course, students will be able to:

- Simulate classical and quantum statistical distributions using C/C++/Scilab.
- Compare Planck, Wien, and Rayleigh–Jeans laws graphically across temperatures.
- Model specific heat of solids using classical, Einstein, and Debye theories.
- Analyze Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein distributions.
- Verify optical laws (Malus, polarization, reflection/refraction) through experiments.
- Determine optical and thermal constants using polarimeter, Stefan's law, and diode characteristics.
- Conduct EM wave experiments using microwaves, ultrasonics, and dipole antennas.
- Integrate programming with physics for data analysis and visualization.
- Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

Unit	Topics	No.of Hours
I	1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature. 2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases 3. Plot Maxwell-Boltzmann distribution function versus temperature. 4. Plot Fermi-Dirac distribution function versus temperature. 5. Plot Bose-Einstein distribution function versus temperature.	30
II	1. To verify the law of Malus for plane polarized light. 2. To determine the specific rotation of sugar solution using Polarimeter. 3. To study dependence of radiation on angle for a simple Dipole antenna. 4. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating. 5. To study the reflection, refraction of microwaves 6. To study Polarization and double slit interference in microwaves. 7. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film. 8. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece. 9. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface. 10. To verify the Stefan's law of radiation and to determine Stefan's constant. 11. To determine the Boltzmann constant using V-I characteristics of PN	60

	junction diode.	
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Essential/ Recommended Readings:

1. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer
2. Scilab by example: M. Affouf, 2012.
3. Scilab Image Processing: L.M. Surhone. 2010, Betascript Publisher
4. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
6. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
7. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

11.2 Discipline Specific Elective (DSE) Courses

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics	
Year: Third	Semester: Fifth	
Course Code:-----	Course Type: DSE1	
Core: Elective	Course Title: Semiconductor Physics	
Credits (in hours per week):4	3L-1T-0P	
Internal Assessment: 25 Marks	External Assessment: 75 Marks	
Course Objectives: • Understand the fundamental electronic properties of semiconductors and their classifications. • Learn the quantum theory of semiconductors, band structures, and carrier dynamics. • Analyze the behaviour of p-n junctions, diodes, and transistors. • Study semiconductor transport phenomena, recombination processes, and optical transitions. • Appreciate the role of semiconductors in modern electronic, photonic, and optoelectronic devices.		
Course outcomes: By the end of this course, students will: • Be able to explain the physical principles governing semiconductor behaviour. • Analyse transport and recombination mechanisms in semiconductors. • Understand the design and function of basic semiconductor devices. • Explore the role of semiconductor physics in the development of modern technologies.		
Unit	Topics	No.of

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		Hours
I	Introduction to Semiconductors: Classification: intrinsic, extrinsic, elemental, and compound semiconductors; Band theory: energy bands, direct versus indirect bandgap; Fermi energy, effective mass of electrons and holes; Carrier concentration in intrinsic semiconductors: Fermi level at different temperatures; Doping: n-type and p-type semiconductors; Carrier concentration in extrinsic semiconductors. Carrier Transport and Dynamics: Drift current and mobility; Diffusion current and Einstein relation; Continuity equation; Carrier generation and recombination (SRH model); Lifetime, diffusion length, quasi-Fermi levels; Hall effect in semiconductors.	25
II	Semiconductor Junctions and Devices: p-n junction: depletion region, built-in potential, Ideal diode equation, I-V characteristics; Forward and reverse bias, breakdown mechanisms (Zener, avalanche); Junction capacitance: transition and diffusion; Zener diode and its application as voltage regulator; LED: working principle, spectral response; Photodiode and solar cell: structure and I-V characteristics; Introduction to Schottky and Tunnel diodes (qualitative).	18
III	Advanced Semiconductor Materials and Devices: Compound semiconductors: GaAs, InP Semiconductor heterojunctions and quantum wells (qualitative); Overview of MOSFETs and CMOS logic; Semiconductor nanostructures: quantum dots, nanowires (concepts only); Applications: LEDs, lasers, photodiodes, solar cells, and detectors.	17

Recommended Readings:

- 1.S.M. Sze & Kwok K. Ng – Physics of Semiconductor Devices
- 2.Donald A. Neamen – Semiconductor Physics and Devices
- 3.Ben G. Streetman & S. Banerjee – Solid State Electronic Devices
- 4.B.G. Streetman – Electronic Devices and Circuits
- 5.Kittel & Kroemer – Thermal Physics (Semiconductor chapters)

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: -----	Semester: Sixth
Course Code:-----	Course Type: DSE 2
Core: Elective	Course Title: Basic Plasma Physics
Credits (in hours per week): 4	3L-1T-0P

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Internal Assessment: 25 Marks

External Assessment: 75 Marks

Course Objectives:

- Introduce students to the basic properties and behavior of plasma.
- Understand how charged particles move in electric and magnetic fields.
- Explore where plasmas occur in nature and technology.
- Learn simple models to describe plasma behavior.
- Build interest in applications like fusion energy and space physics

Course outcomes:

By the end of this course, students will:

- Define plasma and describe its key properties.
- Understand basic motion of charged particles in fields.
- Describe how plasmas are found in space and technology.
- Use simple mathematical models to explain plasma behavior.
- Recognize basic plasma applications in real life.

Unit	Topics	No.of Hours
I	Fundamentals of Plasma: Concept of plasma as the fourth state of matter: basic definition and characteristics of plasma, such as ionization, charge neutrality, and the presence of free electrons and ions. Natural and man-made examples of plasma, including lightning, the sun, auroras, and neon signs. Key plasma parameters such as temperature, density, plasma frequency, and Debye length (conceptual). The classification of plasmas into hot/cold and collisional/collisionless along with an overview of their physical significance. Broad applications of plasma in fields like space science, electronics, and fusion energy.	20
II	Motion of Charged Particles in Electric and Magnetic Fields: Charged particles in a plasma response to electric and magnetic fields, the motion of particles in a uniform electric field, followed by their circular or helical paths in a magnetic field, introducing concepts like cyclotron motion and frequency. The combined effect of electric and magnetic fields through the $E \times B$ drift with examples from space physics such as Earth's magnetosphere. Magnetic confinement. Basic idea of particle collisions and their role in determining plasma conductivity and transport behavior.	20
III	Simple Plasma Models and Applications: Introduction to the idea of treating plasma as a fluid using simple models. The basic concepts of plasma oscillations, such as Langmuir waves, are presented without complex mathematics. A qualitative discussion of	20



wave propagation in plasmas—including electrostatic and electromagnetic waves. Concept of magnetic confinement in fusion reactors, including the idea of tokamaks and magnetic bottles. Applications of plasma in areas like fusion energy, space science, medicine, and industrial processes.

Recommended Readings:

- Francis F. Chen, *Introduction to Plasma Physics and Controlled Fusion*, Volume 1: Plasma Physics, 3rd Edition, Springer, 2016.
- S. Ichimaru, *Basic Principles of Plasma Physics: A Statistical Approach*, W. A. Benjamin, 1973.
- D.A. Gurnett and A. Bhattacharjee, *Introduction to Plasma Physics: With Space and Laboratory Applications*, Cambridge University Press, 2005.
- NASA and ESA Educational Resources – Introductory materials and animations related to space plasmas.
- <https://helioviewer.org> and <https://www.nasa.gov> (search for "space plasma")

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: -----	Semester: Fifth
Course Code:-----	Course Type: DSE 3
Core: Elective	Course Title: Particle and Detector Physics
Credits (in hours per week):4	3L-1T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks
Course Objectives: • This course introduces students to the concepts of particle physics along with the principles • Applications of detectors used in various fields of Physics, including Particle physics, Astrophysics, Nuclear physics and Medical physics. • The course covers the interaction of radiation with matter and theory of detectors, their design • Operation including electronic readout systems and signal processing.	
Course outcomes: By the end of this course, students will: • To understand the concepts of particles physics. • To understand the interaction of radiation with matter. • To understand the different types of detectors used in physics experiments. • To learn the design construction and operation of detectors.	

Unit	Topics	No. of Hours
I	Particle and accelerator Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness, concept of quark model, color quantum number and gluons. Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.	20
II	Introduction to detectors Definition of detectors, various types of detectors and their classification. Basic principle of detector operation and its modes of operation, pulse height spectra, various detector performance parameters: response time, energy resolution, fano factor, efficiency. Gas detectors: gas detector characteristics, Different types of detectors: gas filled ionization detectors, proportional counters, Geiger Mueller (GM) counters and Avalanche counters, gaseous multiplication detector.	20
III	Scintillation detectors: general characteristics, organic scintillators, intrinsic detection efficiency for various radiations. Photomultipliers: basic construction and operation, time response and resolution, noise, gain stability. Scintillation counter operation. Semiconductor detectors: Doped semiconductors, n-p semiconductor junction, depletion depth, detector characteristics of semiconductors. Types of semiconductor detectors with their principle of working: silicon diode detectors, Silicon strip detectors, silicon drift detectors, avalanche photodiodes, germanium detectors, other semiconductor materials.	20

Recommended Readings:

- Introduction to the Physics of Nuclei & Particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
- Radiation detection and measurement: G.F. Knoll, John Wiley & Sons, 2010.
- Techniques for Nuclear and Particle Physics experiments by W R Leo, Springer, 1994.
- Nuclear Radiation Detectors: S. S.Kapoor, V .S. Ramamurthy. 1st Edition, John Wiley & Sons.
- Physics and Engineering of Radiation Detection: S N Ahmed, Academic Press Elsevier, 2007.
- Semiconductor detectors: New developments, E. Gatti and P. Rehak. 2002. Springer.
- Principles of radiation interaction in matter and detection: C. Leroy and P.G. Rancoita. 3rd ed. World scientific.
- Radiation Detection for Nuclear Physics Methods and industrial applications: D. Jenkins.
- Advanced Nuclear Radiation Detectors Materials, processing, properties and applications: Ashok K Batra. IOP Publishing.
- Measurement and Detection of Radiation: Nicholas Tsoulfanidis et. al., Fourth Edition, T and F CRC.
- Principles of nuclear radiation detection: Geoffrey G. Eichholz, John W, Poston. CRC group of

publishers.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Sixth
Course Code:-----	Course Type: DSE4
Core: Elective	Course Title: Fundamentals of Magnetism
Credits (in hours per week): 4	3L-1T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the origin of magnetic moments in atoms and solids.
- Learn different types of magnetic materials and their classification.
- Explore classical and quantum theories of magnetism.
- Analyze magnetic susceptibility, hysteresis, and magnetic phase transitions.
- Understand technological applications of magnetic materials.

Course outcomes:

By the end of this course, students will:

- Describe and distinguish different types of magnetic materials.
- Explain classical and quantum theories of magnetism.
- Analyze temperature and field dependence of magnetic behavior.
- Apply the knowledge of magnetism in materials to technological and industrial applications.

Unit	Topics	No. of Hours
I	Magnetic Moments and Classification of Magnetic Materials: Origin of magnetic moment: orbital and spin contributions; Bohr magneton, gyromagnetic ratio; Magnetization, magnetic field intensity, magnetic susceptibility and permeability; Classification of magnetic materials: diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic materials; Examples and qualitative behavior of each type.	15

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II	Diamagnetism and Paramagnetism: Langevin theory of diamagnetism; Langevin theory of Paramagnetism; Curie's law and Curie-Weiss law; Temperature dependence of paramagnetic susceptibility; Quenching of orbital angular momentum in solids. Ferromagnetism and Magnetic Domains: Weiss theory of ferromagnetism; Spontaneous magnetization and exchange interaction; Hysteresis and hysteresis loop; Soft and hard magnetic materials; Applications: permanent magnets, magnetic memory, transformers.	25
III	Quantum and Advanced Concepts: Quantum theory of magnetism (Heisenberg model – qualitative); Spin waves and magnons (basic concepts); Magnetoresistance and Giant Magnetoresistance (GMR); Magnetic resonance: NMR and ESR basics; Magnetism in nanostructures (overview).	20

Recommended Readings:

1. B.D. Cullity and C.D. Graham – Introduction to Magnetic Materials
2. Kittel – Introduction to Solid State Physics
3. C. Kittel – Quantum Theory of Solids
4. S.O. Pillai – Solid State Physics
5. J.M.D. Coey – Magnetism and Magnetic Materials

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester: Sixth
Course Code:-----	Course Type: DSE5
Core: Elective	Course Title: Electrical Materials
Credits (in hours per week): 4	3L-1T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks
Course Objectives: • Understand the classification and fundamental properties of electrical materials. • Study conduction mechanisms in metals, semiconductors, and insulators. • Analyze dielectric, piezoelectric, and ferroelectric materials and their applications. • Understand materials for capacitors, resistors, conductors, and insulators. • Explore emerging trends in electronic and optoelectronic materials.	
Course outcomes:	

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By the end of this course, students will:

- Identify and classify different types of electrical materials.
- Explain the behavior of conducting, semiconducting, and dielectric materials.
- Apply material knowledge in designing electrical and electronic components.
- Explore modern applications of advanced electrical materials in emerging technologies.

Unit	Topics	No. of Hours
I	Conducting Materials: Electrical conductivity and Ohm's law; Electron theory of metals and limitations; Classification of conductors, resistors, and insulators; Effect of temperature on conductivity; Superconductivity: basic properties and applications. Semiconducting Materials: Band theory and energy gap; Intrinsic and extrinsic semiconductors; Carrier concentration and mobility; p-n junction characteristics; Applications of semiconductor materials in electronics.	25
II	Dielectric and Insulating Materials: Polarization mechanisms; Dielectric constant and loss; Ferroelectric, piezoelectric, and pyroelectric materials; Breakdown in dielectrics and insulating strength; Materials for capacitors and insulators.	15
III	Magnetic and Resistive Materials: Magnetic permeability and susceptibility, Soft and hard magnetic materials; Core materials for transformers and inductors; Resistive materials and temperature coefficient of resistance; Thermistors and varistors. Emerging Electrical Materials: Materials for optoelectronics (LEDs, photodetectors); Transparent conducting oxides; Nanomaterials and carbon-based conductors (graphene, CNTs); Conducting polymers and smart materials; Green materials and sustainability in electrical systems.	20

Recommended Readings:

1. C. S. Indulkar – Electrical Engineering Materials
2. R.K. Rajput – Electrical and Electronic Materials
3. S.P. Seth – Electrical Engineering Materials
4. Dekker – Electrical Engineering Materials
5. Tareev – Physics of Dielectric Materials

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: -----	Semester: Sixth

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Course Code:-----	Course Type: DSE 6
Core: Elective	Course Title: Fundamentals of Optoelectronics
Credits (in hours per week): 4	3L-1T-0P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Introduce students to the fundamental principles of optoelectronics.
- Understand the interaction of light with semiconductor materials.
- Explore basic optoelectronic devices such as LEDs, photodetectors, and lasers.
- Provide foundational knowledge for applications in communication, imaging, and energy devices.

Course outcomes:

By the end of this course, students will:

- Describe the nature of light and light-matter interaction principles.
- Explain semiconductor properties relevant to optoelectronic processes.
- Understand working principles of basic optoelectronic devices.
- Analyze characteristics and performance of LEDs, lasers, and detectors.
- Apply fundamental concepts to optical communication and sensing technologies

Unit	Topics	No. of Hours
I	Fundamentals of Light and Semiconductor Physics: Fundamentals of Light: Introduction of basic properties of light, including its wave-particle duality and photon energy concepts; Interactions of light with matter, such as absorption, emission (spontaneous and stimulated), and the concept of Einstein coefficients. Semiconductor physics: an overview of band theory, types of semiconductors, and carrier dynamics including drift and diffusion. Emphasis is placed on PN junctions, energy band diagrams, depletion regions, and current-voltage characteristics.	20
II	Light-Emitting and Light-Sensing Devices: Light-emitting diodes (LEDs), detailing their working principles, materials, efficiency, and spectral characteristics. Concepts of population inversion, optical gain, threshold condition, and feedback mechanisms, along with types of semiconductor lasers such as Fabry-Pérot and DFB. Photodiodes, including PIN and avalanche types, phototransistors.	20
III	Optical Communication and Emerging Applications: Optical fiber fundamentals, including total internal reflection, numerical	20

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aperture, and types of optical fibers. Dispersion and attenuation in fibers and architecture of a basic optical communication system. Optoelectronic components for integration into communication systems, including modulation and signal processing. Introduction to optoelectronic sensors and their applications in biomedical, industrial, and environment.

Recommended Readings:

- S.O. Kasap, Optoelectronics and Photonics: Principles and Practices
- P. Bhattacharya, Semiconductor Optoelectronic Devices
- Wilson & Hawkes, Optoelectronics: An Introduction
- NPTEL Lectures and IEEE Photonics Publications (for further reading)

11.3 Generic Elective Course (GEC)

Program: B.Sc. (Honors/ Honors with Research)	Subject: Mathematics
Year: First	Semester: First
Course Code:-----	Course Type: GEC-I
Generic Elective Course: Compulsory	Course Title: Differential Calculus
Credits (in hours per week): 4	3L-1T-0P
Internal Assessment : ----	External Assessment : -----
Course Objectives: The primary objective of this course is to introduce the basic tools of calculus, also known as “science of variation”, which provides a way of viewing and analyzing the real-world.	
Course Objectives: The primary objective of this course is to introduce the basic tools of calculus, also known as “science of variation”, which provides a way of viewing and analyzing the real-world.	
Course outcomes: • Understand the concept of limits, continuity and uniform continuity, Indeterminate form of functions • Understand continuity and differentiability in terms of limits and obtain successive differentiation and expansion of functions. Derivation and applications of Rolle’s theorem and mean value theorem. • Apply the concepts of asymptotes, inflexion points, position and nature of double points in tracing of Cartesian curves as well as parametric and polar curves.	

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- Learn to expand the function using Taylor's series. Familiar with the concepts of limit, continuity and partial derivatives of functions of two variables.
- Understand the use of derivatives to explore the behaviour of a given function in locating and classifying its extrema. Learn to find tangents, normals and radius of curvature, envelop and evolute.

Unit	Topics	No. of Hours
I	Limits and Continuity Limits of functions ($\varepsilon - \delta$ and sequential approach), Uniqueness theorem on limits, Algebra of limits, Indeterminate forms, L' Hôpital's rule, Continuous functions and classification of discontinuities, Uniform continuity, Basic Properties of continuous and uniform continuous functions	15
II	Differentiability and Mean Value Theorems Differentiability of a real-valued function, Chain rule of differentiability, Algebra of differentiable functions, Rolle's theorem, Mean-value theorems and their applications, Intermediate value theorem for derivatives, Maxima and Minima for a single variable function on $\mathbb{R}$.	15
III	Successive Differentiation, Taylor's Theorem and Tracing of Plane Curves Higher order derivatives and calculation of the n th derivative, Leibnitz's theorem; Taylor's theorem, Taylor's series expansions of $\sin x$, $\cos x$, e^x , $\log x$, and a^x , Concavity and inflexion points; Singular points, Asymptotes, Tracing graphs of rational functions.	15
IV	Tangents and Normals, Curvature Tangents and normals, Cartesian and polar subtangent and subnormal, Intercepts, Length of the tangent and normal, Lengths of the perpendicular from the pole on tangent, Pedal equation of the curve, Curvature, Cartesian, Polar and parametric formulae for radius of curvature, Envelopes and Evolute.	15

Recommended Readings:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Bartle, Robert G., & Sherbert, Donald R. (2011). *Introduction to Real Analysis* (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
3. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
4. Ross, Kenneth A. (2013). *Elementary Analysis: The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.
5. G.B. Thomas and R.L. Finney (2007) : *Calculus*, Pearson Education
6. Shanti Narayan (2005): *Differential Calculus*, S.Chand, New Delhi
7. Win Kreyszig, (2011): *Advanced Engineering Mathematics*, John Wiley & Sons.
8. Mukesh Kumar, A. P. Singh and Ashok Kumar (2018) *Differential Calculus Medtech*
9. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Mathematics
Year: First	Semester: Second
Course Code:-----	Course Type: GEC-II
Generic Elective Course: Compulsory	Course Title: Differential Equations
Credits (in hours per week):4	3L-1T-0P
Internal Assessment : -----	External Assessment : ----

Course Objectives:

- Analyze the system of ordinary differential equations.
- Evaluate properties of stability for linear and non-linear systems

Course Outcomes:

- Find general solutions to homogeneous and non-homogeneous differential equations.
- Solve ordinary differential equations under appropriate assumptions.

Unit	Topics	No.of Hours
I	Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations.	15
II	First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation of order greater than one with constant coefficients, Cauchy- Euler form.	15
III	Second and Higher Order Differential Equations General solution of homogeneous equation of second order, Principle of superposition for a homogeneous equation; Wronskian, its properties and applications. Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, Method of undetermined coefficients, Method of variation of parameters, Applications of second order differential equations to mechanical vibrations.	15
IV	Bessel and Legendre functions and their properties, Orthogonal properties, recurrence Formula and generating Function.	15

Essential/ Recommended Readings:

1. Ross, S.L. "*Differential equations*". Wiley Publication, 3rd edition, 2014.
2. Tyn Myint U, Ordinary differential equations, Elsevier North-Holland, 1978
3. Simmons G.F. "Ordinary Differential Equations with Applications". TMH, 2003.

4. Joshi, M.C. "Ordinary Differential Equations (Modern Perspective)". Narosa Publishing House, 2006.
5. Wolfgang Walter, Ordinary different Equation, 1998
6. Suggested digital platform: NPTEL/SWAYAM/MOOCs
7. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

Semester III

GE 3: Chemistry of Food Nutrients

Semester IV

GE 4: Chemistry and Environment

11.4 Skill Enhancement Courses (SECs)

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: First	Semester: Second
Course Code:-----	Course Type: SEC 1
Skill Enhancement Courses	Course Title: MATLAB for Beginners
Credits (in hours per week): 2	1L-0T-1P
Internal Assessment : -----	External Assessment : ----

Course Objectives:

- To provide learners with a comprehensive understanding of MATLAB, a high-level language and interactive environment.
- To enhance their skills in MATLAB.
- Lays the foundation, teaching participants how to handle matrices, perform various matrix operations, solve equations, create user-defined functions,
- To visualize data through plotting.

Course Outcomes:

- Learners will become familiar with MATLAB's utility commands.
- Make learners to understand to create matrix in MATLAB
- Make learners to perform matrix operations, solve linear equations with MATLAB
- Make students capable to apply their knowledge MATLAB skills effectively.
- To gain practical skills to solve real-world problems, making them valuable across various engineering and scientific fields.

Unit	Topics	No.of Hours
I	Basic MATLAB: Introduction, Basic features, MATLAB Session, creating MATLAB variables, making corrections, controlling hierarchy of operation & appearance of floating-point number, managing workspace, entering multiple statement per line, getting help	15

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II	MATLAB Programming and Practice: Mathematical functions with examples, basic plotting (creating simple plots, adding titles, axis labels and annotations, multiple data plots in one plot, etc.), Matrix formulation (entering vector, entering matrix, colon operator, line spacing, creating sub matrix, deleting row or column, transpose, dimensions)	15
Essential/ Recommended Readings: 1. Introduction to MATLAB by Rudra Pratap 2. https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf 3. https://www.mathworks.com/academia/students/resources.html 4. https://in.mathworks.com/help/matlab/getting-started-with-matlab.html 5. https://researchcomputing.princeton.edu/external-online-resources/matlab		

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics	
Year: First	Semester: Second	
Course Code:-----	Course Type: SEC 2	
Skill Enhancement Courses	Course Title: Introduction to Physics of Devices	
Credits (in hours per week):2	1L-0T-1P	
Internal Assessment : -----	External Assessment : ----	
Course Objectives: • This paper is based on basic electrical and electronics instruments which cover the devices such as diode, photodiode, solar cell, electromagnet etc. • This course also covers working of ideal and constant current source; ideal and constant voltage source; and dependent and independent current and voltage source.		
Course Outcomes: • Develop the basic knowledge of semiconductor device physics and electronic circuits along with the practical technological considerations and applications. • Understand the operation of devices such as multimeter, current source and voltage source etc.		
Unit	Topics	No.of Hours
I	Measurement of Voltage and current: Working of ideal and constant current source, Ideal and constant voltage source, Dependent and independent current and voltage source. Working of moving coil galvanometer, its use as Voltmeter and Ammeter, Use of digital multimeter for measurement of R, L, C, ac and dc voltage and current, type of transistor etc.	15

	Two layered devices: Working principle and I-V characteristics of p-n junction diode, Zener diode, LED, photo-diode and solar cell. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of ripple factor and rectification efficiency, basic idea about capacitor filter, Working of regulator IC 7805.	
II	1. To examine the performance of a constant current source and constant voltage source. 2. Making voltmeter and ammeter using galvanometer. 3. I-V characteristics of LED 4. Zener diode as voltage regulator. 5. Measurement of efficiency and fill factor of solar cell. 6. Measurement of photocurrent using photodiode with variation in intensity of incident light. 7. To design a regulated power supply (adapter) using bridge rectifier and regulator IC (7805). 8. Design an electrical switch board with fuse and power indicator. 9. The basic idea of First Aid for Electrical Emergencies.	15

References (For Theory):

Essential Readings:

1. Physics of Semiconductor Devices, S. M. Sze and K. K. Ng, 3rd Edition 2008, John Wiley and Sons
2. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
3. H. S. Kalsi, Electronic Instrumentation, TMH (2006).

References (For Laboratory Work):

1. PC based instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India
2. Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino, M. A. Miller, 1994, McGraw Hill
3. Electrical Wiring Components and Accessories and First Aid for Electrical Emergencies kvdl103.pdf (ncert.nic.in)

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: First	Semester: Second
Course Code:-----	Course Type: SEC 3
Skill Enhancement Courses	Course Title: Introductory Vacuum Science & Technology
Credits (in hours per week):2	1L-0T-1P
Internal Assessment : -----	External Assessment : ----

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Course Objectives:

- To provide learners with a comprehensive understanding of vacuum science & technology.
- To enhance their skills to handle the working of different vacuum pump and gauges.
- To understand the basic requirement of vacuum in solid-state devices.
- To provide experimental capability to working with vacuum systems.

Course outcomes:

- Learners will become familiar to low pressure physics.
- Make learners to understand to produce vacuum using different vacuum pumps.
- Make learners to understand to measure vacuum using different vacuum gauges.
- Make learners to perform experiments using vacuum system.
- To gain practical skills to handle vacuum system integrated in different scientific instruments like SEM, TEM and Thin film deposition systems.

Unit	Topics	No. of Hours
I	Vacuum Science & Technology Definition of vacuum, Units of vacuum & their conversion, Need of vacuum, Partial pressure of atmospheric gases, Important areas of applications, Gas kinetics, Gas flow, Mean free path, Viscous, Molecular and transition flow regimes, Ranges/classification of vacuum, Vacuum technology- Vacuum conductance, vacuum impedance, pumping speed, throughput & pump down time. Construction and working principle of Rotary pump, Diffusion pump, Turbo molecular pump, Measurements of vacuum, Mechanical gauges, Gas property gauges, Ionization Gauges, working principle and construction Pirani gauge and Penning gauge.	15
II	Experiment and practice of production & measurements of vacuum: Production of vacuum initially from atmospheric pressure to 10^{-3} torr using Rotary pump. Measurement of vacuum (atmospheric pressure to 10^{-3} torr) using Pirani gauge. Production of vacuum from 10^{-3} torr to 10^{-7} torr using Turbo Molecular Pump. Measurement of vacuum (10^{-3} torr to 10^{-7} torr) using Pirani gauge. Design and perform experiment to calculate pumping speed of a vacuum pump.	15

Recommended Readings:

1. Vacuum Physics and Techniques: 6 (Physics & Its Applications) by T.A. Delchar, **Chapman and Hall; 1994th edition (30 September 1993).**
2. Foundations of Vacuum Science and Technology (Foundations of Vacuum Science & Technology S) edited by James M. Lafferty, **Wiley-Interscience; 1st edition (17 February 1998)**
3. Vacuum Science, Technology and Applications by Pramod K. Naik, CRC Press, 1st Edition 2018.

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: First	Semester: Second

Course Code:-----	Course Type: SEC 4
Skill Enhancement Courses	Course Title: Fundamentals of Electronic Instrumentation
Credits (in hours per week):2	1L-0T-1P
Internal Assessment : -----	External Assessment : ----

Course Objectives:

- To provide learners with a comprehensive understanding and identify the usage of ground level of electronic instruments.
- To develop their skills for the implementation of University or Pharmaceutical labs.
- To handle instruments, operations, and purposefully utilization.
- To visualize and analyze data with the help of Instruments.

Course Outcomes:

- After successful completion of this course, students will be able to identify various facilities required to set up a basic Instrumentation Laboratory.
- They can acquire a critical knowledge of various electronic instruments used in the Laboratory.
- Demonstrate skills of instruments, such as CRO, Function generator, Multimeter, through hands-on-experience.
- Understand the Principle and operation of different display devices used in the display systems and different transducers.
- Comprehend the applications of various biomedical instruments in daily lifelike B.P. meter, ECG, and so on.

Unit	Topics	No. of Hours
I	Introduction to Instruments: Introduction to analog and digital instruments, DC/AC voltmeter and ammeter, Digital multimeters, Sensors, Basic ideas and block diagram of function generator, Introduction to cathode ray oscilloscope (CRO), Cathode ray tube (CRT), Electron gun assembly and Screen. Use of CRO for the measurement of voltage (AC and DC), frequency, phase difference.	15
II	Transducers and optical fiber communication: Classification and selection of transducers, Resistive, capacitive & inductive transducers, Resistive and capacitive touch screen transducer used in mobiles, Piezoelectric transducer, Photo transducer, Digital transducer, Fibre optic general system: development, advantages, disadvantages, Applications of optical fiber for communication.	15

Essential/ Recommended Readings:

1. Electronic Instrumentation by H.S.Kalsi , TMH Publishers
2. Electronic Measurements and Instrumentation by Kishor, K Lal, Pearson, NewDelhi
3. Hand Book of Electronic Instrument by Clyde F. Coombs, McGraw Hill

4. Electronic Instruments and Measurement Techniques by Cooper, W.D.
5. Introduction to Biomedical Instrumentation by Mandeep Singh, PHI Learning.
6. Biomedical Instrumentation and Measurements by Leslie Cromwell, Prentice Hall India.

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: First	Semester: Second
Course Code:-----	Course Type: SEC 5
Skill Enhancement Courses	Course Title: Learning Gaussian
Credits (in hours per week):2	1L-0T-1P
Internal Assessment : -----	External Assessment : ----

Course Objectives:

- To provide learners with a comprehensive understanding of GAUSS VIEW and GAUSSIAN 09 software, a high-level computational chemistry modelling of systems and virtual environment to study simulation.
- To enhance their research in computational physics and chemistry module.
- Lays the foundation, optimizing computational settings for improved accuracy, includes visualizing molecular structures, analyzing electronic properties, correlating computational results with experimental observations.
- To visualize the process of chemical reaction.

Course Outcomes:

- Learners will become familiar in performing electronic structure calculations.
- Make learners to understand about various quantum chemical methods like Hartree-Fock theory, and density functional theory (DFT).
- Make learners to predict a wide range of molecular properties including electronic energies, geometries, vibrational frequencies, molecular orbitals, electronic densities, and spectroscopic properties like UV-Vis, IR, and NMR.
- Make students capable to investigate molecular structures, analyze bonding patterns, and understand chemical reactivity by studying reaction pathways, transition states, and potential energy surfaces.
- To gain practical skills using Gaussian 09 encompass both theoretical understanding of quantum chemistry principles and practical skills in computational chemistry.

Unit	Topics	No. of Hours
I	Introduction to Computational physics and chemistry, Overview of computational physics, chemistry and its applications, Introduction to Hartree-Fock theory and density functional theory (DFT) methods, Overview of Gauss View and Gaussian 09 software and its capabilities, Installation and performing basic calculation.	15

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II	Advanced Gaussian Calculations, Frequency calculations and vibrational analysis, Calculation of electronic properties (dipole moment, polarizability, etc.), Transition state searches and reaction path optimization, Understanding Output Files, Interpretation of Gaussian output files, Extracting and analyzing key results, Visualization of molecular structures and properties, Solvent Effects and Reaction Mechanisms, Introduction to solvation models in Gaussian, Calculating solvent effects using continuum solvation models, Exploring reaction mechanisms with Gaussian, Time-Dependent Density Functional Theory (TD-DFT), Introduction to TD-DFT and electronic excitations, Calculating UV-Vis spectra and excited state properties, Understanding excited state optimizations.	15
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Essential/ Recommended Readings:

- "Molecular Modeling Basics" by Jan H. Jensen.
- www.confex.co.jp/prod_gaussian_new.html
- <https://barrett-group.mcgill.ca/tutorials/Gaussian%20tutorial.pdf>

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
Year: Third	Semester:
Course Code:-----	Course Type: SEC 6
Core: Elective	Course Title: Energy Storage Devices
Credits (in hours per week): 2	1L-0T-1P
Internal Assessment: 25 Marks	External Assessment: 75 Marks
Course Objectives: • Introduce fundamental concepts of energy storage mechanisms. • Explain the working principles and classification of batteries, capacitors, and supercapacitors. • Familiarize students with materials used in energy storage devices and their electrochemical properties. • Discuss the design, performance parameters, and applications of various energy storage systems. • Enable students to explore recent advancements and sustainability aspects in energy storage technologies.	
Course outcomes: • Understand the need and types of energy storage systems. • Explain the working and components of various batteries and supercapacitors.	

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- Compare energy storage technologies based on performance metrics.
- Evaluate materials and sustainability concerns in energy storage.
- Apply knowledge to practical energy storage applications and basic testing techniques.

Unit	Topics	No.of Hours
I	Introduction to Energy Storage, Supercapacitors, Ultracapacitors, and Storage technologies Need for energy storage, overview of global energy scenario; Types of energy storage systems: mechanical, thermal, electrical, electrochemical; Classification: primary and secondary energy storage. Basics of electrochemical cells: electrodes, electrolytes, redox reactions; Working principles of batteries: primary and secondary cells; Lead-acid, nickel-cadmium, nickel-metal hydride, lithium-ion batteries: construction, working and applications. Principle of charge storage: electric double layer and pseudocapacitance; Materials for supercapacitors: carbon-based, conducting polymers, metal oxides; Comparison with batteries: energy and power density. Solid-state batteries, redox flow batteries, sodium-ion batteries; Hydrogen storage systems and fuel cells: basics and prospects; Hybrid energy storage systems.	15
II	Suggested Practical Activities • Measurement of internal resistance and efficiency of batteries. • Characterization of a commercial supercapacitor. • Preparation of simple coin cell and performance testing. • Charge-discharge cycle testing using battery testing setup. • Demonstration of fuel cell operation and hydrogen generation.	15

Recommended Readings:

- B.E. Conway – Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications
- D. Linden and T.B. Reddy – Handbook of Batteries
- A. Yoshino – Lithium-ion Batteries: Science and Technologies
- P.G. Bruce – Solid State Electrochemistry
- Recent review articles from journals like Energy Storage Materials, Journal of Power Sources, etc.

Program: B.Sc. (Honors/ Honors with Research)	Subject: Physics
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Year: Third	Semester:
Course Code:-----	Course Type: SEC 7
Core: Elective	Course Title: Error Analysis and Data Reduction
Credits (in hours per week):2	1L-0T-1P
Internal Assessment: 25 Marks	External Assessment: 75 Marks

Course Objectives:

- Understand the nature, origin, and types of errors in experimental physics.
- Gain competency in handling and analyzing experimental data quantitatively.
- Learn techniques for error propagation and statistical treatment of uncertainties.
- Apply data reduction techniques to improve the reliability of experimental results.
- Develop practical skills in presenting and interpreting scientific data.

Course outcomes:

- Distinguish between systematic and random errors in experimental data.
- Apply appropriate statistical tools to estimate and reduce measurement errors.
- Propagate uncertainties through mathematical functions using standard methods.
- Interpret data using graphical and numerical techniques.
- Report experimental results with appropriate error estimates and confidence levels.

Unit	Topics	No. of Hours
I	Introduction to Measurement and Errors: Significance of measurements in physics; Classification of errors: gross, systematic, and random; Sources of errors in experiments; Accuracy, precision, sensitivity, and resolution; Absolute and relative errors, Significant figures and rules of rounding off Statistical Treatment of Data: Arithmetic mean, median, and mode; Measures of dispersion: range, mean deviation, standard deviation, and variance; Standard error of the mean; Gaussian distribution: properties and applications; Confidence intervals and level of significance; Chi-square test for goodness of fit	18
II	Error Propagation and Data Reduction Techniques: Error propagation in functions (sum/difference, product/quotient, powers, and trigonometric functions); Least squares fitting: linear and nonlinear cases; Data smoothing and interpolation (linear and polynomial); Introduction to correlation and regression analysis; Graphical representation of data with error bars; Use of spreadsheets and basic Python/Matlab tools for error analysis and data visualization	12

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Recommended Readings:

- John R. Taylor, An Introduction to Error Analysis, University Science Books
- Philip R. Bevington and D.K. Robinson, Data Reduction and Error Analysis for the Physical Sciences, McGraw-Hill
- G. L. Squires, Practical Physics, Cambridge University Press
- A. G. Hughes and R. B. Thomas, Elementary Theory and Application of Statistical Methods, John Wiley
- B. L. Welch and S. J. Kalas, Statistics for the Physical Sciences, Springer

11.5 Value Addition Courses (VAC)

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics	
Year: -----	Semester: Even	
Course Code:-----	Course Type: VAC 1	
Skill Enhancement Courses	Course Title:	
Credits (in hours per week):2	2L-0T-0P	
Internal Assessment : -----	External Assessment : ----	
Course Objectives: • To explain the concept of various forms of Non-renewable and renewable Energy. • Familiarize about the utilization of various renewable energy sources technologies for thermal and electric power need with environmental merits, cost economics compared to fossil fuels. • The utilization of renewable energy sources for both domestics and industrial applications. At the end of the course, the students are expected to identify the new methodologies/technologies for effective utilization of renewable energy.		
Course Outcomes: After completing this course, student will be able to • Understand the commercial energy and renewable energy sources. • Analyse the solar energy systems. • Know the working principle of various energy systems: hydro power, wind energy, geothermal, ocean and tidal. • Capability to do basic design of renewable energy systems. • Know the hydrogen energy system. • Upon completion of this course, the students can able to identify the new. methodologies / technologies for effective utilization of renewable energy sources.		
Unit	Topics	No.of Hours

I	Fossil fuels and alternative sources of energy: Introduction, utilization, advantages, and limitations of fossil fuels. Requirement and types of alternative sources of energy. Conventional and non-conventional sources. Renewable energy sources, sustainable development, and social implications. Global and national energy scenarios of renewable energy. Solar radiation and thermal collectors: Solar radiation and its measurement. Types of thermal collectors-Flat plate and concentrating collectors. Solar energy storage and applications: Solar water heating, cooling techniques, solar distillation, drying, solar ponds. Thermal energy storage systems and solar water pumping. Principle of solar cell, photovoltaic system for electric power generation, advantages, disadvantages and applications of solar photovoltaic systems. Battery storage & solar testing.	15
II	Wind Energy: Wind characteristics and site selection. Principle and basic components of wind energy conversion system (WECS), horizontal and vertical axis windmills, performance characteristics. India's wind energy potential, distribution across the world. Factors affecting wind energy. Advantages and challenges associated with wind power systems. Introduction to solar-wind hybrid energy system. Hydrogen as green energy: Introduction to hydrogen energy, operating principles and types of fuel cells. Brief description of hydrogen production, storage, transportation and applications. Benefits and problems associated with hydrogen energy. Fuel cells testing.	15

Essential/ Recommended Readings:

1. Kothari P, Singal K C and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd., New Delhi, 2008.
2. Sukhatme S P and Nayak J K, "Solar Energy – Principles of Thermal Collection and Storage", Tata McGraw Hill, 2008.
3. Abbasi SA A and Naseema Abbasi, "Renewable Energy Sources and their Environmental Impact", PHI Pvt. Ltd., 2001.
4. Frank Kreith and Yogi Goswami D, "Handbook of Energy Efficiency and Renewable Energy", CRC Press, 2007
5. Bent Sorensen, "Renewable Energy", Academic Press, 2004
7. Boyle G, "Renewable energy: Power for a sustainable future", Oxford University Press, 2004.
8. Renewable Energy Sources I Twidell & Weir / Taylor and Francis / 2nd Special Indian Edition.
9. Non- conventional Energy Sources / G.D. Rai/ Dhanpat Rai and Sons.
10. Renewable Energy Resources I Tiwari and Ghosal I Narosa.
11. Energy Resources Utilization and Technologies /Anjaneyulu & Francis/ BS Publications/2012.
12. Principles of Solar Energy / Frank Kreith & John F Kreider / Hemisphere Publications.
13. Non-Conventional Energy Systems / K Mittal / Wheeler.
14. Renewable Energy Technologies I Ramesh & Kumar / Narosa.
15. Webstor.srmist.edu.in
16. Alternate_energy_ebook.pdf
17. www.vssut.ac.in>lecture>pdf

3/2

Program: B.Sc. (Honours/ Honours with Research)	Subject: Physics
Year: -----	Semester: Even
Course Code:-----	Course Type: VAC 2
Value Added Course	Course Title: Digital Literacy
Credits (in hours per week): 2	2L-0T-0P
Internal Assessment : -----	External Assessment : ----

Course Objectives:

- Equip Physics students with essential digital skills for academic, research, and scientific communication.
- Introduce tools for data handling, visualization, documentation, and collaboration.
- Foster awareness of digital ethics, cyber security, and responsible online behavior.
- Enable students to effectively utilize digital resources for literature review, data analysis, and project work.

Course Outcomes:

After completing this course, student will be able to

- Use productivity tools (word processors, spreadsheets, and presentations) efficiently for academic and scientific documentation.
- Navigate scientific databases, perform literature searches, and manage references using citation tools.
- Create basic scientific visualizations and perform simple data analysis using tools like Excel or Python.
- Collaborate using cloud-based platforms and tools (e.g., Google Workspace, GitHub).
- Understand cyber safety, data privacy, and ethical use of digital content and resources.

Unit	Topics	No. of Hours
I	Digital Productivity & Communication Tools: Introduction to digital literacy and its role in scientific learning, Overview of operating systems (Windows/Linux basics), Word processing: formatting scientific documents in MS Word / LaTeX, Spreadsheet essentials for data entry, formulae, and basic graph plotting, Effective presentations using MS	15

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